國立臺灣大學理學院氣候變遷與永續發展國際學位學程

碩士論文

International Degree Program in Climate Change and Sustainable Development

College of Science

National Taiwan University

Master's Thesis

以社會網絡觀點探查臺灣中小學永續發展教育

Exploring Education for Sustainable Development Implementation in Taiwan's Primary and Secondary Schools through a Social Network Perspective

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中華民國 114 年 7 月

July 2025

doi:10.6342/NTU202501048

誌謝

經歷無數次的摸索與修改，這篇碩士論文終於完成。它不只是我對永續發展教育（ESD）熱忱的展現，更是來自於研究旅途中許多支持與鼓勵的交織與成就。有太多感謝的話語想獻給在這段旅程中出力的每一位。

首先，感謝師長的指導與陪伴，讓我培養研究的熱忱，也逐步鍛鍊出獨立研究能力。特別感謝我的指導教授周老師，從問題意識的釐清、研究設計的細節，到面對困境的堅持與突破，每一次討論都令我收穫良多——我深深珍惜這些對話，不只是因為它們讓我更明白自身的不足，也總能帶來新的視角與方向，成為我繼續前進的動力。感謝莊老師願意共同指導這份跨領域的研究，持續督促我強化研究邏輯與溝通表達。感謝何老師擔任我的口試委員，從您的提點中我獲得了珍貴的教育現場洞察，也深受您長期實踐的精神所感動。感謝廖老師在 IPCS 課程與研究方法訓練中的悉心指導，您總是仔細閱讀學生的寫作，給予明確且深入的回饋，幫助我釐清研究本質。

因為春季入學的緣故，我與身邊同儕的研究步調不同。當我還在醞釀想法時，少了能同步討論的同伴；而當他人剛開始摸索研究時，我卻已經得加快腳步。但幸運的是，因為路途上有珍貴的夥伴相助，我能堅定走完這條路。謝謝姐姐與怡璉，在初期陪我聊研究概念，讓我有了啟動碩論的勇氣。謝謝 Iris 與 Lizzie 願意被我拉進論文進度回報小組，像燈塔一般照亮我穩定產出的路途。謝謝臺美生態學校綠旗工作坊的姊姊們，慷慨接納我參與其中進行田野調查，當時累積的經歷與人脈成為研究寶貴的資源。謝謝森永學堂的大家，讓我在實踐中更深刻體會永續發展教育的精神。謝謝張馨予、夏翊智、妮臻在我口試練習上的協助，儘管我們所專注的領域已大不相同，依然給予我實用且深刻的建議與演練機會。謝謝總是比我還相信我能做到的周芷安與蕎包，每一次訊息與相聚都充滿溫暖與支持。

謝謝研究室 406 的大家，是你們作為我碩論旅程重要的研究夥伴與朋友，見證了我從研究新手村出發、開始蒐集資料，到口試的衝刺階段與後續。謝謝誠哲的協助，讓我得以從零開始進行這份教育主題的質性研究；謝謝玫宜籌組了持續回報進度與真誠討論的讀書會；謝謝婉瑜讓壓力之下依然有歡笑與滿滿的儀式感；謝謝余衡與怡君的精妙提問，我才能更深入反思自己的研究問題、方法與討論。

doi:10.6342/NTU202501048

還有始終陪伴在側的阿澐，謝謝你從我最初 IPCS 推甄開始，到論文口試、甚至在之後的國際研討會階段，總能接住我、推我一把。每當喪失信心時，都是你溫柔地陪我釐清想法、重新振作，讓我能盡己所能地完成每一階段。

而最深的感謝獻給我堅實的後盾——家人。即使你們未必理解我所研究的內容，卻總是願意花時間傾聽、討論，在我靈感枯竭時陪我一起腦力激盪。因為聽了太多關於我研究的內容，你們甚至開始會使用「永續發展教育」、ESD 造句，這樣的對話與陪伴，我想是成就自己持續練習產出自己觀點與聲音的關鍵。

最後，我想深深地誠摯感謝每一位參與我田野調查與訪談的教育工作者。感謝所有願意無私分享的教授、校長、老師與來自不同部門的專案負責人——你們的經驗不只是寶貴的研究資料，更是讓我深受感動的教育信念。每一次的訪談交流，都是我更想完成這份研究的原動力。

我始終相信，只要永續發展教育仍持續進行，我的研究就還未真正完成。但因為有眾多人的參與與支持，我才能完成這個階段的思考與書寫，讓更多人認識臺灣在永續發展教育（ESD）實踐上的現狀與可能性。由衷感謝所有支持我完成碩士論文的你們。

doi:10.6342/NTU202501048

中文摘要

全球各國為響應聯合國永續發展倡議，在結合教育體制與永續發展教育（Education for Sustainable Development，ESD）已有所進展。ESD 旨在為學習者提供實踐永續社會所需的知識、技能與價值觀。然而許多國家尚未全面推行 ESD，在缺乏系統性支援的情況下，可能導致學校層級落實該教育轉型需大幅依賴於學校動員社會網絡的能力。此外，這些網絡如何發展、維護及其資源流動仍未得到充分探討。本研究旨在填補這一研究空白，探討支持臺灣基礎教育實施 ESD 的社會網絡中包含哪些類型的行動者與關係，以及何種資源透過這些網絡流動以影響學校的 ESD 實踐——臺灣提供關鍵的研究脈絡在於其作為環境教育領先世界、ESD 仍逐步發展的國家。透過訪談 29 位受訪者（包含 11 所學校的 17 位中小學教育者），本研究採用混合方法社會網絡分析探討臺灣中小學的 ESD 實踐及其社會網絡。研究結果顯示，臺灣的 ESD 網絡由來自中小學、政府、學術界、企業及民間團體的多元行動者組成，透過三個脈絡途徑構成：跟進國際永續發展議程的潮流、既有環境教育基礎，以及對學校層級挑戰的由下而上回應。在這些網絡中，校長與教育部是具有高度中心性的行動者，另發現較具中心性的行動者多具環境教育背景。這些社會網絡促進四類重要資源的流動——人力、智識、物質與財務資源——有益於學校的 ESD 實踐。此外，研究發現網絡具有動態特質，常因 ESD 計畫的時效性與人員異動而受到干擾，促使學校發展維持資源流動的策略。總結而言，本研究從新穎的社會網絡角度揭露臺灣基礎教育當前採行 ESD 之經驗，提供同樣轉型至 ESD 的教育體系參照。研究建議學校應建立超越傳統環境教育圈的連結，並強化內部跨界能力。

關鍵字：永續發展教育（Education for Sustainable Development，ESD）、社會網絡（social network）、永續發展（Sustainable Development）、環境教育（Environmental Education，EE）、基礎教育

doi:10.6342/NTU202501048

ABSTRACT

In response to the United Nations' global call for sustainable development, countries have made progress aligning their education systems with Education for Sustainable Development (ESD). This education aims to equip learners with knowledge, skills, and values to support sustainable societies. Yet full implementation remains incomplete in many countries, which might leave the integration of ESD at the school level dependent on schools' ability to mobilize social networks. Moreover, how these networks are developed, maintained, and their resource flows remain underexplored. This study addressed these gaps by examining what types of actors and relationships form the social networks that support ESD implementation in Taiwan's basic education, and what kinds of resources flow through these networks to influence ESD practices in schools. Taiwan provides a valuable research context as a country where Environmental Education is world-leading, while ESD is still gradually developing. Drawing on interviews with 29 participants, including 17 educators at 11 schools, this research explored ESD practices and social networks in Taiwanese primary and secondary schools. Mixed-method social network analysis revealed that Taiwan's school-based ESD networks comprise diverse actors from primary and secondary schools, government, academia, business, and civil groups, brought together through three contextual pathways: alignment with international Sustainable Development agendas, existing Environmental Education infrastructure, and bottom-up responses to school-level challenges. Within these networks, principals and the Ministry of Education are typically high-centrality actors, with more central actors often having a background in Environmental Education. These social networks facilitate the flow of four essential resource categories—human, intellectual, physical, and financial resources—that benefit schools' ESD practices. Furthermore, the networks were found to be dynamic, often disrupted by the temporary nature of ESD advocacy programs and staff turnover, prompting schools to develop strategies to sustain resources. In conclusion, this study contributed to a clearer understanding of Taiwan's current adoption of ESD in basic education in a social network perspective, offering insights for educational systems similarly transitioning to ESD. The research recommends that schools establish connections beyond traditional environmental education circles and strengthen internal boundary-spanning capabilities.

Keywords: ESD (Education for Sustainable Development); social network; Sustainable Development; Environmental Education (EE); basic education

doi:10.6342/NTU202501048

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Chapter 1 Introduction

Education for Sustainable Development (ESD) represents a transformative approach to education, designed to equip individuals with the knowledge, skills, and values needed to build sustainable societies (UNESCO, 2018). This education is also recognized as a critical tool for advancing all 17 Sustainable Development Goals (SDGs) (UNESCO, 2020, 2022). Research indicates that embedding ESD and SDG values in primary and secondary education yields lasting benefits. In the short term, it fosters environmental awareness and enhances problem-solving skills, while in the long term, it promotes active citizenship, strengthens personal commitment to sustainability, and equips students with the mindsets and behaviors needed to tackle environmental and community challenges (Fekih Zguir et al., 2021; Ssossé et al., 2021). As recognition of the importance and beneficial effects of Education for Sustainable Development (ESD) grows, 140 countries have published their country-specific initiatives for ESD 2030, according to data from the official UNESCO website (UNESCO, 2024a). This widespread alignment in ESD efforts reflects a growing global commitment to integrating sustainability into educational frameworks.

However, a nation's proactive participation in ESD does not necessarily guarantee full implementation or advancement of a comprehensive ESD system. For example, China has yet to define ESD's integration into its education system and alignment with the SDGs (Zhou & Lee, 2022), Qatar lacks a comprehensive approach to incorporating ESD into the national curriculum (Fekih Zguir et al., 2021), and even Japan, a leader in international education, faces challenges due to its traditional system potentially hindering ESD's transformative impact (Nagata, 2017). Globally, few institutional efforts

doi:10.6342/NTU202501048

have been reported regarding the integration of ESD into national or subnational education policies and practices. According to Buckler and Creech (2014), the gap between policy and practice remains a significant challenge for many United Nations Member States.

Despite progress made by various nations, supporting systems and structures for integrating Education for Sustainable Development (ESD) into basic education have yet to be established in many contexts. As a result, ESD implementation may depend on the voluntary efforts of individual educators and informal networks. As core institutions for delivering compulsory education and shaping future generations, schools in basic education play a critical role in national sustainability efforts. It is therefore important to understand how schools conduct ESD amid existing policies, resource constraints, and developing institutional support, as these factors may influence the effectiveness of implementation. Yet scarce research reveals how primary and secondary schools conduct ESD amid developing institutional support.

1.1 The Social Network Underlying the Educational Changes

Given the limited understanding of how schools implement ESD amid developing institutional support, this study adopts a social network approach for three key reasons. First, ESD emphasizes cross-sectoral collaboration and partnership, which aligns naturally with a social network perspective. International frameworks, including those by UNESCO (2009, 2020), explicitly highlight the need to establish and strengthen ESD networks at national and local levels. These partnerships are not merely organizational—they are essential mechanisms for capturing the evolving dynamics of ESD practices.

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Second, network analysis offers a systematic way to examine the relationships among diverse actors involved in ESD. A social network consists of actors connected by relational ties, with attention to both the structure (e.g., density, centrality) and function (e.g., communication, collaboration) of these relationships (Robins, 2015). Applying network concepts to education has yielded insights into both in-school and inter-school processes: strong teacher networks within schools support innovation (Moolenaar & Sleegers, 2010), while cross-school interactions create resource-sharing networks that enhance professional development (Hite et al., 2010). Third, social network analysis reveals how resource flows and power dynamics shape ESD implementation. Networks are not neutral—they facilitate the mobilization of social capital, providing access to educational, economic, and socio-cultural resources (Lin, 2001). The network flow model (Borgatti & Lopez-Kidwell, 2011) further conceptualizes networks as conduits for resource exchange, helping uncover how different actors gain or restrict access to critical supports. In the context of ESD, this approach is especially relevant, as successful implementation often hinges on both strong internal networks (e.g., within-school collaboration) and external ones (e.g., links to NGOs, policymakers, or community actors) (Verhelst et al., 2023).

Regarding the resources that the social network deliver, resources that flow through social networks can be classified as intellectual, human, physical, and financial, which are drawn upon studies on headteachers' resource networks (Hite et al., 2010) and common types of organizational resources (Hite et al., 2006), which emphasize the influence of these resources on school performance. This research follows this categorization because of seeing their importance towards ESD implementation. Intellectual resources include knowledge, ideas, and information. This resource benefits professional development, which can encourage the educators' participation (Goller &

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Rieckmann, 2022) and facilitate efficient implementation (Murphy et al., 2021). Human resources refer to contributions of individuals providing their time and efforts. Studies found that the leadership (Mogren and Gericke, 2017) and the teamwork (鄭權鑫 et al., 2006) crucial in ESD practices. Physical resources and financial resources provide material support and funding for implementation. Physical resources foster the real-life learning environments that UNESCO (2018, 2020) identifies as essential; and provision of financial resources is advocated as a key mechanism to systemically integrate ESD by the United Nations General Assembly Resolution 74/223 (2019). Thus, these resources might influence the ways in which schools can plan, deliver, and sustain ESD activities. Studies on schools implementing Education for Sustainable Development (ESD) affirm the critical role of resources in supporting ESD practices (Verhelst et al. 2023; 吳清山 et al., 2014). Resource exchange thus serves as an important indicator to understanding how social networks function.

1.2 Taiwan's ESD Landscape: A Case Study of School-Level Implementation Amidst National Challenges

Taiwan presents an ideal case study for researching ESD, given its unique educational landscape. As one of only six countries globally with an Environmental Education Act (葉欣誠, 2017), Taiwan provides legal foundations for integrating principles of ESD into education.

Environmental Education (EE) traditionally focuses on ecological awareness and environmental protection, while ESD expands this scope to incorporate economic development, social justice, and cultural dimensions of sustainability. Taiwan's

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development approach—building ESD upon its established EE framework—offers researchers a clear view of how these educational philosophies can progressively evolve in policy and practice.

As noted by Kopnina (2018), the global trend has seen Environmental Education (EE) gradually transition toward the broader framework of ESD. Among the 71 countries that implement EE globally[1]. Taiwan's development pattern offers a microcosm of this educational shift. This makes Taiwan's progress in ESD institutionalization particularly valuable for other comparative research.

Building on this established EE framework, Taiwan took a significant step in 2022 with the launch of the “New-generation Environmental Education Development” (NEED) policy, a four-year initiative spearheaded by the Ministry of Education (教育部, 2021b). This policy marks a major evolution in Taiwan’s approach, expanding the focus from EE to a more comprehensive ESD framework that aligns with the Sustainable Development Goals (SDGs). Researchers have further supported this trajectory, pointing out that EE provides the basis of developing ESD (王順美, 2016; Huang, 2021).

Despite these significant policy advancements, the integration of ESD into Taiwan’s primary and secondary education system remains incomplete. Until the written moment (2025), ESD faces peripheral issues in the current national curriculum (the 12-Year National Education Curriculum) not fully incorporating ESD principles. Additionally, the NEED policy, though promising, lacks sufficient institutional support, as it operates under the Department of Science and Technology, which limits its scope and impact. Furthermore, there is a lack of formal pre-service and in-service training for teachers on

[1] This number was calculated in this research using data from the official website of the Global Environmental Education Partnership, retrieved on January 12, 2025.

doi:10.6342/NTU202501048

ESD practices.

Nevertheless, some primary and secondary schools in Taiwan have made notable progress in adopting ESD, often through voluntary participation in government-supported programs. Prior to the implementation of the NEED policy, several longstanding initiatives had already promoted sustainability in schools (Wang et al., 2020; 中華民國環境教育學會, Ed., 2022). These include the Green School Partnership Program, the Sustainable Circular Campus Project, and the US-Taiwan Eco-Campus Partnership Program. These programs have provided schools with resources and opportunities to introduce ESD practices, offering a glimpse into the potential for broader implementation. This study also finds that there are schools in Taiwan that have not participated in these formal programs but have still successfully integrated ESD into their practices. These schools demonstrate that, even within an incomplete macro-environment for ESD, proactive schools can innovate and lead in ESD. Their experiences could provide valuable insights to inspire other schools to embrace and integrate ESD.

1.3 Research Question and Objectives

Building on Taiwan's context as a case study, this research addressed a significant gap in the ESD implementation literature by focusing on the role of social networks within schools. While previous studies have examined the educators' capacity development (Goller and Rieckmann, 2022; Murphy, 2021), school leadership (Mogren and Gericke, 2017), characteristics (Verhelst et al. 2023) and other requirements for ESD implementation (吳清山 et al., 2014), the challenges for ESD practices at the scale of a school (葉莉婷, 2015), the national advocation (郭金水, 2012; 王順美, 2016, 2023;

doi:10.6342/NTU202501048

UNESCO, 2018; Edwards, et al., 2020) or from the essence of ESD (Ssossé et al., 2021; Gan et al., 2019), limited attention has been given to schools' ESD implementation from a social network perspective. This research thus addresses the two following questions:

1. What types of actors and relationships form the social networks that support ESD implementation in Taiwan's basic education?
2. What kinds of resources flow through these networks, and how do they influence ESD practices in schools?

By investigating these networks in Taiwanese schools, this research aims to identify the composition of these networks and analyze how these connections influence schools' ESD practices. Rather than evaluating effectiveness, the focus is on understanding the participating actors, relational patterns, and overarching context of these networks. These empirical findings served as a critical first step toward identifying how social relationships contribute to ESD implementation. This research may contribute insights relevant to other educational systems navigating similar transitions from Environmental Education (EE) to ESD.

doi:10.6342/NTU202501048

Chapter 2 Research Design and Methods

This chapter outlines the methodological framework employed to investigate the role of social networks in Education for Sustainable Development (ESD) implementation across Taiwan's primary and secondary schools. Drawing upon social network analysis as theoretical lens, this research adopted a systematic approach to examine both internal and external network dynamics that influence ESD integration. The following sections detail the research design through a social network perspective, explain the implementation procedure, elaborate on the sampling contexts, outline the selection of research targets, describe the data collection approach, and specify the focus of network analysis, thereby providing a comprehensive framework for examining how social networks facilitate ESD implementation in Taiwanese schools.

2.1 Conceptual Foundation: Social Networks and ESD in Schools

A social network is a concept used to identify entities, referred to as "actors," and the relationships between them, known as "ties" (also referred to as "entities" or "nodes"), within a specific context (Knoke & Yang, 2019; Marin & Wellman, 2011). In social network analysis, several key assumptions are considered. First, relations within networks are often more influential than individual attributes such as gender, race, age, and values when explaining observed behaviors (Knoke & Yang, 2019). Second, the composition and structure of social relations affect how actors perceive, believe, and act, shifting the analytical focus to the "social structures between actors" (Herz et al., 2014; Knoke & Yang, 2019). Finally, social networks are dynamic and continuously evolving, reflecting

doi:10.6342/NTU202501048

ongoing changes in the relationships among actors (Knoke & Yang, 2019).

2.1.1 The Importance of Social Networks in Educational Research

The application of Social Network Analysis (SNA) in educational research offers significant advantages, as it enables systematic modeling of how interactions among group members lead to specific outcomes (Carolan, 2014). Traditionally, quantitative statistical methods have dominated educational research. These methods primarily collect what is referred to as "actor-by-attribute data," focusing on individual attributes while neglecting the social relationships between individuals that contribute to achieving outcomes (Carolan, 2014).

Existing empirical studies on green schools and eco-schools, including those conducted in various countries and in Taiwan, predominantly evaluate the effectiveness of Education for Sustainable Development (ESD) through the presence or absence of specific factors. For example, such studies examine the effects of green schools on students' sustainability consciousness (Olsson et al., 2019) or the influence of eco-schools on students' environmental values, motivation, and knowledge (Mogren et al., 2018). However, these studies assume that participants are independent of one another, failing to account for the interactive relationships among students, staff members, or even between schools. These interactions may significantly influence the effectiveness of ESD implementation, yet they remain largely unexplored.

Social relationships are essential to consider because educational subjects and topics are inherently embedded within complex and intertwined social networks that reflect current educational realities (Carolan, 2014). Social Network Analysis (SNA) offers a valuable approach to understanding these relationships, moving beyond traditional 'actor-by-attribute data' to emphasize often-overlooked 'relational information.' This approach

doi:10.6342/NTU202501048

recognizes that actors are not independent of one another and highlights the importance of the social context in which they are situated (Carolan, 2014a).

One key insight from social network theories is their explanation of how certain nodes or groups accumulate greater social capital (Borgatti & Lopez-Kidwell, 2011), which is particularly relevant when examining individual behavior within educational contexts. Understanding these network dynamics helps reveal how social relationships influence individual actions and decisions within school environments."

Although studies applying Social Network Analysis (SNA) to Education for Sustainable Development (ESD) remain limited, educational research has increasingly utilized SNA to explore the impact of social relationships on various aspects of education. As noted, “Social network analysis (SNA) has gained popularity in educational research over the last 30 years” (Pantic et al., 2023). SNA studies in the field of education began around 2005 and have experienced significant growth since 2010, contributing to the increasing prominence of educational SNA research (Baker-Doyle & Yoon, 2020).

Based on social network studies, researchers were able to reveal the social relations across different sectors during the ESD implementation and dissemination in the country (Kolleck, 2019); researchers could posit that specific social structures could advocate the ESD implementation (“structural anchoring”) in municipalities (Schönheit, A. L., Gebauer, R., & Rink, D., 2022); identify the crucial actors’ position in teaching staff’s social network and how the interaction of teachers operates, to efficiently accelerate the innovation spread in the education (Blumenschein, D., & Hannisdal, B. 2024).

2.1.2 Insights from Previous Social Network Studies

These studies have implications for enhancing the implementation of ESD programs

doi:10.6342/NTU202501048

within and across schools. Empirical evidence indicates that cross-school interactions among teachers contribute to the formation of resource networks, facilitating schools' access to resources and the professional development of teaching staff (Hite et al., 2010). Furthermore, schools occupying central positions within broader networks and maintaining preexisting relationships with other schools are more likely to establish successful partnerships (Bridwell-Mitchell, 2017). However, there may be diminishing returns to forming excessive partnerships, as the increased effort required to sustain numerous relationships can detract from the maintenance and investment in existing collaborations (Bridwell-Mitchell, 2017).

In the realm of ESD, actors collaborating in ESD implementation are found to be composed of various types, such as “municipal governments or administrations, NGOs (most of them with an educational or an environmental background), businesses (most of them committed to Corporate Social Responsibility), formal education (schools and universities dedicated to sustainability) and non-formal education (e.g. further education colleges or Environmental Education centres)” (Kolleck, 2016; Schönheit et al., 2022).

The social networks of ESD composed by different actors are also found to be beneficial to both schools and the local community. Alkaher and Gan (2020) made contributions to understanding how these networks can positively influence the society through their examination of school partnerships across multiple levels. Using the single case of River School, they revealed how educational institutions implement ESD through interconnections among various actors (government, civil society, business, and community) as well. Their study introduced a novel perspective by positioning the development of social capital as a valuable outcome of the school’s ESD partnership, highlighting its multiple benefit for sustainability initiatives, community development and environmental protection (Alkaher & Gan, 2020).

doi:10.6342/NTU202501048

2.1.3 Research Gaps in Social Network Studies

While there has been research examining social networks in the context of Education for Sustainable Development (ESD), several limitations are evident in existing studies. One significant limitation is the reliance on questionnaire surveys for social network data collection, which constrains the ability to thoroughly explore the underlying reasons for headteachers' engagement or disengagement in networks, as well as the impact of various resources on educational change (Bridwell-Mitchell, 2017). Additionally, previous research has lacked detailed accounts of the actual experiences and processes through which schools form partnerships, leaving the activities of these partnerships and the social capital acquired by schools largely unexamined (Bridwell-Mitchell, 2017).

Future research in this area could benefit from incorporating interview-based methods to gain insights into the perspectives of policymakers. Additionally, studies could focus on examining the roles and influence of specific stakeholders within the network, as well as providing explanations for quantitative social network analysis findings within the context of education (Vargas, V. R., Lawthom, R., Prowse, A., Randles, S., & Tzoulas, K., 2019; Hite et al., 2010).

The limitations identified in previous studies present an opportunity for qualitative research to investigate the diverse processes and strategies involved in the formation of school partnerships. Such research could enhance our understanding of the mechanisms underlying school partnership networks. Incorporating qualitative methods could enhance the validity of findings by providing richer, more contextual insights into the dynamics of social networks. While quantitative analysis tools offer significant benefits, a mixed-methods approach is recommended for conducting social network analysis (Luxton & Sbicca, 2021).

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Furthermore, the implementation of Education for Sustainable Development (ESD) in educational systems and schools varies significantly across countries (Kolleck, 2016), and studies focusing on ESD-related social networks are notably limited in Taiwan. Given that Taiwan is undergoing a national shift from Environmental Education (EE) to ESD, it is crucial to examine the social networks within this context to better understand the processes driving this transition.

2.1.4 Quantitative and Qualitative Approaches in Social Network Studies

Social network analysis (SNA) is a method used to understand the structure of social networks (Tabassum et al., 2018). It involves identifying the entities, or "actors," and the relationships, or "ties," between them within a specific context (Knoke & Yang, 2019; Marin & Wellman, 2011). Originated from qualitative methods, social network analysis (SNA) is designed to uncover the social meaning and dynamics of relationships (Hollstein, 2011). With advancements in computational tools, quantitative approaches have since gained prominence (Edwards, 2010). Both qualitative and quantitative methods offer unique strengths, and their integration can enhance data collection and analysis in SNA.

The qualitative approach is valuable for reconstructing the “social meaning” of research subjects, understanding social reality as a dynamic “process” (Hollstein, 2011). This approach provides richer contextual information and deeper insights into the perceptions and practices within networks. Data collection often involves interviews or participant observation, with methods like grounded theory, narrative analysis, or conversation analysis applied to analyze the data (Hollstein, 2011; Luxton & Sbicca, 2021). In contrast, the quantitative approach is more structured and efficient, relying on tools such as surveys to manage large datasets. It enables the standardized numerical measurement, statistical analysis and visualization of social network structures, providing

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results that are both visually engaging and generalizable (Carolan, 2014a; Froehlich et al., 2020).

Despite their strengths, both approaches have limitations. Qualitative SNA lacks standardized procedures for analysis, making replication and systematic analysis challenging (Herz et al., 2014). On the other hand, quantitative methods often fail to uncover the motivations behind relationships or explore the formation processes of social networks (Blumenschein & Hannisdal, 2024). These limitations hinder a comprehensive assessment of network dynamics.

Since the essence of social network analysis is to systemically explain the outcome from the relational data in a certain context (Carolan, 2014b), the complementary nature of qualitative and quantitative approaches highlights the value of mixed-method designs in SNA (Edwards, 2010; Pantic et al., 2023). “Mixed-method social network analysis (MMSNA)” combining both methods allows SNA to address both the external 'structure' of social relations and the internal 'processes' that shape these networks (Pantic et al., 2023). By concurrently analyzing numerical properties and contextual meanings, researchers can achieve a more comprehensive understanding of social networks (Edwards, 2010; Hollstein, 2011; Pantic et al., 2023).

To expand the findings on the ESD networks, this research combined two types of SNA approaches. Also, this research mainly relied on the qualitative way to collect network data, as previous research cases showed that qualitative studies can contribute network research in network exploration and network practices (Hollstein, 2011), which are the main goals of this research. Subsequently, these qualitative data were analyzed concurrently through content analysis and quantitatively visualized into social network graphs, which allows the application of numeral social networks measurement, such as centrality and homophily.

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2.2 Theoretical Framework

This research integrates social capital theory (Lin, 2001) and the network flow model (Borgatti & Lopez-Kidwell, 2011) to analyze how social networks influence educational practices, particularly in the context of Education for Sustainable Development (ESD) implementation in Taiwan's schools. This integrated framework enables examination of both individual and organizational relationships within schools—among faculty, students, and external educational stakeholders—to comprehensively understand the dynamics affecting ESD practices.

Social capital theory, as articulated by Lin (2001), social networks are closely linked with social capital, which enhances an individual's access to collective resources, including economic, technological, and social/political/cultural assets. Within this framework, social networks serve as structures that facilitate resource mobilization, generating two types of returns. These resources contribute to both "instrumental returns", which are tangible, goal-oriented outcomes, as well as "expressive returns", which are intangible benefits in psychological and relational domains.

The network flow model (Borgatti & Lopez-Kidwell, 2011) builds upon social capital theory by conceptualizing social systems as networks facilitating resource flow through connected nodes. The model comprises two relational phenomena: "backcloth" and "relational events" (Borgatti & Lopez-Kidwell, 2011).

The backcloth refers to the static "underlying infrastructure" of a network, consisting of both similarities and social relations. Similarities are the shared attributes among individuals, such as spatial proximity, that define their commonalities. These are considered traits rather than social ties, which allows for a more enriched interpretation

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of network results (Crossley et al., 2015). Regarding social relations, they are defined by specific roles, such as being a teacher, or by cognitive or affective connections, such as knowing or liking someone. Together, the backcloth provides a foundational layer for analyzing the structural and relational aspects of network dynamics.

Operating within the constraints of the backcloth, the "relational events" encompass interactions, such as communication or collaborative behaviors, and flows, such as the exchange of resources. While relational events are often transitory, they can also serve as measures of social ties, depending on the research design (Borgatti & Lopez-Kidwell, 2011).

In general, social network studies focus on observing social relations or interactions to construct the network of interest, while flows are often considered the outcomes that the research seeks to uncover. However, flows can also be directly observed, depending on the research context (Borgatti & Lopez-Kidwell, 2011). For instance, studies on economic trade networks may measure the movement of goods as a key component of network analysis (Borgatti & Lopez-Kidwell, 2011). This dual role of flow, as both a product and a measurable aspect of networks, highlights its versatility in social network research.

In this model, two primary mechanisms govern these processes: capitalization, where nodes acquire resources or opportunities that flow within the network through their ties; and contagion, where traits or behaviors can be influenced by the broader environment like the network and spread throughout the network. These mechanisms highlight the importance of how the flow of resources and the diffusion of traits influence the adoption of practices, such as ESD, within the school network.

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2.3 Research Design and Implementation

This study focused on Taiwan as the research area, a country where Environmental Education is world-leading, while Education for Sustainable Development (ESD) is still gradually evolving. The research aimed to address two main questions: (1) What types of actors and relationships form the social networks that support ESD implementation in Taiwan's basic education? (2) What kinds of resources flow through these networks and how do these networks influence ESD practices in schools? Drawing on interviews with 29 participants—including 17 educators from 11 schools—this study employed both social network analysis and qualitative interview analysis to explore how ESD is practiced and supported across primary and secondary schools in Taiwan.

To systematically address these research questions, the study followed a multi-phase research design involving four key stages: (1) contextual review and stakeholder identification, (2) data collection through semi-structured interviews and field observations, (3) data processing and coding, and (4) network analysis and interpretation. This stepwise approach is illustrated in Figure 2.1 and provided a coherent structure for linking empirical data with theoretical insights.

The first stage involved a literature review of Taiwan’s educational environment to identify relevant policies, institutional actors, and contextual factors influencing ESD. This review served as the foundation for identifying key stakeholders and designing the interview framework.

The second stage consisted of two phases of semi-structured interviews with a total of 29 participants drawn from various sectors, including primary and secondary schools, academia, government, business, and civil society organizations (Appendix 1, Appendix 2). Participants were based in ten counties across Taiwan, ensuring a geographically

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diverse sample (Figure 2.2). The first phase involved exploratory interviews with 12 participants to gain an initial understanding of Taiwan's ESD landscape. These insights informed the selection of schools for the second phase, which focused on 17 participants from schools actively implementing ESD. In addition to interviews, field observations were conducted at six ESD-related events and five school sites to enrich contextual understanding.

The third stage involved transcription and coding of all collected interviews and observational data. Rather than employing a formalized coding framework such as thematic analysis, the coding process was primarily interpretive and focused on identifying patterns relevant to actors, relationships, and types of support for ESD implementation. This pragmatic approach allowed for flexibility in capturing context-specific nuances and the diverse roles stakeholders played within the ESD landscape. Codes were used to extract information about collaboration, resource exchange, influence, and institutional positioning, which served as the groundwork for mapping the social networks and interpreting the dynamics within and across different sectors. The coding results also guided the construction of relational data for the subsequent network analysis.

In the final stage, network analysis focused on two core dimensions: network composition (identifying actors and their interactions) and resource flow (analyzing types and pathways of exchanged resources). The findings were visualized using Gephi software to generate social network graphs, which facilitated interpretation and the development of recommendations for enhancing ESD implementation in Taiwan.

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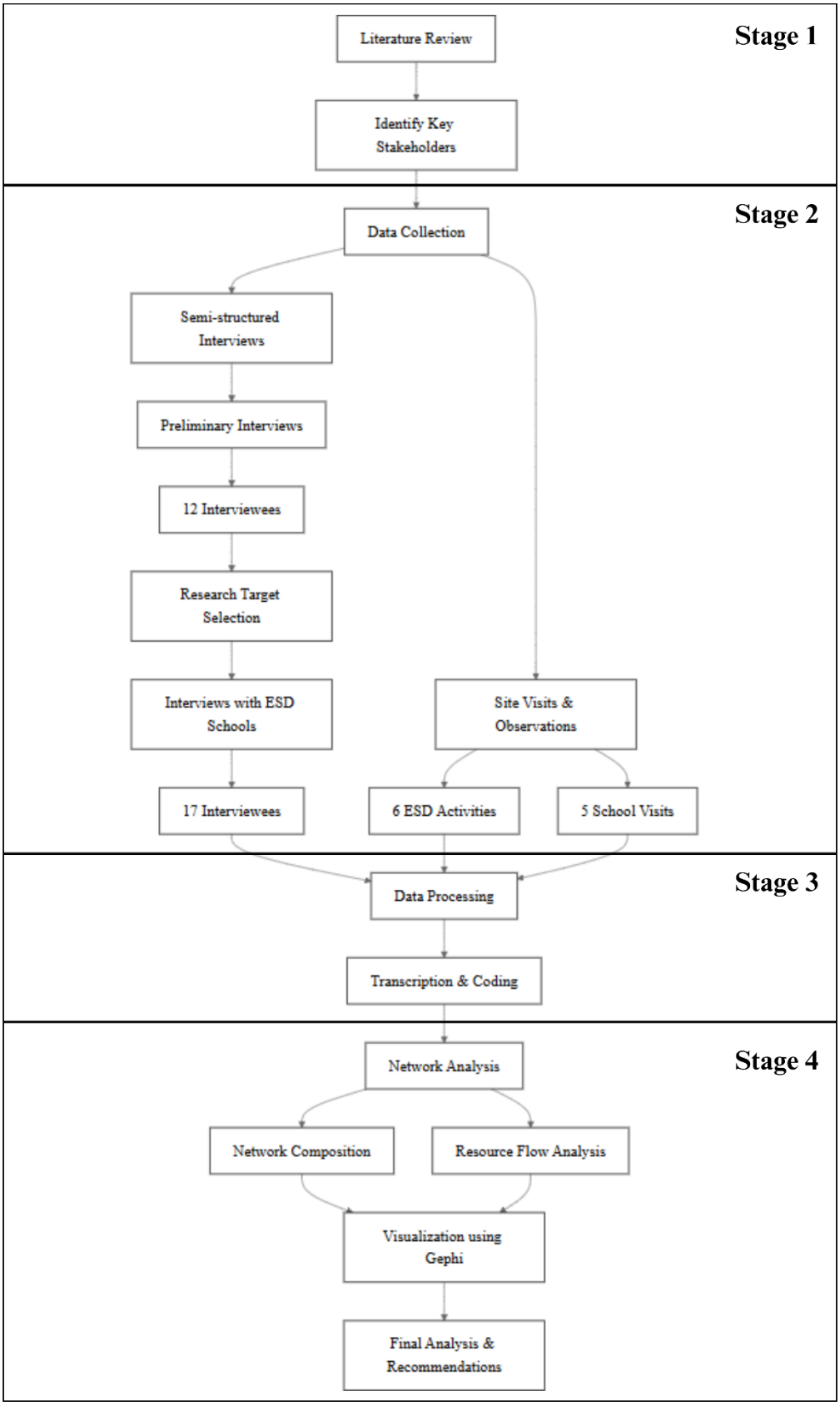

Figure 2.1 Research Procedure Diagram

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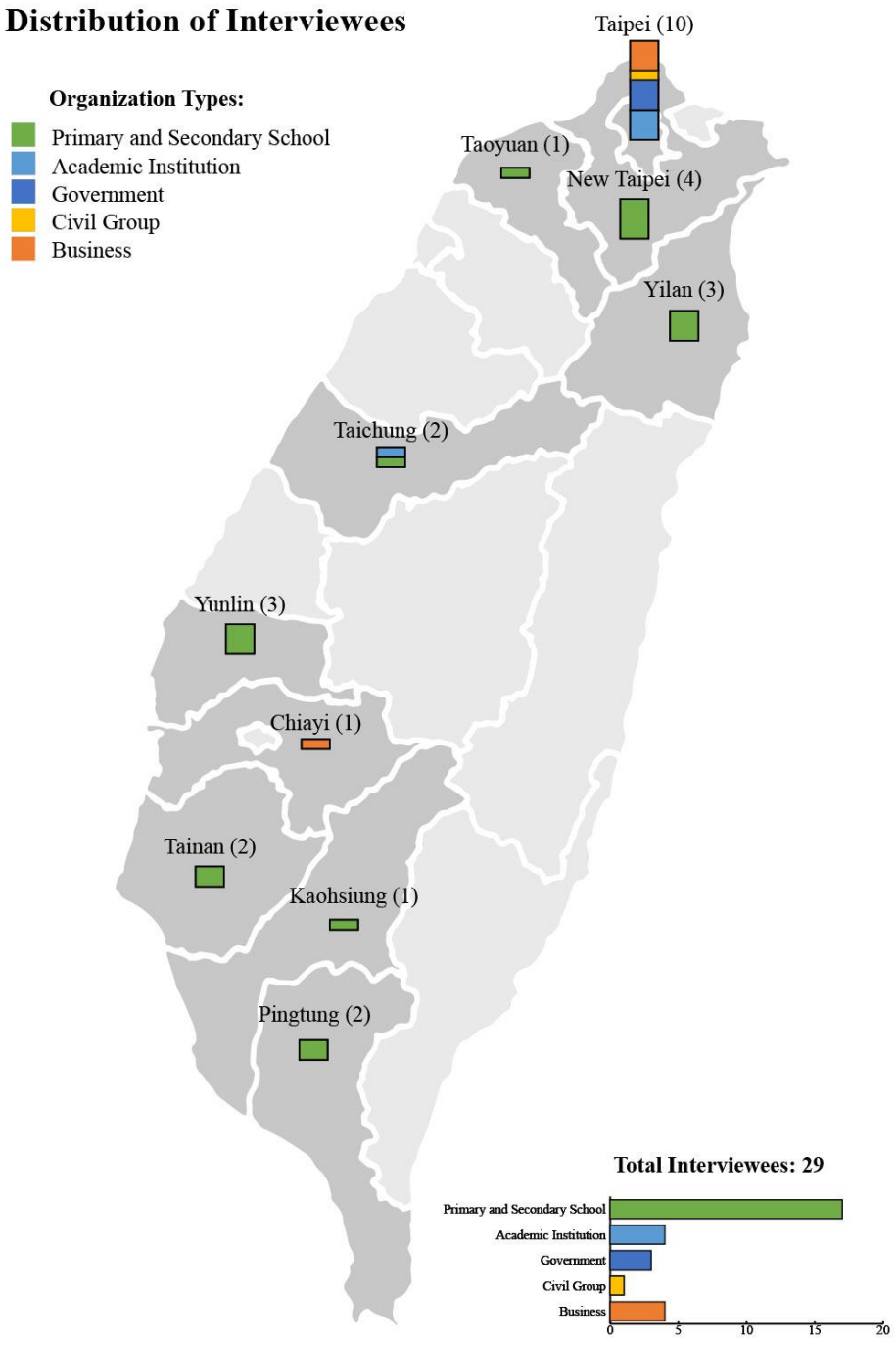

Figure 2.2 Geographical Distribution of 29 Interviewees in Taiwan

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2.3.1 Considerations in Sampling Contexts and School Characteristics

This section elaborates on three key contextual dimensions that influenced both the study's design and the interpretation of its findings: (1) Taiwan's main whole-school ESD programs involving primary and secondary schools, (2) schools' educational models, and (3) their geographical locations.

(1) Taiwan's Main Whole-School ESD Programs

In Taiwan, Education for Sustainable Development (ESD) programs in primary and secondary schools play a critical role in advancing sustainability, particularly given the ongoing phase of ESD institutionalization, which necessitates a more voluntary and flexible approach. To address this, several key ESD programs in Taiwan adopt the "whole-school approach," integrating sustainability across all aspects of school life. This approach, endorsed by UNESCO as a cornerstone of ESD, emphasizes sustainability in governance, facilities, teaching, and community engagement (UNESCO, 2014, 2020, 2024; 王順美 et al., 2024; 教育部, 2021). By embedding sustainability into both school operations and educational practices, these programs aim to foster long-term, transformative change within schools and communities.

Three major voluntary programs in Taiwan employ the whole-school approach to promote sustainability across all dimensions of school life: the Green School Partnership Project, the Sustainable Campus Renovation Project, and the US-Taiwan Eco-Campus Partnership. These programs, described in the following sections, provide essential frameworks for schools seeking to integrate ESD into their curricula and operations.

The Green School Partnership Project in Taiwan was established in 2000, making it the earliest of the whole-school ESD programs. Inspired by the UK's Eco-Schools

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Programme and Canada's SEEDS Schools, it adopted a whole school approach to promote EE(NTNU Graduate Institute of Environmental Education, 1999). Its founding members highlighted that the initiative aims to shift away from the traditional fragmented, marginal approach to a more comprehensive education advocating Environmental Education (張子超 et al., 1999). It emphasizes creating an adaptable and holistic Environmental Education ecosystem through "cooperative relationships within the school and among schools" (王順美, 2004a). The project also strives to develop Environmental Education actions that are "not passive, but rather self-initiated" (王順美, 2004b).

A key focus of the initiative was fostering robust partnerships. The Program encourages participants to engage in exchanges within the school, between schools, with professionals, non-governmental organizations, and local educational authorities, as well as the central Ministry of Education (Mechanisms of the Partnership Network Initiative) (大地旅人環境工作室, 2008; 張子超 et al., 1999). The Green School Partnership Program facilitates the sharing of Environmental Education experiences and outcomes through major open platforms. Additionally, it integrates external reports, teaching materials, relevant websites, and event information to support the Green Partnership Network and achieve the goal of strengthening "partner network relationships" (張子超 et al., 1999).

Currently, its mission is to practice EE and ESD through four main aspects, which are “school policies and management”, “school buildings and space”, “curriculum and teaching”, finally, “lifestyle practices and community interactions” (Ministry of Education, 2023). The main feature of the Green School Partnership Program is its bottom-up approach, as it is implemented through an online platform, it encourages its main targeted implementers (the school faculty) to engage in the program simply through

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registering the account and share their EE actions and outcomes.

Its design of rewarding “Hope-tree mechanism” aims to incentivize implementers to keep sharing their practices (Wang et al., 2020). Once the report is uploaded and verified, the committee will distribute the “leaf” or/and “watering machine” corresponding to the topic and scale of the reported action, which engaging more people to a whole-school level and collaborating with the community are more expected.

The second-oldest whole-school ESD program, the "Sustainable Circular Campus Project" (formerly known as the "Green Campus Promotion and Renovation Award Program"), was launched in 2001 (Wang et al., 2020). It is implemented with the support of a team of sustainable campus experts who guide schools in their campus transformation. The program consists of both hardware and software components. The hardware aspect focuses on "ecological restoration and maintenance" and "sustainable architecture," which guide the planning of space and facilities. The software aspect includes Environmental Education and sustainable living, primarily aligning with the implementation of compulsory national education and emphasizing the integration of the campus environment with local characteristics.

This program particularly focuses on environmental management. Its emphasis on hardware can be traced back to the program's origins, when campus buildings faced damage from the “921 Earthquake” in 1999, leading to a need for post-disaster reconstruction (高翠霞 & 蔡崇建, 2011). The main mechanism of the Sustainable Circular Campus Project is to assist schools in sustainably transforming their campus infrastructure. It offers two models: the "demonstration case" and the "exploration case," which focus respectively on technical upgrades and the assessment of the school environment. The incentive mechanism of the program primarily includes financial subsidies to support campus renovations. Additionally, the program provides access to

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relevant scholars in architecture (E01, E02), allowing schools to receive professional consultation and design support for their renovation projects.

The Eco-Campus Partnership Program in Taiwan was launched in 2014, making it the most recent of the three. This program is largely adopted from the mechanism of "Eco-Schools" program developed by Foundation for Environmental Education (FEE), which is a global prominent initiative of EE and ESD. Since its first launch in 1994, the Eco-Schools Programme has accumulated FEE member organizations from 73 countries and International Schools from 26 countries in 2023 (Gough et al., Eds., 2020).

In the collaboration with the U.S. Environmental Protection Agency (US EPA) and the National Wildlife Federation (NWF), the Ministry of Environment launched US-Taiwan Eco-Campus Partnership program (the Eco-Campus Partnership Program) in 2014, leading schools to foster students' autonomy in the context of environmental actions with community (王懋雯 et al., 2015).

Similar to the Eco-Schools Programme run by FEE, the Eco-Campus Partnership Program in Taiwan also operates as a certification system, which serves as its main incentive mechanism. The certification process functions as the application guidelines and simultaneously motivates the participants. Once a school is accredited, it qualifies to be recognized as an Eco-School, with certification levels ranging from Bronze, Silver, to the highest Green Flag schools. Additionally, an annual ceremony is held to honor the accredited schools, celebrating their commitment and providing an opportunity for interaction among the participating schools.

This program has two main features. First, the Eco-Campus Partnership Program operates within a clear framework, offering more specific routes to follow. The

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framework consists of the Seven Steps and 12 pathways. The Seven Steps [2]guide the school's practices, focusing on teaching and community engagement as part of the Education for Sustainable Development (ESD). The program also specifies that applicants take action based on the designated 12 pathways[3], which are mainly coherent with the environmental aspect of the 17 Sustainable Development Goals (SDGs).

Furthermore, youth participation is a key focus in this program. The "Eco-Action Team" mandates a specific ratio of student participation, which increases with the accreditation level. The development of youth autonomy is considered one of the most important benefits of this program.

The above three programs generate a holistic, long-term impact by encouraging schools to adopt sustainable practices that extend beyond the classroom, fostering partnerships that involve the entire school community.

(2) Education Models in Formal Education: Standardized and Experimental

In 2011, the President announced the launch of Taiwan's twelve-year national compulsory education program, founded on the principles of "universal coverage," "non-compulsion," "quality assurance," and "social justice" (教育部, 2021a). This reform expanded Taiwan's basic education to 12 years, integrating the previous nine-year basic education system with senior high school education. The system is divided into three stages: elementary school, junior high school, and high school.

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[2] The seven steps outline a comprehensive approach to fostering sustainability in schools, starting with forming an Eco-Action Team, conducting an environmental audit, and developing an Eco-Action Plan, followed by monitoring progress, integrating sustainability into the curriculum, engaging the school community, and culminating in the creation of an Eco-Code to unite the entire school in environmental action.

[3] These 12 key environmental issues include: water, waterways (watersheds, oceans, and wetlands), sustainable food, biodiversity, transportation, climate change, consumption and waste, energy, healthy living, healthy campuses, forests, and school habitats.

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Not all primary and secondary schools in Taiwan are required to adhere to the the Curriculum Guidelines of 12-Year Basic Education (commonly referred to as the "108 Curriculum Guidelines"). Schools participating in school-based experimental education are exempt from the constraints of the national curriculum, as their curriculum planning and implementation are more flexible. This flexibility is a direct result of the introduction of the *Experimental Education Act*, which aims to foster educational innovation (Ministry of Education, 2024). Since the promulgation of the three types of *Experimental Education Acts* in 2014, the education models in Taiwan's formal education system have often been compared as two distinct categories: standardized education and experimental education.

Standardized education, also referred to as traditional or mainstream education in Taiwan, is primarily governed by the *Primary and Junior High School Act* (國民教育法) and the *Senior High School Education Act* (高級中等教育法) ("Primary and Junior High School Act," 2023). In contrast, experimental education provides an alternative to standardized education, emphasizing educational innovation. Students who complete their education in experimental schools receive official certification, allowing them to progress to the next stage of formal education.

According to the *Department of Statistics, Ministry of Education* (2024), experimental education in Taiwan has experienced significant growth, despite the challenges posed by declining birth rates. By 2023, the proportion of students enrolled in experimental education nearly doubled, increasing from 0.62% in 2018 to 1.10% of the total student population. Over the past five years, the number of experimental education institutions—including both school-based and consigned public schools—has risen by nearly 80%, reaching a total of 132 schools. Meanwhile, student enrollment in these institutions has surged by nearly 70%, reaching 13,926 students.

Three major acts underpin the development of alternative education, specifically

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experimental education, in Taiwan: the *Enforcement Act for School-based Experimental Education* (學校型態實驗教育實施條例), the *Act Governing the Commissioning of the Operation of Public Schools at the Senior High School Level or Below to the Private Sector for Experimental Education* (公立國民小學及國民中學委託私人辦理條例), and the *Enforcement Act for Non-school-based Experimental Education at the Senior High School Level or Below* (高級中等以下教育階段非學校型態實驗教育實施條例).

Since the Ministry of Education enacted these "Three Experimental Education Acts" in 2014, experimental education has made significant progress in four key areas: (1) integrating local communities into curriculum design, (2) shifting from traditional one-way instruction to self-directed and collaborative learning approaches, (3) promoting shared governance in school administration, and (4) incorporating sustainable management practices in rural schools. As a result, these innovative educational models have enabled experimental education institutions to develop unique teaching philosophies and tailor their curriculum implementation to meet the specific needs of their students and communities.

Experimental education and formal education differ fundamentally in their core pedagogy, including learning objectives, teaching methods, and teacher recruitment practices. Experimental education emphasizes fostering diverse thinking and self-exploration, with students actively engaging in discussions and interactions. Teachers are selected based on the specific needs of the curriculum, with an emphasis on specialized expertise (教育部, 2018b). In contrast, formal education tends to be subject-specific, with relatively stable and fixed objectives. Teaching is often one-directional, with a stronger emphasis on listening and fixed class periods. Teachers in formal education are primarily chosen for their subject-specific expertise.

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In addition, there are significant differences in the learning environment, admission processes, and governance structures between the two systems, highlighting the practical distinctions in their implementation. Experimental education is more flexible, often extending beyond the traditional classroom to include various learning locations (教育部, 2018b). Admissions are often district-based or independently managed. Additionally, the term of service for principals in experimental education is not limited to a single additional term, allowing for more continuity in the school's development plan. In contrast, formal education is predominantly campus-based, with most schools following a district-based admission system. Principals in formal education are generally limited to two consecutive terms at the same institution (Primary and Junior High School Act, Senior High School Education Act). These distinctions underscore the flexibility and innovative approaches of experimental education when compared to the more conventional methods used in formal education.

According to a list of experimental education institutions published by 親子天下 in 2023, as well as the findings from this study, there were a total of 286 experimental education institutions in Taiwan in 2023, offering 226 distinct curriculum features. Among these, the top ten curriculum features are outlined below (Figure 2.3), with Indigenous education, Montessori education, and Waldorf education being the most prominent. While it is not always straightforward to establish a direct connection between these educational philosophies and Education for Sustainable Development (ESD), many of the key curriculum features in these experimental education programs integrate sustainability concepts. As a result, even though some schools may only have limited or indirect ties to ESD, they actively implement ESD practices. For example, in the case of Indigenous education, Pingtung Evergreen Lily Elementary School (長榮百合國民小學)

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has achieved ECO Program Green Flag certification, while in the context of Waldorf education, Chaocuo Waldorf Education Experimental Elementary School (潮厝華德福教育實驗國民小學) has also participated in the ECO Program and earned the permanent Green Flag certification.

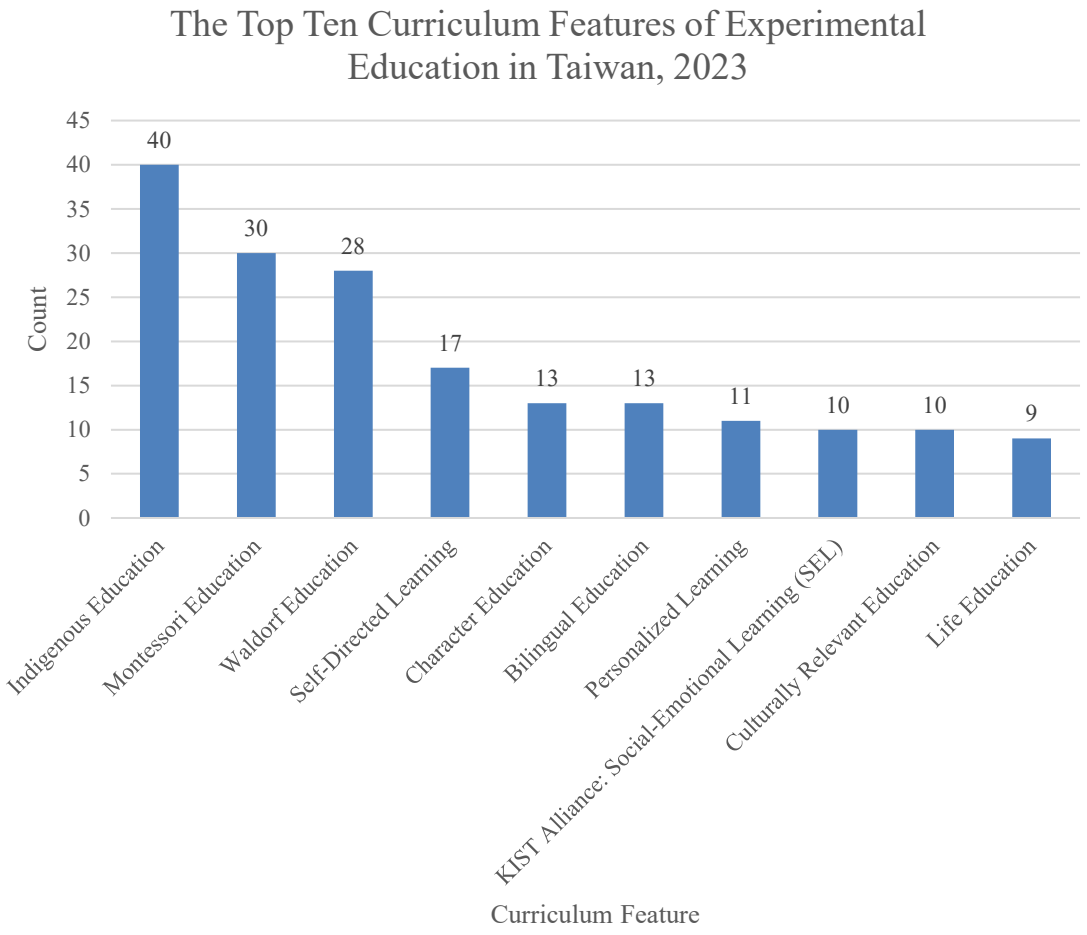

Figure 2.3 The Top Ten Curriculum Features of Experimental Education in Taiwan, 2023

Source: Analysis by this research based on data from 2023 Taiwan Experimental Education List (親子天下, 2023).

In addition to the top ten ranked curriculum features, several experimental education institutions offer curricula that explicitly align with sustainability concepts. These include

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ecological education (offered by 5 institutions), food and agriculture education (4 institutions), ecological environment studies (2 institutions), SDGs-focused research and presentations, local ecological and cultural studies, and other related topics.

While formal education in Taiwan is required to follow the national curriculum guidelines, the 108 Curriculum Guidelines serve as the primary framework for incorporating concepts related to Education for Sustainable Development (ESD) in these schools. In contrast, experimental education institutions have greater flexibility, as they are less constrained by these national guidelines. This autonomy allows experimental schools to design and implement curricula that may adopt alternative approaches to ESD, which can differ significantly from the approaches used in primary and secondary schools within the formal education system.

(3) School Location: Remote Area and Others

To better understand the diverse types of primary and secondary schools in Taiwan, it is important to consider not only the variations in educational models, as discussed above, but also the influence of school location on the implementation of Education for Sustainable Development (ESD).

School location, as a geographical attribute, is closely associated with the composition of students and faculty, the social capital of schools, and their overall performance. Schools' locations can be categorized in various ways, such as by natural environment, cultural landscape (e.g., rural vs. urban), or socio-economic status. These factors are interrelated and often influence one another. In Taiwan, one of the most frequently discussed issues regarding school location is that of "remote areas." The definition of a "remote area" takes into account several factors, including transportation,

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cultural aspects, available amenities, internet access, and socio-economic conditions.

Furthermore, there is an official classification and recognition standard for schools located in remote areas, based on these five factors: the *Grading and Accreditation Standards for Schools in Remote Areas* [偏遠地區學校分級及認定標準] (Ministry of Education, 2018). The Department of Statistics, Ministry of Education, publishes an annual list of remote-level classifications for all primary and secondary schools in Taiwan.

In Taiwan, primary and secondary schools located in remote areas account for 31% of the student population, with primary schools representing the largest proportion. Given the relatively poor educational conditions in these schools, the *Act for Education Development of Schools in Remote Areas* was enacted in 2017 to address these disparities.

These schools are subject to government intervention, which aims to reduce inequalities caused by regional differences. The *Act for Education Development of Schools in Remote Areas* [偏遠地區學校教育發展條例] was introduced to help bridge these gaps. However, the allocation of educational resources remains a contentious issue. There is ongoing debate regarding how to distribute funding more effectively, particularly after schools are graded based on their location and needs (*National Academy for Educational Research e-newsletter*, 2024).

Additionally, while research on the impact of remote school locations on educational outcomes is still developing, preliminary findings suggest a significant correlation between the geographical location of schools and their performance. Notably, this study found that schools in remote areas demonstrate a high level of participation in the Eco-Campus Partnership Program, with 35%, highlighting an active alignment to sustainability initiatives (Figure 2.4).

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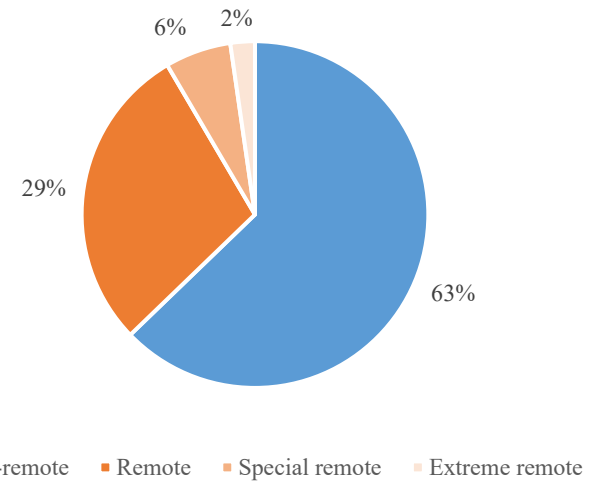

Figure 2.4 Percentage of Primary and Secondary Schools Participating in the Eco-Campus Partnership Program by School Location

In summary, the implementation of ESD in Taiwan varies significantly between remote and non-remote schools, primarily due to differences in geographical location, available resources, and educational infrastructure. While remote schools face considerable challenges—such as limited access to educational materials, internet connectivity, and social capital—government initiatives like the "Act for Education Development of Schools in Remote Areas [偏遠地區學校教育發展條例]" have provided crucial support in addressing these disparities. Despite these challenges, remote schools have shown notable engagement with sustainability initiatives, as evidenced by their high participation in ecological school programs.

On the other hand, non-remote schools, with greater access to resources and support systems, may have more structured and comprehensive ESD programs, but they do not always face the same level of urgency in integrating sustainability into their curricula. This contrast underscores the importance of tailored approaches in ESD implementation, recognizing that schools in remote areas require more targeted policies and resources to

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fully engage with sustainable education. Ultimately, the experience of remote schools in Taiwan suggests that with adequate support, even those in less favorable conditions can effectively contribute to the goals of ESD.

These contextual considerations are essential for understanding how school characteristics shape the ESD implementation process. The insights drawn from schools' participation in whole-school ESD programs, their educational models, and their geographical locations are fully integrated into the case selection and sampling strategy discussed in the preceding section.

2.3.2 Case Selection and Sampling Strategy

The primary focus of this research is on "implementing schools" that are actively implementing Education for Sustainable Development (ESD). To ensure the selected school represent a certain level of progress and competence in their ESD efforts, the schools' ESD implementation is carefully examined to follow "whole school approach". The whole school approach to ESD integrates sustainability across all aspects of school practice, including governance, facilities, teaching, and community engagement (UNESCO, 2020; 王順美 et al., 2024; 教育部, 2021b). This comprehensive approach is essential for transforming learning environments, which is highlighted by UNESCO and supported by New-generation Environmental Education Development (NEED) policy in Taiwan (UNESCO, 2020; 王順美 et al., 2024; 教育部, 2021b). This study employed a two-stage selection process to identify schools that demonstrate proficiency in implementing Education for Sustainable Development (ESD) through a whole school approach (Figure 2.5). The first stage established an initial pool of potential schools

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through both the Eco-Campus Partnership Program's Green Flag certification and expert recommendations. The second stage applied a weighted scoring system that evaluated schools based on their ESD implementation (10 points) and stakeholder recommendations (weighted ×5). This systematic approach ensured an objective selection of schools while incorporating both quantifiable criteria and expert insights.

Figure 2.5 The Selection Process of the ESD Implementing Schools

Stage 1: Initial School Selection

The initial pool of schools was established through two complementary sources. First,

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schools that achieved "Green Flag" status in the Eco-Campus Partnership Program were identified as having met a baseline threshold of ESD implementation. Since the Eco-Campus Partnership Program not only offers the most transparent and well-organized information compared to other ESD-related initiatives, its origin, the Eco-Schools Programme, is notified by UNESCO as a global initiative advocating ESD in whole school approach. Second, this pool was expanded through recommendations from ESD experts and stakeholders during preliminary interviews, ensuring the inclusion of schools recognized for their ESD practices but potentially not formally certified.

Stage 2: Weighting and Scoring of Schools

The evaluation of schools employed a comprehensive scoring system comprising two primary components: ESD implementation and stakeholder recommendations. The ESD implementation score, with a maximum of 10 points, was calculated across three dimensions. Program participation, worth up to 3 points, assessed involvement in established initiatives such as the Eco-Campus Partnership Program, Sustainable Circular Campus Project, and GPPT. Public recognition, contributing up to 2 points, evaluated schools' web presence and documented ESD-related achievements. The final component, whole-school ESD practices, provided up to 5 points based on performance across four core areas derived from UNESCO's Greening Education Partnership (UNESCO, 2024b) and NEED framework (教育部, 2021b): campus environment and resource management, school leadership and governance, local action and community engagement, and curriculum development and teaching.

The recommendation score incorporated both direct endorsements and general mentions by stakeholders. Schools received 0.5 points for each basic mention and 2 points

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for direct recommendations. To emphasize the significance of expert insights, the final recommendation score was multiplied by a factor of 5, reflecting the value placed on professional judgment in identifying exemplary ESD practices.

The selection process concluded by categorizing schools according to their location (remote or non-remote), following the Grading and Accreditation Standards for Schools in Remote Areas (偏遠地區學校分級及認定標準) (教育部, 2018a). Second, schools were classified based on their education models (experimental or standardized), which experimental schools' reference is the List of Experimental Education Schools and Institutions (實驗教育學校及機構名單) (教育部國民及學前教育署, 2023).

From each category, schools with the highest combined scores were selected, resulting in a final sample of 11 schools (Appendix 2). The sample achieved a relatively balanced geographical distribution, with 5 schools from remote areas and 6 from urban settings. The distribution across educational levels included 7 primary schools and 4 secondary schools, ensuring representation of diverse institutional contexts in the study of ESD implementation.

In terms of education models, 4 experimental schools and 7 traditional schools were selected. This distribution is particularly noteworthy given that experimental schools comprise only approximately 5% of Taiwan's primary and secondary schools, suggesting their disproportionate representation in our sample reflects their active engagement in ESD implementation.

2.3.3 Data Collection Approach

The interview outlines were customized for 29 participants, including 17 educators, and varied by category of interviewees, with each designed to target specific information,

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as summarized in Table 1. Given the substantial length of interview transcripts, they are not appended to this thesis. Nonetheless, all quoted material reflects participants' original words as transcribed and analyzed with rigor. Regarding the social network data collection of the ESD-implementing schools, four kinds of relational phenomena recognized in the network flow model are targeted to be observed, enabling the transformation of interview data into comprehensive social network data. Hence, the design of interview questions for educators from ESD-implementing schools employs a hybrid approach to capture the ESD networks.

Table 1 Interview Objectives and Outlines

Category	**Target Acquired Information**
Public Sector	Insights into government policies and regulations related to ESD. External resources and collaborations for schools' ESD. Challenges faced by government agencies in promoting ESD.
Private Sector (Including business and civil groups)	External resources and collaborations for schools' ESD. Perspectives on the overall dissemination of ESD among primary and secondary schools.
Academia	Insights into current developments in Taiwan ESD. Identification of potential gaps and suggestions for ESD implementation in primary and secondary schools. Perspectives on the overall dissemination of ESD among primary and secondary schools.
Primary or Secondary School	The resource flow exchanged for the practices of whole-school ESD. The process of the school's engagement in ESD implementation. Perspectives on the influence of the school's attributes (location and educational model). The influence of existing ESD systems (e.g., policies, regulations) on the school. Perspectives on the overall dissemination of ESD among primary and secondary schools.

This research mainly captures the networks ties of social networks through social

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relations and interactions. First, social relations are identified through the roles of participants within and outside the school, emphasizing position-based relationships. Specifically, this research defined network members by identifying individuals who have participated in ESD practices. This approach helps delineate the boundaries of the social network for data collection purposes. As Marin and Wellman (2011) suggest, position-based approaches provide a guiding principle for selecting interviewees who are integral to the social network. Second, interactions are captured by examining instances of collaboration. Questions focusing on "collaborating with" are used to collect data on connections, enabling the derivation of edge data that represents these interactions within the network.

Resource flows which channel through network ties are operationalized by this research as questions about what resources are beneficial for the schools' ESD practices. This could be seen as the function that social networks have brought about.

To comprehensively guide the interviewees to recall the resource flow, this research categorized resources into four types: human, intellectual, financial, and physical. These classifications draw upon studies on headteachers' resource networks (Hite et al., 2010) and common types of organizational resources (Hite et al., 2006), which emphasize the influence of these resources on school performance. Furthermore, studies on schools implementing Education for Sustainable Development (ESD) affirm the critical role of these resource types in supporting ESD practices. For instance, Verhelst et al. (2023) identified key characteristics of ESD-effective school organizations, including "school resources" such as infrastructure, financial resources, professional positions related to ESD, and effective time management skills. Similarly, a study on ESD in elementary schools (吳清山 et al., 2014) highlighted that school staff considered external resource support essential for ESD development. This includes enhancing ESD understanding,

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teaching expertise, teaching materials, and teacher recruitment.

Based on empirical findings of the above research: Human resources refer to the time, effort, and labor contributions of individuals, such as project members, consultants, or lecturers, who actively participate in ESD activities. Intellectual resources pertain to the content of knowledge or ideas that offer intangible inspiration or understanding to actors, independent of the individuals themselves. Financial resources involve monetary assets, which are flexible and can be used to acquire other necessary resources. Physical resources are tangible assets, including infrastructure, hardware, or learning spaces, that directly support ESD practices.

In addition, this research also designed the question, “where are resources obtained?” This question helps clarify how actors (alters) within the network influence the focal individual (ego). It allows respondents to elaborate on the structure and composition of their social networks, identifying the types of resources transmitted through these ties. This approach provides a more nuanced understanding of the functional dynamics within the social network.

Lastly, similarities, which are the backcloth of social networks, were also taken into account in this research. After the interviews, this research collated the actors’ data or further investigated the actors, which aims to facilitate setting up the infrastructure of a social network. The similarity in traits focuses on the affiliation with the school (internal or external), sector, geographical location, and the Environmental Education background.

2.3.4 Network Analysis Focus

Regarding the analysis of social networks, this research concentrated on two primary aspects of analysis: network composition and resources. Following De Schepper et al.

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(2023), who emphasized the value of these aspects in social network studies, this research investigated how the composition of actors and the resources exchanged between them influence ESD effectiveness. Network composition identified the actors and their relationships, helping to pinpoint the most influential ties for ESD adoption. The resources aspect explored the function and accessibility of the resources exchanged, as these factors significantly impact the success of ESD practices in schools.

This research adopted the ego-centric network analysis approach. The analysis perspectives of social network studies are often divided into two types: ego-centric or whole network. Ego-centric network analysis focuses on a single focal actor, known as the 'ego,' and the other actors it is connected to, referred to as 'alters.' In contrast, whole network analysis can be seen as the macrolevel of ego-centric network analysis, consisting of the ego-centric networks of all actors within a system or context (Crossley et al., 2015; Herz et al., 2014).

The selection of ego-centric networks for analyzing each implementing school's faculties is justified by several reasons. Firstly, considering there have not been any research about social networks in Taiwan's ESD, it is difficult to define the comprehensive set of schools implementing ESD and the related actors, making whole network data collection impractical and potentially unreliable. Secondly, ego-centric network analysis has gained significant attention over the past decade due to its scalability advantages when dealing with exponentially growing data, where analyzing entire networks at once becomes challenging (Tabassum et al., 2018). The restrictive structure of ego-centric networks allows for focused analysis of the properties and characteristics of each ego within its personal network, providing deep insights while maintaining manageable memory constraints.

Furthermore, ego-centric network analysis enables a detailed examination of one

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actor (the ego) and its connections with other actors, allowing for in-depth discussion of the actors and ties in each case. This granular approach is particularly valuable in establishing a foundation for future research aimed at discovering whole networks. Additionally, ego-centric networks data can accommodate actors from different domains, overcoming a limitation of whole network analysis, which typically focuses on actors within a defined single context (Crossley et al., 2015; Herz et al., 2014).

To present the findings, through software Gephi (Bastian et al., 2009), the ESD social network graphs visually depicted the actors and their relationships, supplemented by qualitative insights from interviews and observations.

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Chapter 3 The Context of ESD in Taiwan

The societal context is crucial for understanding social networks, as well as the implementation of Education for Sustainable Development (ESD). In Taiwan, the institutionalization of ESD provides the framework within which practices are conducted in schools. To comprehensively understand the ESD social networks across Taiwanese primary and secondary schools, it is essential to examine how and to what extent the nation has advanced in incorporating ESD into its educational system. This chapter seeks to explore the ESD context in Taiwan. It begins with a historical overview provided to trace the evolution of ESD from its inception to the present. Next, the current institutionalization status was analyzed. Through this chapter, the background of the ESD implementing schools' ESD network is clarified.

3.1 ESD Development in Taiwan

The emergence of Education for Sustainable Development (ESD) in Taiwan is not a sudden phenomenon or a simple adoption of UNESCO-led initiatives. Rather, it is deeply rooted in the country's long-standing tradition of Environmental Education (EE).

The origins of ESD in Taiwan can be traced to the early 1990s when environmental concerns gained prominence in national education policies. Given the close relationship between ESD and EE in Taiwan, reviewing the development of EE helps explain why ESD remains predominantly influenced by environmental perspectives. 王順美 (2016) highlights that EE laid the foundation for ESD but emphasizes the need to further integrate social, economic, and cultural dimensions to achieve comprehensive ESD goals.

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This context underscores the challenges in Taiwan's ESD development and calls for greater emphasis on multidimensional integration and practice in future efforts.

This section provides an overview of the emergence of Education for Sustainable Development (ESD) within Taiwan's educational system, tracing its evolution from the Environmental Education Act of 2010 to the country's growing alignment with international sustainability initiatives (Appendix 3). Taiwan's trajectory reflects a progression from the independent development of Environmental Education (EE) to its integration with and eventual transition into ESD. Key milestones include the early incorporation of EE into the curriculum and Taiwan's increasing participation in global ESD networks, which facilitated a shift towards more integrated sustainability education. Understanding this historical context is essential for evaluating Taiwan's current ESD landscape and its alignment with global frameworks such as ESD for 2030.

3.1.1 Initial Stage: Environmental Education Predating ESD

At the close of the 20th century, Environmental Education (EE) was introduced to Taiwan, while the concept of Education for Sustainable Development (ESD) was beginning to take shape within international frameworks, particularly under the auspices of the United Nations.

The 1972 United Nations Conference on the Human Environment in Stockholm led to the establishment of numerous environmental protection agencies and the creation of the United Nations Environment Programme (UNEP). This conference marked a pivotal moment by linking environmental, social, and economic issues, thereby laying the groundwork for future discussions on sustainable development (葉欣誠, 2017). In 1977, the Tbilisi Declaration furthered the development of Environmental Education, marking

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the beginning of Environmental Education (UNESCO & UNEP, 1978).

Later, the World Commission on Environment and Development published its landmark report, "Our Common Future", also known as the Brundtland Report (World Commission on Environment and Development (WCED), 1987), in which it introduced the now widely accepted definition of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This report was pivotal in establishing sustainable development as a key framework for future development policies at all levels of government. Additionally, although brief, Chapter 3.2 of the Brundtland Report highlights the importance of "broadening education", recognizing that shifts in values and attitudes toward environmental and developmental issues are essential for achieving long-term sustainability (World Commission on Environment and Development (WCED), 1987).

However, during this period, ESD was still in its early stages of development, lacking a clear and widely accepted definition. In contrast, Environmental Education in Taiwan had already begun its formal development, even as ESD was emerging internationally. This divergence in development is evident in the timeline: while ESD started to gain traction globally in the early 1990s, Taiwan's focus at the time was primarily on the foundational stages of EE.

In Taiwan, the Environmental Protection Administration (EPA) was established in 1987, followed by the creation of the Ministry of Education's Environmental Protection Task Force in 1990. These institutional developments established the foundational framework for the growth of Environmental Education in Taiwan.

Since the adoption of Agenda 21 at the United Nations Conference on Environment and Development (UNCED), commonly referred to as the Earth Summit in 1992, the concept of combining education with sustainable development began to take root. Agenda

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21, particularly in Chapter 36, highlighted the role of education in promoting sustainable development, calling for greater awareness and capacity-building for sustainable practices at all levels of society (United Nations, 1992). This document symbolized a milestone in international discussions about ESD, though the term "Education for Sustainable Development" itself was not fully formalized yet. The call for ESD in Agenda 21 laid the groundwork for its eventual growth but did not immediately trigger significant shifts in national educational systems.

Following the adoption of Agenda 21, the green school movement emerged as a direct response to its call for a comprehensive approach to sustainable development. While Agenda 21 emphasizes both environmental protection and the integration of sustainable development principles, the green school movement specifically embodies these ideals within the educational context. Central to this movement is the whole school approach, which seeks to embed sustainability into every facet of school life—ranging from curriculum and infrastructure to school governance and community engagement. This approach not only encourages environmental stewardship but also fosters a broader understanding of sustainability as a core value in education.

Although Taiwan did not initially adopt the green school movement, nearly a decade later, the Executive Yuan established the National Council for Sustainable Development (NCSD) in 1997 (National Council for Sustainable Development, 2024). This move was in response to the global call from the Earth Summit. It marked a significant step in aligning Taiwan’s policies with the international emphasis on sustainability and laid the foundation for future Environmental Education and initiatives within the country.

In 1999, requested by the Environmental Protection Bureau and inspired by international Environmental Education models, professors from National Taiwan Normal University’s Environmental Education Institute developed operational teaching materials

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for Environmental Education. This led to the establishment of the Green School Partnership Program in 2000, which aligned with the global green school movement, with the institute leading its implementation. Another program related to ESD was initiated shortly after the Green School Partnership Program, motivated by the pressing need to address the unsustainable practices highlighted by a major natural disaster in Taiwan. The Sustainable Circular Campus Project, launched in 2001 by the Ministry of Education in response to the 921 Earthquake of 1999, prioritized the reconstruction of numerous schools and provided funding for infrastructure improvements (高翠霞 & 蔡崇建, 2011).

Simultaneously, global efforts toward sustainability advanced through the establishment of the Millennium Development Goals (MDGs), which were implemented over the period from 2000 to 2015 (United Nations, 2001). These eight goals are widely regarded as the foundational framework for the subsequent proposal of the Sustainable Development Goals (SDGs) 15 years later (UNDP, 2016).

In 2002, the Johannesburg World Summit on Sustainable Development (WSSD) strengthened global commitments to sustainable development at all levels. The Summit proposed the Decade of Education for Sustainable Development (DESD), emphasizing the role of education in advancing sustainability (UNESCO, 2005). In response to this proposal, the United Nations General Assembly (UNGA) adopted Resolution 57/254 in December 2002, officially establishing the DESD to take place from 2005 to 2014.

After the 2002 United Nations World Summit on Sustainable Development, Taiwan released its Sustainable Development Action Plan and designated 2003 as the inaugural year for sustainable development initiatives (referred to as 「永續元年」), signaling the country's commitment to aligning with global sustainable development goals (行政院環

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境保護署主任秘書室, 2003). In 2004, the National Development Council (NDC) published *Taiwan's Agenda for the 21st Century: National Sustainable Development Vision and Strategic Framework* (行政院經濟建設委員會, 2004).

Throughout the document, education plays a supporting role but is not addressed in a cohesive or strategic manner. There is no clear framework outlining how educational strategies could be leveraged to achieve the overarching goals of sustainable development. Instead, references to education are scattered across the strategies of the three main dimensions, with no dedicated section on how educational content should be developed or implemented. Nevertheless, the document highlights that Environmental Education (EE) was a central focus in Taiwan's national discourse on sustainability at the time. The emphasis on EE over Education for Sustainable Development (ESD) is evident in several sections. Despite the inclusion of Professor 王鑫, a member of the National Sustainable Development Committee's Sustainable Education Group, the term "ESD" is notably absent. In the section on "Taiwan's Sustainable Development Principles and Directions," 'Environmental Education' is mentioned under strategies for the 'sustainable environment' dimension. However, in discussions of 'sustainable economy' and 'sustainable society,' education is categorized as 'social education,' reflecting a separation between educational approaches to environmental and socio-economic issues. This contrasts with the ESD framework, which calls for a more integrated approach to both environmental and socio-economic challenges.

This indicates that Taiwan's approach to sustainable development at the time relied heavily on Environmental Education, particularly aimed at "enhancing lifelong education for sustainability" to raise public awareness and understanding of environmental issues. However, the focus remained predominantly on the environmental dimension, rather than

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adopting a more comprehensive ESD approach.

At the time, Taiwan was still focused on the initial phase of Environmental Education, which concentrated mainly on raising awareness about environmental issues and promoting environmental stewardship. The formal development of ESD took longer to gain momentum.

The Decade of Education for Sustainable Development (DESD), initiated in 2005, was divided into two phases following the 2009 World Conference on Education for Sustainable Development (Buckler & Creech, 2014). The first phase (2005–2009) emphasized raising global awareness and building capacity for Education for Sustainable Development (ESD). The second phase (2010–2014) shifted its focus toward improving the quality of education, embedding sustainability more deeply into educational systems and practices at all levels. This transition underscored the importance of not only raising awareness but also equipping individuals with the knowledge and skills necessary for sustainable development.

Globally, DESD had a significant impact by increasing recognition of ESD and clarifying its definition, which facilitated its dissemination. UNESCO's advocacy efforts prompted the establishment of national ESD policies, fostered ESD-focused collaborative organizations, and contributed to the gradual formation of international ESD networks (張珍悅 & 徐勝一, 2010).

In Taiwan, the academic discussion of ESD began in 2002, initially framing ESD as closely aligned with Environmental Education (EE) (葉欣誠, 2017). Early studies during the first phase of DESD continued to interpret ESD as a reinterpretation of EE within the same conceptual framework (葉國樑 et al., 2006). By the mid-phase, Taiwanese scholars developed a more nuanced understanding of ESD. 張珍悅 and 徐勝一 (2010)

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examined the global interplay between ESD and EE, noting that during this period, ESD was largely synonymous with EE in Taiwan, the United States, and other nations, where EE remained the dominant paradigm.

It was only later, as the concept of Education for Sustainable Development (ESD) became more clearly defined internationally during the Decade of Education for Sustainable Development (DESD), that Taiwan began to more comprehensively integrate sustainability into its educational framework, aligning with the evolving global perspectives on sustainable development. While elements of sustainability were already present in Environmental Education (EE) during this period, they were not central to its core values or objectives.

EE in Taiwan continued to strengthen, evolving from voluntary integration into educational settings to the formal establishment of the Environmental Education Act in 2011. In contrast, ESD remained largely peripheral within Taiwan's education system during this time. This disparity highlights the complex and gradual transition from a focus on Environmental Education to a more integrated approach that encompasses the broader dimensions of sustainability under the framework of ESD.

3.1.2 Intermediate Stage: Environmental Education Growing Alongside ESD

The enactment of the Environmental Education Act in 2010 ("The Environmental Education Act (環境教育法)," 2010), which was officially implemented in 2011, marked a landmark development in advancing Environmental Education in Taiwan (中華民國環境教育學會, Ed., 2022). It laid the foundation for the formal institutionalization of Environmental Education, further reinforced in 2011 with the publication of the *National Environmental Education Guidelines* (環境部, 2011). These guidelines outlined both

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short- and long-term objectives for promoting Environmental Education, emphasizing the fostering of environmental awareness, ethics, and sustainable practices across the nation. The Act not only made Environmental Education a legal requirement but also marked a significant step toward integrating sustainability into the national education framework. Additionally, it highlighted Taiwan's unique position as the sixth country to legislate Environmental Education (葉欣誠, 2017).

While Taiwan's initiatives in Environmental Education were taking shape, global efforts to promote Education for Sustainable Development (ESD) were also advancing. The second phase of the Decade of Education for Sustainable Development (DESD) spanned from 2010 to 2014 (Buckler & Creech, 2014). At the conclusion of the Decade, the world recognition of ESD importance did not stop. Building on the achievements of the DESD, the Global Action Programme (GAP) was launched in November 2014 to sustain the ESD initiative. Officially introduced during the UNESCO World Conference on Education for Sustainable Development in Nagoya, Japan, the GAP was framed around the theme "Learning Today for a Sustainable Future." This initiative aimed to advance the global Education for Sustainable Development (ESD) agenda by promoting the incorporation of sustainability principles into education systems worldwide (UNESCO, 2014). It represented a pivotal moment in ESD's evolution, shifting toward a more action-oriented approach to fostering sustainability through education in the years that followed.

In 2014, the DESD Forum held in Nagoya connected Taiwanese Environmental Education scholars with international ESD trends, enhancing their awareness of ESD. This initiative was prompted by research project requests from the Environmental Protection Administration (now the Ministry of the Environment), which involved Taiwanese scholars in the event. The subsequent commissioned research project resulted

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in the publication *Action Strategies for Sustainable Development Education*, which, based on the current state of EE and ESD development in Taiwan and drawing on ESD case studies from Japan, South Korea, and the Netherlands, proposed a draft action strategy for ESD in Taiwan (王順美, 2016). 王順美 (2016) argued that a critical issue that needed to be addressed was the establishment of a dedicated government agency for ESD. This, she suggested, would involve cross-ministry collaboration to actively integrate Taiwan's accumulated achievements in ESD, leveraging existing EE resources and regulations to strengthen the integration of ESD into formal, non-formal, and informal education in Taiwan.

Although the proposed strategy was not fully implemented, the engagement with Education for Sustainable Development (ESD) continued to develop within Taiwan's academic field. Scholars such as 黃玫玲 (2012) explored the international education competencies that elementary school teachers should possess, which this research believes could contribute to ESD; 郭金水 (2012) critically assessed the current state of ESD in Taiwan with overemphasis in environmental aspect, emphasizing the need to strengthen its social and economic dimensions; 吳清山 et al. (2014) identified challenges faced by elementary school educators in implementing ESD and outlined potential areas for improvement; and 葉欣誠 (2017) using the concept of the framing effect, examined feasible approaches to promoting ESD based on Taiwan's development of Environmental Education (EE). From these academic studies in Taiwan, a clear pattern emerges that scholars are increasingly advocating for a more comprehensive approach to ESD. This involves broadening its focus beyond Environmental Education to encompass social and economic dimensions, while also addressing the practical challenges faced by educators in its implementation.

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While Taiwan's academic field has shown increasing engagement with ESD, this trend is part of a larger global movement. According to Grosseck et al. (2019), the academic discussion on ESD steadily rose from 2005 to 2014, coinciding with the UN Decade of Education for Sustainable Development (DESD). UNESCO played a pivotal role in promoting ESD globally during this period. However, despite the UN's efforts to introduce ESD to its member states, the concept remained ambiguously defined, and its interpretation varied across countries, influenced by diverse cultural and educational contexts. This variation underscores the need to localize ESD implementation strategies (Wang, 2015).

In 2014, Taiwan established a program responding to international ESD trends. Under official collaboration with the United States government, the Taiwan-U.S. Eco-Campus Partnership Program was formally launched. This initiative led to the establishment of the first cohort of Eco-Campus Alliances, comprising 11 primary and secondary schools across Taiwan (王懋雯 et al., 2015). This initiative aligned with the Eco-Schools Programme, an internationally recognized framework supported by the United Nations, which encourages schools to integrate Environmental Education and sustainability practices into their curricula. The Taiwan Eco-Campus Partnership Program, as a localized version of this international initiative, exemplified Taiwan's commitment to advancing sustainability through education.

While on the global stage, significant developments in Education for Sustainable Development (ESD) were taking place. In September 2015, the United Nations Sustainable Development Summit adopted the "2030 Agenda for Sustainable Development," introducing 17 Sustainable Development Goals (SDGs) aimed at addressing global challenges such as poverty, inequality, climate change, and environmental degradation. The 2030 Agenda for Sustainable Development has also

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strengthened countries' commitment to the SDGs by encouraging regular, inclusive, and country-led Voluntary National Reviews (VNRs), which serve as a basis for the voluntary, state-led reviews conducted by the high-level political forum (HLPF) (UNDESA, 2024).

Just a few months after the emergence of the 2030 Agenda, world leaders reached a breakthrough in December 2015 with the adoption of the Paris Agreement at the UN Climate Change Conference (COP21) in Paris. This historic agreement set long-term climate goals to limit global temperature rise and underscored the importance of international cooperation in addressing climate change, particularly in terms of finance and adaptation for developing countries.

Although the Paris Agreement focused primarily on climate change, it, alongside the SDGs, created a shared global recognition of the urgency of sustainable development. Both initiatives highlighted the need for concrete actions across various sectors, fostering a sense of global responsibility and an awareness that achieving these ambitious goals required widespread transformation. This growing global commitment to sustainability provided the backdrop for a renewed emphasis on ESD as a critical tool for engaging individuals, communities, and nations in driving sustainable change.

In this context, UNESCO's 2017 publication, Education for Sustainable Development Goals: Learning Objectives, further articulated how ESD could contribute to achieving the SDGs (UNESCO, 2017). The document provided concrete learning objectives for educators and policymakers to guide the integration of sustainable development principles into educational curricula and practices. By linking ESD directly to the SDGs, the publication reinforced that education would play an essential role in enabling individuals and societies to meet global sustainability challenges.

This increasing recognition of the interconnectedness of climate action and sustainable development, driven by the momentum of the SDGs and the Paris Agreement,

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marked the beginning of a significant shift in the global approach to education. Researchers described this period after 2015 as one of "high growth" for ESD, with ESD increasingly seen as vital for equipping people with the knowledge, skills, and values needed to support sustainable transformation of countries around the world (Grosseck et al., 2019).

During the intermediate stage of ESD development in Taiwan, Environmental Education (EE) flourished, largely due to the enactment of the Environmental Education Act. Globally, the importance of Education for Sustainable Development (ESD) was reinforced through the Global Action Programme (GAP), which introduced more tools and resources. Additionally, the global emphasis on sustainable development, driven by the SDGs and the Paris Agreement, acted as a catalyst for further progress.

Although ESD had not yet been incorporated into Taiwan's educational policies and most people were still unfamiliar with the concept, it was occasionally addressed in EE-related events 葉欣誠 (2017) and gained governmental attention through funded research, such as the *Action Strategies for Sustainable Development Education* (王順美, 2016). There is hope for ESD's expansion, as the study has shown that ESD's broader framework offers advantages over EE in fostering greater awareness and consensus across various disciplines (葉欣誠, 2017). The growing international and national focus on sustainable development during this stage further heightened recognition of ESD, ultimately leading to its emergence into Taiwan's educational policies in the next phase of its development.

3.1.3 Recent Stage: Environmental Education Transitioning to ESD

During the intermediate stage of ESD development in Taiwan, Environmental Education (EE) flourished, largely due to the enactment of the Environmental Education

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Act. Globally, the importance of Education for Sustainable Development (ESD) was reinforced through the Global Action Programme (GAP), which introduced more tools and resources. Additionally, the global emphasis on sustainable development, driven by the SDGs and the Paris Agreement, acted as a catalyst for further progress.

In line with international efforts, Taiwan's National Council for Sustainable Development (NCSD) released its first Voluntary National Review (VNR), demonstrating its alignment with global progress on sustainable development after two years (Executive Yuan, 2017). This signaled that Taiwan's authorities had taken the promotion of sustainable development with ambition.

Aligned with the global Sustainable Development Goals (SDGs), the development of the "Taiwan Sustainable Development Goals" (Taiwan SDGs) was officially completed in 2019, following nearly three years of work since 2016. Established by the National Council for Sustainable Development (NCSD) under the Executive Yuan, these national goals serve as a blueprint for addressing sustainability challenges within Taiwan’s unique social, environmental, and economic context.

The Taiwan SDGs provide a comprehensive framework for sustainable development across various sectors, reflecting Taiwan’s growing commitment to sustainability and laying a solid foundation for future Education for Sustainable Development (ESD).

In the same year, 2019, the country also launched the Twelve-Year National Basic Education Curriculum, a significant reform aimed at modernizing Taiwan’s education system. While the curriculum does not explicitly prioritize ESD, it echoes key sustainable development concepts. The Core Competencies and Integrative Issues create opportunities to integrate sustainability-related themes into teaching and learning. However, as ESD is not explicitly mandated, the curriculum allows educators to incorporate sustainability topics into existing subject areas at their discretion.

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Given that the Twelve-Year National Basic Education Curriculum offers flexibility for educators to integrate sustainability concepts, the SDGs Education Handbook (永續發展目標教育手冊) published by Ministry of Education can serve as a more directive resource. It supports educators in approaching ESD more effectively and aligning their teaching practices with the Taiwan SDGs (*永續發展目標(SDGs)教育手冊-臺灣指南*, 2020). Rather than offering specific, prescriptive strategies, the handbook provides guidance and tools to help teachers incorporate sustainability into their classrooms in a way that is contextually relevant and aligned with both local and global sustainability goals. This publication also serves as a response to global developments, Taiwan began aligning its educational system with the international focus on the SDGs. The content of the Handbook largely followed UNESCO's 2017 publication *"Education for Sustainable Development Goals: Learning Objectives"*.

The "marriage" of ESD and the SDGs was officially announced at the World Conference on Education for Sustainable Development in May 2021 (UNESCO, 2020). Because of the Berlin Declaration on Education for Sustainable Development made at the Conference, ESD is recognized as a key enabler for achieving all 17 SDGs. In particular, SDG 4.7—focused on "Education for Sustainable Development and Global Citizenship"—is central to equipping learners with the knowledge, skills, and values needed to drive the transformation toward sustainability (UNESCO, 2022). As outlined in the Berlin Declaration, the "ESD for 2030" framework and its accompanying Roadmap provide a strategic approach for the next decade. The Roadmap focuses on five priority action areas to mobilize action on ESD: policy, transforming learning environments, capacity development of educators, youth empowerment, and local-level action (UNESCO, 2020).

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While global progress in ESD advocacy continues, Taiwan is also making strides in advancing ESD. Beginning in 2022, Taiwan launched the NEED Policy (New-generation Environmental Education Development Policy), a four-year initiative that marks a crucial step in integrating ESD into the country's education system (中華民國環境教育學會, Ed., 2022). This policy represents a significant evolution from Taiwan's long-established focus on Environmental Education (EE) to a broader, more integrated approach that aligns with the full scope of the Sustainable Development Goals (SDGs). At its core, the NEED Policy builds upon Taiwan's EE framework, which has been central to the country's educational philosophy for decades. Moreover, the NEED Policy expands this foundation by promoting a shift towards ESD, recognizing that sustainable development requires addressing the social, economic, and cultural dimensions. As shown in Table 2 below, the Ministry of Education has devised the NEED Policy as a paradigm shift from Environmental Education to ESD.

Table 2 Comparison of the Environmental Education Paradigm Shift

Current Environmental Education	**Aspect**	**Development of the Next Stage of Environmental Education**
Environmental-related Issues	Content Scope	Diverse issues in environment, society, and economy
Establishing "Responsible Environmental Behavior"	Ultimate Goal	Establishing "Core Sustainability Competence"
Protecting the environment and solving environmental problems	Core Values	Creating opportunities for environmental and economic synergy
Teaching focused on environmental advocacy, experience, and concepts	Teaching Strategies	Interdisciplinary, thematic inquiry-based and hands-on teaching
Learning focused on improving environmental quality	Learning Guidelines	Learning focused on promoting sustainable development

doi:10.6342/NTU202501048

Source: 中華民國環境教育學會 (Ed.) (2022).

Thus, the NEED Policy represents a significant step in the ongoing evolution of Taiwan's educational system towards one that more explicitly incorporates sustainability principles and the SDGs, providing a framework for educators to engage with ESD. This policy aims to equip students not only with environmental awareness but also with the knowledge, skills, and values necessary to contribute to a sustainable future in all aspects of society.

In recent years, the global discourse on net-zero emissions has gained prominence, reflecting its growing importance in the sustainable development agenda and its relevance to Education for Sustainable Development (ESD) both globally and in Taiwan. As nations increasingly align their policies with global climate objectives, sustainability is being integrated across governance, industry, and society. Under the Paris Agreement, Nationally Determined Contributions (NDCs) address climate change while aligning with broader national development priorities, fostering sustainability across multiple sectors. This interconnected framework of climate action and sustainable development provides essential context for analyzing Taiwan's Environmental Education policies and their alignment with global sustainability and climate goals.

Following the launch of Taiwan's New-generation Environmental Education Development (NEED) policy, the nation advanced its climate action agenda by unveiling its Net-Zero Emissions Roadmap in March 2022 (*Taiwan's Pathway to Net-Zero Emissions in 2050*, 2022). The roadmap outlines 12 key strategies for the transition, reaffirming Taiwan's commitment to the 2015 Paris Agreement. Notably, the promotion of a "Green Lifestyle" is emphasized, with Environmental Education as a central component. This underscores the growing convergence of net-zero objectives and

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Education for Sustainable Development (ESD) in Taiwan, highlighting the critical role of education in driving the country's climate transition.

Taiwan's evolving Environmental Education policies reflect the significant influence of global initiatives such as the Paris Agreement and the United Nations Sustainable Development Goals (SDGs) on the nation's educational strategies for sustainability. The ongoing revisions to Taiwan's National Environmental Education (EE) Guidelines (國家環境教育綱領) illustrate a progressive alignment with international frameworks and shifting priorities in Environmental Education (環境部, 2011, 2023).

The first version, introduced in 2011, emphasized broad environmental concepts but lacked explicit integration of global frameworks like the SDGs or specific climate action targets, such as net-zero emissions (環境部, 2011). The 2019 revision marked a pivotal change by aligning Taiwan's Environmental Education goals with both the SDGs and national sustainability objectives, highlighting the country's growing commitment to global sustainability. The 2023 revision further advanced this alignment, explicitly linking the guidelines to Taiwan's 2050 Net-Zero Emissions Transition Policy (環境部, 2011). For the first time, the core principles incorporated net-zero transition alongside sustainability, environmental justice, and intergenerational well-being, underscoring a decisive move toward embedding climate action into Taiwan's educational framework.

This growing alignment with international climate frameworks, including the Paris Agreement and the broader Sustainable Development Goals (SDGs), marks a significant transformation in Taiwan's approach to Environmental Education. The integration of net-zero transition into the latest guidelines reflects the country's commitment to embedding climate action within its educational policies, emphasizing the expanding role of education in achieving both national and global climate objectives.

doi:10.6342/NTU202501048

As climate action and sustainable development become increasingly integral to national policy goals, Education for Sustainable Development (ESD) emerges as a pivotal mechanism for embedding sustainability into societal and educational priorities. Recognizing the urgency of the climate crisis, UNESCO has highlighted the importance of greening schools as a central component of climate change education.

In 2022, the UN Secretary General's Transforming Education Summit introduced the Greening Education Partnership, aimed at accelerating climate change education globally. Building on this initiative, UNESCO released the “Green School Quality Standard” in 2024, setting an ambitious target for at least 50% of schools worldwide to adopt green practices by 2030 (UNESCO, 2024b). This initiative underscores the growing role of ESD in advancing the global net-zero transition. Thus, the commitment to net-zero emissions can also be seen as a major catalyst for shifting the macro-environment in which ESD operates. As the government’s comprehensive approach—spanning energy transition, industrial transformation, and societal shifts—takes shape, it has fostered a more practical, results-oriented framework for sustainable development. The increasing emphasis on sustainability in national policies and industry standards further strengthens the demand for ESD.

Taiwan's transition from Environmental Education (EE) to Education for Sustainable Development (ESD) is evident in the evolution of its major whole-school programs which was established in the early 2000s: The Green School Partnership Program, established in 2000, was developed by professors from National Taiwan Normal University's Graduate Institute of Environmental Education following a 1998 request from the Environmental Protection Bureau (NTNU Graduate Institute of Environmental Education, 1999); and the Sustainable Circular Campus Project emerged simultaneously while explicitly incorporating "sustainable" in its title, reflecting broader sustainability

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goals influenced by the 1992 UN Earth Summit's Agenda 21 and the 1997 Kyoto Protocol (Sustainable Campus Development Guide, 2009; 高翠霞 & 蔡崇建, 2011).

The evolutionary paths of these programs demonstrate Taiwan's broader shift from EE to ESD. The Green School Partnership Program's transformation is evident when comparing its 2009 (蘇慧貞, Ed., 2009) and 2023 (Ministry of Education, 2023) vision statements, showing increased emphasis on sustainable development, regional connections, and integration with the Twelve-Year National Education Curriculum. A significant shift occurred around 2018 with the introduction of community-focused approaches. The 2023 vision expanded "School Life" to include "interaction with schools and communities and practical life," encouraging members to inspire community actions beyond personal environmental behaviors. This community mindset was reinforced through the "watering can" count in the reward mechanism.

The Sustainable Circular Campus Project underwent substantial reorientation, shifting from energy conservation, carbon reduction, and disaster prevention (2010-2013) to emphasizing Sustainable Development Goals (SDGs) since 2019. The most recent transformation occurred from 2023 (until 2026), when it was renamed the "Smart Climate-Friendly Campus Program" and explicitly aligned with the "International Sustainable Development Action Period" (教育部資訊及科技教育司, 2024a, 2024b). This latest phase promotes campus climate audits and focuses on carbon emission reduction, directly supporting Taiwan's 2022 "Pathway to Net-Zero Emissions by 2050" initiative. This alignment reflects the global trend of integrating climate change education into ESD frameworks.

This research identifies three distinct stages in the evolution of Environmental

doi:10.6342/NTU202501048

Education in Taiwan, illustrating its growing alignment with ESD: the initial stage of Environmental Education Predating ESD, the intermediate stage of Environmental Education Growing Alongside ESD, and the current stage of Environmental Education Transitioning to ESD. The key turning points in these stages are largely defined by the enactment of the Environmental Education Act in 2011 and the publication of Taiwan's Voluntary National Review (VNR) in 2017.

In the period preceding the enactment of the Environmental Education Act, Taiwan was in the process of maturing its Environmental Education initiatives. During this time, the Decade of Education for Sustainable Development (DESD) (2005-2014) was underway internationally (UNESCO, 2005). Although some Taiwanese scholars began to engage with the concept of ESD, their efforts were not yet sufficiently robust to make a significant impact.

The enactment of the Environmental Education Act marked a significant shift, requiring public primary and secondary schools, as well as government agencies, to undergo training in Environmental Education. This legal framework also established certification mechanisms for Environmental Education personnel, which contributed to the widespread adoption of EE across Taiwan. Notably, the Act incorporated the concept of sustainability, which effectively allowed Taiwan's ESD practices to build upon existing EE structures. However, scholars have expressed concerns about the limitations if the transition continues to focus primarily on the environmental aspect (王順美, 2016; 葉欣誠, 2017). These concerns suggest that ESD in Taiwan should integrate diverse perspectives to adopt a more holistic approach to sustainability.

In 2017, Taiwan introduced its Voluntary National Review (VNR), signaling a heightened commitment to sustainable development at the national level (Executive Yuan, 2017). This period saw not only the advancement of Taiwan’s first policy document

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outlining the specific elements of ESD, the New-generation Environmental Education Development (NEED) policy, but also growing interest in sustainability from sectors beyond Environmental Education. Other sectors, including local governments, businesses, and private organizations, began to embrace the concept of sustainability. Taiwan's government further solidified its commitment on Sustainable Development and Net-Zero emissions in 2022, emphasizing the importance of sustainable practices. This research suggests that the shift towards sustainability during this period transcended the boundaries of traditional Environmental Education, fostering broader recognition and engagement with SDGs across various sectors.

3.2 Examining Progresses in Taiwan's ESD Institutionalization

The institutionalization of Education for Sustainable Development (ESD) represents a crucial step toward achieving systemic educational change that can withstand shifts in priorities, personnel, and other challenges identified by UNESCO during the Decade of Education for Sustainable Development (DESD) (Buckler & Creech, 2014). UNESCO's ESD for 2030 framework emphasizes five priority areas for comprehensive ESD implementation: advancing policy, transforming learning environments, building educator capacities, empowering youth, and accelerating local level actions. This study primarily examined Taiwan's progress in the first three areas, as these most directly relate to the institutional and educational dimensions of ESD implementation. Through this lens, Taiwan's journey in institutionalizing ESD reveals both progress and persistent challenges in aligning with these international priorities.

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3.2.1 Advancing Policy

Taiwan's journey in institutionalizing Education for Sustainable Development (ESD) has been marked by significant policy developments and structural changes since the late 1990s. In 1997, the establishment of the National Council for Sustainable Development (NCSD) laid the foundational framework for sustainable development governance. This was followed by several key policy initiatives, including the 2009 "Policy Guidelines for Sustainable Development" and the 2011 implementation of the Environmental Education Act. The nation's commitment to global sustainability frameworks was demonstrated through its first Voluntary National Review in 2017, and the subsequent development of Taiwan-specific SDGs in 2019. The Ministry of Education's publication of the SDGs Education Handbook in 2019 and the implementation of the New-generation Environmental Education Development (NEED) Policy (2022-2025) represent recent efforts to integrate ESD into the educational system.

However, the institutionalization process faces several structural challenges. A primary concern is the lack of a dedicated leadership unit for ESD implementation. While NCSD exists as a cross-ministerial body with the Ministry of Education heading the education promotion division, research by 王順美 (2016) indicates that educational reports lack cohesive planning, appearing more as compilations of various divisions' results rather than systematic initiatives. 葉欣誠 (2017) further critiques NCSD's effectiveness, noting that despite its high-level positioning, its task force nature and lack of independent budget, personnel, and administrative power significantly limit its ability to implement major policies. Both scholars advocate for the Ministry of Education to assume the primary leadership role in ESD, given that ESD's core focus is educational transformation and encompasses broader aspects beyond environmental concerns. As of

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2024, Taiwan still lacks a national-level organization to comprehensively lead ESD efforts, resulting in the absence of standardized guidelines for ESD content, teaching methodologies, and evaluation criteria.

The current institutional framework presents additional challenges in policy implementation. The NEED policy, despite its ambitious goals, faces limitations due to its organizational positioning under the Department of Science and Technology of the Ministry of Education. Expert E04 highlights that this arrangement restricts the policy's influence to a "niche audience," primarily reaching Environmental Education networks rather than the broader national education system. E04 argues that for effective implementation in primary and secondary schools, the policy should instead be led by the K-12 Education Administration, which oversees national education systems[4].

This perspective is reinforced by E01, who criticizes the Department of Science and Technology's knowledge-oriented approach, noting its lack of educational expertise. Based on years of observation, E01 and E02 point out that under the department's leadership, invited experts primarily focus on knowledge transmission rather than educator empowerment.

3.2.2 Building Educator Capacities

In terms of educator's capacity development, both pre-service and in-service training systems show substantial limitations. At the pre-service level, teacher preparation programs at major institutions like National Taiwan University and National Taiwan Normal University only offer Environmental Education as an elective course (University,

[4] Since 2013, the K-12 Education Administration (教育部國民及學前教育署) has been responsible for developing, implementing, and overseeing policies for primary and secondary education, as well as preschool education (吳清山, 2021).

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2024; University). ESD is merely listed as an "emerging issue" among nearly thirty other educational topics in the mandatory "Educational Issues Seminar" course, indicating its marginalized status in teacher preparation.

The in-service training system presents equally concerning challenges. Despite the Environmental Education Act's mandate that all school staff participate in Environmental Education training, the implementation shows significant gaps. The Act requires all civil servants, including school administrators, teachers, and K-12 students, to complete at least four hours of environmental and sustainability education annually (The Environmental Education Act [環境教育法], 2010). However, qualitative research conducted by (Huang et al., 2021) reveals that these mandatory courses are often perceived as mere "paperwork" and "bureaucratic exercises" by school staff, suggesting a disconnect between policy intentions and practical implementation.

The availability of ESD-specific training opportunities remains scarce. A search on the "National Teacher In-Service Training Information Network" reveals only 106 courses containing "ESD" between 2002 and December 2024, with just 14 courses offered in 2024 (National Teacher In-Service Training Network, n.d.). The NEED policy's approach to teacher training primarily targets local Environmental Education advisory groups, potentially limiting its reach to those already engaged in Environmental Education circles.

The quality and format of existing training programs also raise concerns. E01 and E02 note that current training primarily consists of one-time lectures, lacking the sustained engagement necessary for effective professional development. E01 expresses particular frustration with this limitation, emphatically stating that "teacher training is most important, but the way in-service training is conducted... it will never, never change!" This sentiment reflects deep concerns about the systemic inadequacies in professional

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development approaches.

3.2.3 Transforming Learning Environments

The Curriculum Guidelines of 12-Year Basic Education—commonly referred to as the "108 Curriculum Guidelines"—reflect both the progress and ongoing challenges of institutionalizing Education for Sustainable Development (ESD) in learning environments. The guidelines influence pedagogy, teacher roles, classroom practices, and student engagement, highlighting how ESD principles are being gradually integrated into the fabric of everyday education. In Taiwan, the 108 Curriculum Guidelines have served as the foundation for curriculum planning and implementation in Taiwan's K-12 schools since their introduction in 2019. Unlike the previous Curriculum Guidelines for Nine-Year Compulsory Education (九年一貫課綱), which emphasized Basic Competencies (基本能力), the 108 Curriculum Guidelines have shifted the focus to Core Competencies (核心素養). These competencies aim to cultivate students as "lifelong learners" (終身學習者), emphasizing the Three Major Dimensions and Nine Items of Core Competencies. Another significant innovation in the 108 Curriculum Guidelines is the emphasis on interdisciplinary learning. The 108 Curriculum Guidelines demonstrates potential for integrating the concept of Sustainable Development into school education. This is evident in its "Fundamental Philosophy" (基本理念), which states that school education should encourage students to actively contribute to the sustainable development of society, nature, and culture. According to 張子超 (2023), "sustainable development has already been incorporated into the 108 Curriculum Guidelines," he highlighted the alignment between the concept of sustainable development and the "Social Participation" dimension, one of the Three Major Dimensions of Core Competencies. This dimension

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includes “Moral Practice and Civic Awareness,” “Interpersonal Relationships and Teamwork,” and “Multicultural and Global Understanding.” These elements directly resonate with the principles of sustainable development, providing a strong foundation for integrating Education for Sustainable Development (ESD) into school curricula.

To further examine the alignment between Taiwan's Core Competencies and the concept of Education for Sustainable Development (ESD), Table 3 shows the identification of broader correlations across multiple dimensions. Taiwan’s Core Competencies framework exhibits alignment with UNESCO’s key competencies for sustainability, highlighting its potential to advance ESD. Notable alignments are observed in several areas. The "Systematic Thinking and Problem-Solving" competency closely corresponds to UNESCO’s systems thinking and integrated problem-solving competencies, emphasizing the capacity for analyzing complexity and devising solutions. Similarly, "Planning, Execution, and Adaptive Innovation" aligns with UNESCO’s strategic and anticipatory competencies, underscoring skills in innovative planning and adaptability in response to change. Additionally, the emphasis on "Interpersonal Relationships and Teamwork" mirrors UNESCO’s collaboration competency, while "Moral Practice and Civic Awareness" aligns with normative competencies focused on understanding and applying ethical values.

Taiwan's framework also includes unique competencies not explicitly addressed in UNESCO’s framework, such as artistic literacy and technological competency. These partially aligned competencies reveal areas where Taiwan’s framework diverges from UNESCO’s sustainability-oriented approach. On one hand, these differences highlight gaps in fully aligning with UNESCO’s explicit focus on sustainability, suggesting that incorporating a stronger sustainability orientation could enhance Taiwan’s framework’s environmental and future-focused aspects. On the other hand, the inclusion of unique

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competencies in Taiwan's framework—such as artistic literacy and technological skills—offers an opportunity to enrich ESD, providing a broader and potentially more comprehensive approach to addressing contemporary sustainability challenges.

Furthermore, the curriculum introduces 19 suggested integrative issues designed to be incorporated into course design, including gender equality, human rights, environment, oceans, ethics, life education, rule of law, technology, information, energy, safety, disaster prevention, family education, career planning, multiculturalism, reading literacy, outdoor education, international education, and Indigenous education (Ministry of Education, 2021a). These issues align with key aspects of the Sustainable Development Goals (SDGs), reflecting the broader principles of sustainability.

Table 3 The Three Major Dimensions and Nine Items of Core Competencies in the Curriculum Guidelines of 12-Year Basic Education (108 Curriculum Guidelines)

Three Major Dimensions	**Nine Items of Core Competencies**	**Connotations of Core Competencies**	**Alignment with Key competencies for Sustainability of ESD**
Autonomous Action	Physical and Mental Well-being and Self-Improvement	Develop qualities for holistic physical and mental growth. Through selection, analysis, and application of new knowledge, effectively plan career development and pursue continuous self-improvement for excellence.	Self-awareness competency (partially aligned)
	Systematic Thinking and Problem-Solving	Cultivate systematic and meta-cognitive thinking skills, including understanding problems, critical analysis, and logical reasoning, to effectively address life and existential challenges.	**Systems thinking competency, integrated problem-solving competency**
	Planning, Execution, and Adaptive Innovation	Develop abilities to plan and execute initiatives, foster creativity, and respond to societal changes, enhancing personal adaptability and resilience.	**Strategic competency, anticipatory competency**
Communication and Interaction	Symbol Usage and Communication Skills	Possess the ability to understand and utilize various symbols—such as language, text, mathematics, body language, and art—for effective expression and communication, while also demonstrating empathy and	Collaboration competency (partially aligned)

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		understanding towards others.	
	Technology, Information, and Media Literacy	Skillfully use technology, information, and various media, cultivating ethics and media literacy to analyze, critically evaluate, and think about media content.	Critical thinking competency (partially aligned)
	Artistic Literacy and Aesthetic Appreciation	Develop abilities in perceiving, creating, and appreciating art, fostering an attitude and skills to analyze, construct, and share the beauty and goodness in people, events, and things.	Self-awareness competency (partially aligned), normative competency (partially aligned)
Social Participation	**Moral Practice and Civic Awareness**	Cultivate moral values, a sense of social responsibility, and civic awareness. Actively engage in public issues and participate in social activities.	**Normative competency**
	Interpersonal Relationships and Teamwork	Foster friendly interpersonal relationships and build good interactions with others, while developing skills in communication, coordination, and inclusivity for effective teamwork.	**Collaboration competency**
	Multicultural and Global Understanding	Cultivate a belief in cultural self-identity, respect, and appreciation for diversity, while actively addressing global issues and understanding international affairs.	Systems thinking competency (partially aligned), normative competency (partially aligned)

Source: Adaptation based on Curriculum Guidelines of 12-Year Basic Education (教育部, 2021a) and Core Competencies for Sustainability (UNESCO, 2018).

While the guidelines promote student-centered pedagogy, interdisciplinary learning, and key competencies aligned with ESD principles, the integration remains partial and uneven. Notably, the term “Education for Sustainable Development” is absent from the guidelines themselves. Instead, sustainability-related themes are embedded in a non-compulsory manner, leaving schools with considerable autonomy in interpreting and implementing these elements. This flexibility may account for the limited explicit application of ESD terminology in Taiwan’s primary and secondary education as of 2024, despite substantial alignment in practice.

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Curriculum integration poses a further challenge. Under the 108 Guidelines, “Sustainable Development” is treated as one of five aspects of Environmental Education, which is itself just one of 19 major issues recommended for integration. This structural arrangement reflects a form of marginalization, where sustainability is framed as an optional theme rather than a core educational concern.

This hierarchical framing has several implications. First, the peripheral positioning of sustainable development within the broader curriculum limits its visibility and potential impact. Second, the absence of a clear, comprehensive framework for integrating these 19 issues leads to practical difficulties in implementation at the school and classroom levels. Third, presenting all 19 issues as equally important may overwhelm educators and dilute focus. Finally, the lack of mandatory requirements undermines incentives for systematic integration into teaching practices.

Beyond the formal curriculum structure, the development of appropriate learning environments through policy-driven programs presents its own set of challenges. The NEED policy action plan connects various initiatives such as "Sustainable Circular Campus," "Climate Change Education," and "Disaster Prevention Education," which contribute to ESD, but remain largely focused on environmental aspects. Expert E04 argues that ESD training should be independent of Environmental Education systems to avoid perpetuating narrow interpretations of sustainability that focus solely on environmental protection. The current approach risks maintaining an environmental-centric perspective while potentially overlooking crucial social dimensions of sustainable development.

In addition to policy-driven initiatives, several national programs have played an active role in fostering sustainable practices within schools. Collectively, the Green School Partnership Program, the Eco-Campus Partnership Program, and the Sustainable

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Circular Campus Project have impacted hundreds of schools and enhancing their sustainable practices nationwide. According to this research, the cumulative number of schools accredited under the Eco-Campus Partnership Program has increased to 438 in 2023[5], accounting for nearly 11% of Taiwan's primary and secondary schools[6]. In addition, the annual number of schools participating in the Green School Partnership Program reached 755 at least in 2024[7], representing approximately 18% of all primary and secondary schools in Taiwan. Furthermore, the Sustainable Circular Campus Project has provided funding 1,630 times to schools between 2003 and 2024[8], with 353 schools receiving support on more than one occasion. These efforts reflect a broad investment to fostering sustainability across Taiwan's educational landscape.

Despite notable achievements, significant challenges persist in the diffusion and sustainability of ESD programs in Taiwan. The Eco-Campus Partnership Program faces concerning implementation gaps. While accredited schools continue to increase, only around 5% achieve Green Flag certification—indicating full whole-school approach implementation—since the program's inception (Environmental Protection Administration, 2023). The majority of accredited schools follow less rigorous

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[5] The data of the accredited schools were acquired from the official contractor of the Eco-Campus Partnership Program in June 2024. Since the accreditation of 2024 has not yet finished, this research presented the complete annual data in 2023.

[6] According to the Ministry of Education's document, *Summary Analysis of Statistical Results on Basic School Profiles for the 112th Academic Year* (112 學年學校基本概況統計結果提要分析), the number of primary and secondary schools in Taiwan is 4,116 including both public and private schools, which was accessed for this research in August 2024.

[7] The data on the Green School Partnership Program in Taiwan were derived from the official website's "Partnership Achievement Query" section. These data were then processed through data crawling conducted by this research to calculate the number of participating schools as of August 2024. It should be noted that the program's annual ranking resets at the beginning of each year and accumulates over time. Therefore, with four months remaining in the year, additional schools may still join the program. Accordingly, the number of 755 schools represents the minimum number of participating schools for 2024.

[8] The data on the Sustainable Circular Campus Project were derived from the official website's "Integrated Query of Annual Project Results" section in January 2025 and analyzed by this research.

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approaches and are not required to track post-accreditation results, suggesting a conservative, passive adoption pattern.

The Green School Partnership Program exemplifies the deterioration of collaborative networks from “network” (網絡) to “net” (網路). As Professor E01 noted, this subtle linguistic distinction in Chinese reflects a broader shift from rich, physical interactions to primarily virtual exchanges (March 4, 2024). Originally designed to foster partnerships and co-creation among schools, the program has undergone key changes, including the discontinuation of the "medal award mechanism" (2004–2016) to simplify administration and the reduction of collaborative activities (Interviewees PU3, PR2, PR3, March 6, 2024). According to the 2007 MOE report on the Taiwan Green School Partnership Network and Environmental Education Support Program (96 年度教育部臺灣綠色學校伙伴網絡及環境教育輔導計畫), the program previously facilitated outdoor education collaborations through workshops and partner meetings (大地旅人環境工作室, 2008). However, recent practices have shifted to primarily offering annual committee response workshops and certification briefings (Interviewees PU2, PU3, PR2, PR3, March 6, 2024), indicating a decline in interschool engagement efforts. Moreover, participation has declined since 2016 (Wang et al., 2020), reflecting a fundamental shift from its partnership-centered mission.

Currently, the program survives by transforming into the Ministry of Education's official Environmental Education portal rather than remaining a partnership platform. To combat "marginalization," it has aligned with the "12-year National Education Reform," integrating curriculum content to increase teacher participation (Wang et al., 2020). The case of the Green School Partnership Program highlights a critical tension: while bottom-up mechanisms are essential for implementation, they require sustained top-down support.

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Lastly, teaching resources are another issue. E03 highlights a fundamental issue in the implementation of teaching resources like the SDGs Education Handbook. The handbook's designation as supplementary material rather than core educational guidance reflects the relatively low priority given to ESD in the overall education system. E03 notes that teachers' use of these materials is highly selective, with engagement often dependent on individual interest rather than systematic implementation requirements. This discretionary approach, while offering flexibility, may result in inconsistent ESD implementation across different educational settings.

Examining Taiwan's ESD institutionalization through UNESCO's priority action areas reveals several critical gaps requiring attention. In terms of "advancing policy," while Taiwan has established basic frameworks, it still lacks a dedicated national-level organization with sufficient authority and resources to lead ESD implementation effectively. This institutional void has resulted in the absence of standardized guidelines for ESD content, teaching methodologies, and evaluation mechanisms. The area of "building capacities of educators" presents particular challenges, with both pre-service and in-service training systems showing substantial limitations in scope, frequency, and effectiveness. Regarding "transforming learning environments," current initiatives like the NEED policy and its affiliated programs [9] provide a foundation, but their predominantly environmental focus may limit the holistic transformation needed for comprehensive ESD implementation, particularly in addressing social dimensions of

[9] The affiliated programs of NEED (New-generation Environmental Education Development) policy include Sustainable Circular Campus, Climate Change Education, Disaster Prevention Education, Tree Conservation Education, Campus Invasive Species and Ecological Environment Management, and Sustainable Energy Talent Development (教育部. (2021b). *教育部「新世代環境教育發展」政策中長程計畫(111-114 年)*. 教育部 Retrieved from https://drive.google.com/drive/folders/1xDDrBp0U3OqJhqYUarI7iAklgqj_95AY

doi:10.6342/NTU202501048

sustainability. While some positive developments exist, such as emerging research from academia (陳沛嵐, 2021; 蔡瀞慧 & 黃雲龍, 2023) and the overlapping social networks between ESD researchers and policy developers, systematic changes are needed to strengthen Taiwan's alignment with UNESCO's framework.

Looking ahead, priority should be given to establishing a dedicated ESD leadership unit within the Ministry of Education, developing comprehensive educator training programs, and creating stronger policy mechanisms to ensure consistent implementation across educational institutions. These steps would help bridge the gap between Taiwan's current ESD institutionalization and the systemic transformation envisioned in UNESCO's ESD for 2030 framework.

3.3 Summary for ESD Development in Taiwan

This chapter reviewed the evolving context of Education for Sustainable Development (ESD) in Taiwan, which is transitioning from its foundations in Environmental Education (EE) to a broader ESD framework influenced by global trends. The global and national development on Sustainable Development catalyzed the maturity of ESD. Thus, this research marked 2017 as a significant milestone for ESD in Taiwan. This year saw the National Council for Sustainable Development (NCSD) release Taiwan’s first Voluntary National Review (VNR). This national-level commitment laid the groundwork for the increased promotion of ESD in the years that followed. Beyond government initiatives, the momentum for ESD also intensified within existing educational programs. After 2017, several ESD-related initiatives, such as the Green School Promotion Program (GPPT), began to emphasize sustainable development more

doi:10.6342/NTU202501048

strongly. The program started encouraging schools to highlight sustainability actions in their reports starting in 2018. Similarly, the Sustainable Circular Campus Project, which had been operating for several years, formally began requiring schools to integrate their SDG-related actions into program documentation by 2018, marking a significant shift toward SDG-focused education.

Despite the implementation of the NEED policy, the regulatory training requirements outlined in the Environmental Education Act, and other advances, Taiwan's Education for Sustainable Development (ESD) system is still in its developmental stages. To fully integrate ESD into the national educational framework, there is a pressing need for stronger policies to elevate its importance at the national level, such as making the Ministry of Education directly responsible for overseeing ESD initiatives. Additionally, greater investment is needed in capacity building for educators. Currently, government-funded in-service ESD training remains limited, and mandatory preservice training for formal educators lacks sufficient ESD content. Even Environmental Education, with its longer history in Taiwan, is only offered as an elective.

The transformation of ESD learning environments is also influenced by the 108 Curriculum Guidelines and various ESD-related programs. However, Sustainable Development is only marginally addressed in these Guidelines, and many ESD programs face challenges such as short-term impacts, limited reach, and voluntary participation mechanisms, which means not all schools participate, and some miss out on valuable opportunities for engagement. Furthermore, the absence of a comprehensive ESD framework leaves a gap that burdens educators. This situation could lead them to integrate the principles of sustainable development in a superficial manner rather than fostering a deeper, more meaningful understanding.

In this context, social networks within and between schools could serve as a

doi:10.6342/NTU202501048

complementary solution to addressing gaps in the development of ESD. Drawing on the network flow model, these networks can serve as key channels for resource acquisition. Social networks can influence resource accessibility and enhance the agency of individuals and schools, thereby fostering more effective ESD practices. The next chapter examined the status and functions of social networks in schools currently implementing ESD in Taiwan.

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Chapter 4 The Social Network Ecosystem of ESD

This chapter aims to answer the central research question: What types of actors and relationships form the social networks that support ESD implementation in Taiwan's basic education system? Given the growing momentum for Education for Sustainable Development (ESD) in Taiwan, schools are increasingly forming their own social networks to implement ESD initiatives. As discussed in Chapter 3, because Taiwan's ESD system is still in its developmental phase, understanding the factors that have supported schools' progress in ESD implementation is essential. Section 4.1 provided an overview of the current state of ESD implementation, focusing on social network characteristics such as network size, composition, resource flows, and potential key actors. Section 4.2 further examined the actors involved in Taiwan's ESD social networks, with particular attention to the contextual factors shaping these networks.

4.1 Overview of Social Networks of Different Schools

To understand the progress made by Taiwan's schools in implementing Education for Sustainable Development (ESD), it is essential to first provide an overview of their current ESD status. This section employs social network analysis to examine key aspects of these networks. The analysis is conducted from an ego-centric perspective, as this research approach allows for a deeper investigation of these schools' case studies. Through ego-centric networks, the ESD implementation status of each school is effectively showcased. The statistical measures presenting the results include network size ("degree"), composition (measured by the E-I index), and the flow of resources within the network, offering insights into how these resources support ESD

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implementation.

The ego-centric networks of schools implementing Education for Sustainable Development (ESD) consist of the "ego," which represents the school itself, as well as the "alters," entities linked with the ego, which include individuals or organizations that engage in resource-exchanging behaviors directly or indirectly with the school. In this context, direct alters refer to those who have a direct relationship with the school, while indirect alters are individuals or organizations that, although not directly linked to the school, are connected through other alters within the network. These indirect alters were identified by the interviewed educators and have been shown to have an impact on the ESD initiatives. Although these indirect alters do not have a direct link to the school, their influence is recognized due to their potential to affect the school's ESD practices, primarily through their interactions with the interviewees themselves. Thus, these indirect alters are included in the ego-centric network, as they may exert influence on the school's ESD efforts in ways that may not always be immediately visible but are still significant.

4.1.1 The Size of ESD networks in ESD Implementation

The degree of a school's ego-centric network is a crucial measure for understanding the scope of its social network, reflecting the size of the network and the extent of its connections (Crossley et al., 2015). In this context, the degree of a network is determined by counting only those alters directly connected to the ego—the school itself. This metric reveals the number of alters that directly contribute to the school's Education for Sustainable Development (ESD) practices.

As shown in the Figure 4.1, the median degree of the ESD networks is 16, represented by the bars in darker colors. Notably, the experimental school located in a remote area has the highest degree, with a value of 42, which is five times larger than the

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lowest degree of 8, found in a school in a formal education system located in a non-remote area. In addition to the comparison of the two schools' social network degree, the average values of ESD network size in experimental schools and those in remote areas are both approximately 2 to 3 times larger than those in formal education schools and those in non-remote areas. This disparity suggests that schools in more remote locations and experimental education may have larger and more diverse social networks contributing to their ESD initiatives.

On the other hand, the bars in brighter colors represent alters that are not directly connected to the school. One significant observation is that NS4 possesses the largest number of indirect connections, resulting from several alters linked to Principal 12 who do not directly interact with or contribute to the school's ESD efforts. It can be assumed that much of the principal's own social network has yet to be integrated into or shared with the school's ESD initiatives.

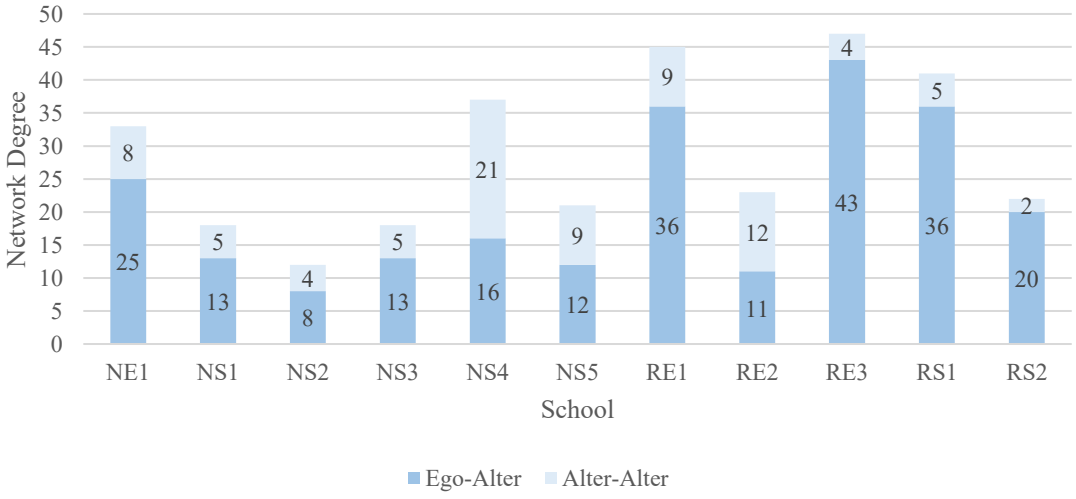

Figure 4.1 Degree of Schools' Ego-Centric Networks

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4.1.2 ESD Network Composition of the Implementing Schools

To analyze the composition of the ESD networks in implementing schools, this research calculated the E-I index based on three key characteristics of the alters: their affiliation with the school (internal or external), sector, geographical location, and Environmental Education (EE) background. This method provides insights into the current partnership patterns of ESD implementing schools.

The E-I index, developed by Krackhardt and Stern (1988), is a widely used measure in social network analysis. It is calculated by comparing the number of external ties ("E") with the number of internal ties ("I"). The resulting index value ranges from -1 to 1, where a value closer to +1 indicates that the school tends to associate with alters whose characteristics differ from those of the school itself, while a value closer to -1 suggests that the school's network consists of alters with similar attributes. A value of 0 indicates a balanced mix of external and internal ties.

(1) Trait of Affiliation with the School: Internal or External

Firstly, a predominantly external network for affiliation is revealed by the calculation results of E-I index, with all ego-centric networks from the 11 schools showing overall positive values (Figure 4.2). This high inclusion of alters outside the schools aligns with UNESCO's recommendation that the implementation of Education for Sustainable Development (ESD) should involve not only school staff but also a diverse range of stakeholders.

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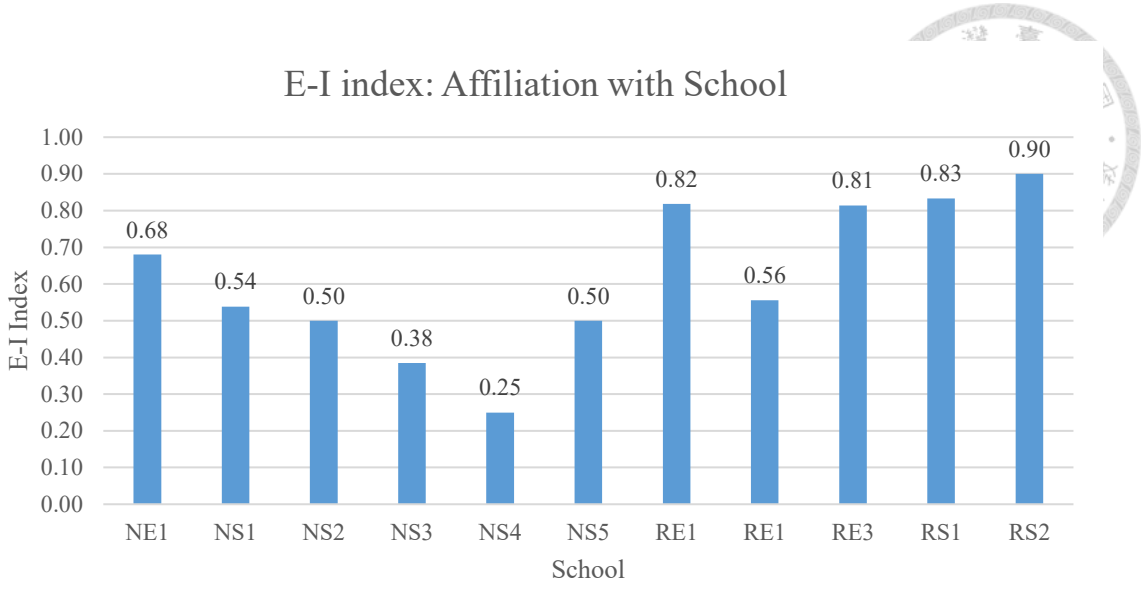

Figure 4.2 E-I Index Based on Ties to Alters Affiliated with the School (Internal) or External Organizations

(2) Trait of Sector Types: Primary and Secondary Schools or Others

Building on the analysis of affiliation patterns through the E-I index, this research further examined the network heterogeneity by looking at the sector types of stakeholders involved with the schools. The E-I indices based on sector types also reveal a generally high degree of heterophily across the schools, with a median value of +0.44 (see Figure 4.3). This indicates that the schools predominantly form partnerships with stakeholders outside the primary and secondary education sector, which can provide more diverse resources to support the implementation of Education for Sustainable Development (ESD).

A closer look at the sectoral composition of each school's ego-centric network (see Figure 4.4) reveals a wide range of stakeholders, including parents and alumni, civil society organizations (NGOs and community groups), local and central government bodies, businesses (such as corporate-funded foundations), and academia (e.g., scholars

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and universities). This diverse network composition aligns with Alkaher and Gan (2020) findings, which demonstrated how such multi-stakeholder partnerships can transform schools into social community centers that facilitate meaningful dialogue between schools and their communities. Their research suggests that these varied connections with the civil society, community, government and business not only strengthen environmental citizenship at the local level but also contribute to the development of social capital, as each stakeholder brings unique resources and perspectives to ESD initiatives (Alkaher & Gan, 2020). The presence of such diverse actors in schools' networks could therefore indicate potential for both enhanced sustainability outcomes and strengthened community bonds through ESD practices.

Aggregating the data from all 11 schools, basic education schools account for the largest proportion of alters, followed by government bodies and civil groups (NGOs and community organizations) (Figure 4.4). However, when the faculty members of the surveyed schools (the egos) are excluded, the proportion of alters from basic education schools drops to third place, with government and civil groups moving up in rank.

This finding suggests that governmental bodies and civil organizations play significant roles in the implementation of Education for Sustainable Development (ESD). Their central position in the network indicates that they provide key resources essential for advancing ESD initiatives. A possible explanation for this is found in Kolleck (2016) study, which showed that NGOs and government actors held central roles in ESD networks in German municipalities. Although this study was conducted in Germany, its findings offer a useful comparison: in both Germany and Taiwan, governmental bodies lead the introduction of ESD, while schools voluntarily adopt these initiatives. This top-down incentivizing mechanism encouraging voluntary adoption may explain why governmental bodies are positioned as key players. In Taiwan, as noted in Chapter 3, the

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government not only initiates the main ESD programs but also provides essential resources, further supporting the idea that governmental and civil organizations play a leading role in the ESD process.

Regarding civil groups such as NGOs and community organizations, which make up the second-largest proportion in schools' ESD ego-centric networks, they play a crucial role in real-life learning and community engagement supported by narratives of the interviewees. These civil society organizations are thus considered by this research as essential partners for schools in supporting ESD initiatives to fulfill community-based learning and engagement.

In addition to the importance of governmental and civil groups, including NGOs and community organizations, the high heterophily observed in the schools' alters' sectors suggests that schools are less focused on forming connections with other ESD-implementing schools. This may be due to barriers in establishing interschool partnerships. This is supported by Principal S09's observation on interschool collaboration:

> Taiwan's education system is highly self-centered. Each school is like a mountain peak; you can suggest cooperation, but they may not necessarily collaborate because their pace is different. Each school is its own peak, a fortress that is difficult to approach, keeping the school tightly sealed. Collaborating or working together is not easy. (Principal, S09)

The findings of this research are aligned with Principal S09's statement. It was observed that connections between primary and secondary schools are mainly limited to experience exchanges or consultations, functioning more as facilitation than true collaboration. This challenge may stem from the self-centered atmosphere fostered by Taiwan's ESD mechanisms. Many programs and competitions are designed to target and reward individual schools, reinforcing a competitive rather than collaborative approach.

Moreover, the lack of opportunities for interschool partnerships contributes to this

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issue, as highlighted by PR5 from the corporate-funded educational foundation, “I’m not sure what the exact barrier is, but I feel that, even though the schools are in the same area, the principals need opportunities from us to interact.” (PR5, corporate-funded educational foundation)

On a positive note, interschool collaboration is still encouraged and supported by organizations such as the corporate-funded educational foundation where PR5 works. However, it remains limited overall. While this lack of collaboration may not significantly impact the schools in this study—since they have other avenues to access resources—it could widen the gap between schools that are actively implementing ESD and those that are not. If this fragmentation continues, ESD implementation in Taiwan may lack the collective momentum needed for broader systemic change.

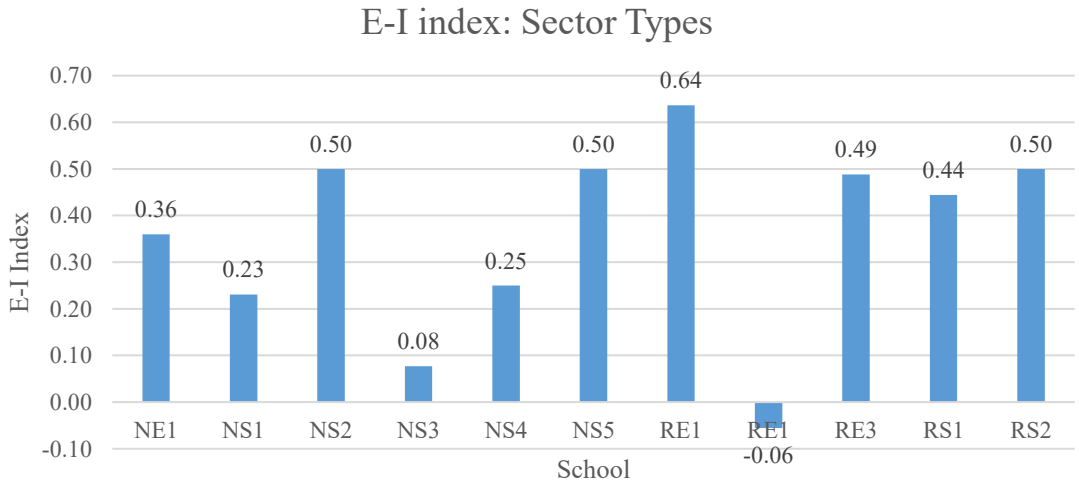

Figure 4.3 E-I Index Based on Ties to Alters' Sector Types in Primary and Secondary Schools (Internal) and External Sectors

External sectors consist of civil groups associated with schools (including parents and alumni), civil society groups (such as NGOs and community organizations), government bodies, businesses, and academia.

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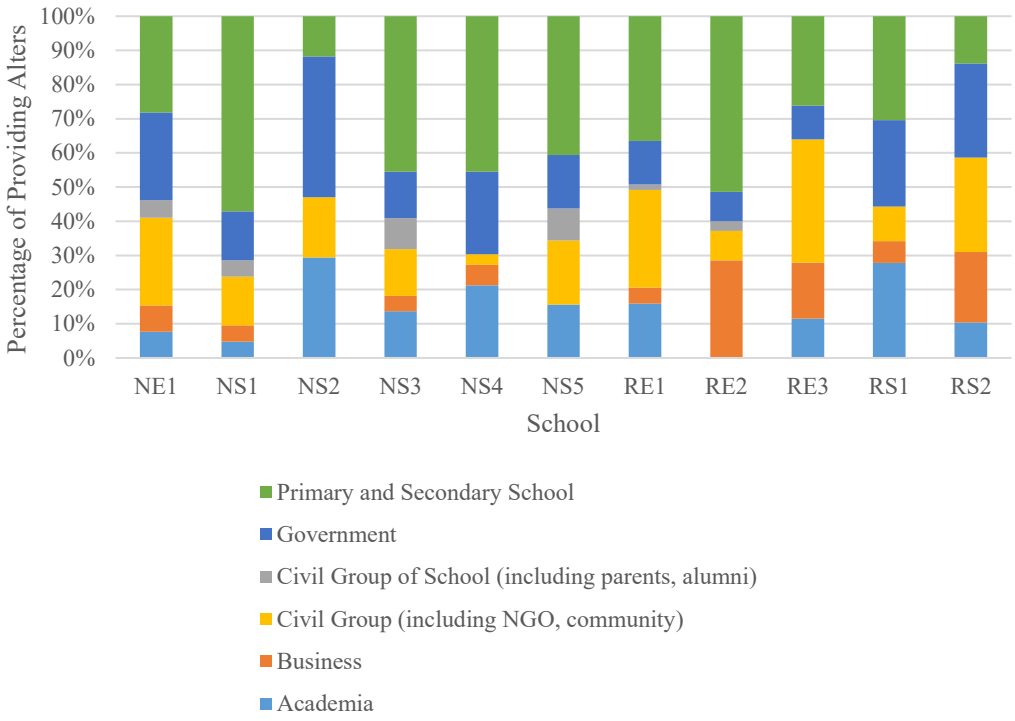

Figure 4.4 Proportion of Various Sectors within the Ego-Centric Networks of 11 Schools Implementing Education for Sustainable Development (ESD)

(3) Trait of Geographical Location: Same County or Others

Next, is the geographical location trait examined by the E-I index to assess the partnership patterns of ESD-implementing schools (Figure 4.5). While PR5's assumption suggests that schools within the same geographic area should naturally collaborate, the findings from the E-I index analysis tell a more nuanced story. Specifically, the partnership patterns among the 11 interviewed schools reveal a lack of consistency in forming connections with alters within the same county. The overall absolute values are no more than 0.57, indicating that neither external nor internal ties significantly outweigh the other. Moreover, the median value of the E-I indices across the 11 schools is 0.00, suggesting that schools engage with both local and external partners relatively equally. However, upon closer examination of the absolute values of the positive and negative E-

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I indices, it is observed that the median of the positive E-I indices is only +0.13, considerably lower than the median of the negative indices (-0.33). The data showing larger absolute values of negative E-I indices, indicative of location heterophily, suggests that local collaborations (i.e., those within the same county) are stronger than cross-county partnerships.

The findings suggest that schools may adopt varying strategies and preferences when selecting partners, either within or outside their immediate geographic area. However, maintaining collaborations with partners within the same county remains a key component of effective ESD implementation, as evidenced by this research. Interview data reveals that every school engaged in this study collaborates with their local community and faculty, both of which play critical roles ESD. This underscores the importance of not neglecting local partnerships. On the other hand, interactions with alters outside the immediate area also contribute to the schools' efforts, primarily by broadening their perspectives and expanding access to resources. According to the interviews, external partners include central government bodies that provide national programs to support schools in various counties, university scholars who aid in professional development, school visits that inspire innovative practices, and even international collaborations that enhance community engagement on a global scale.

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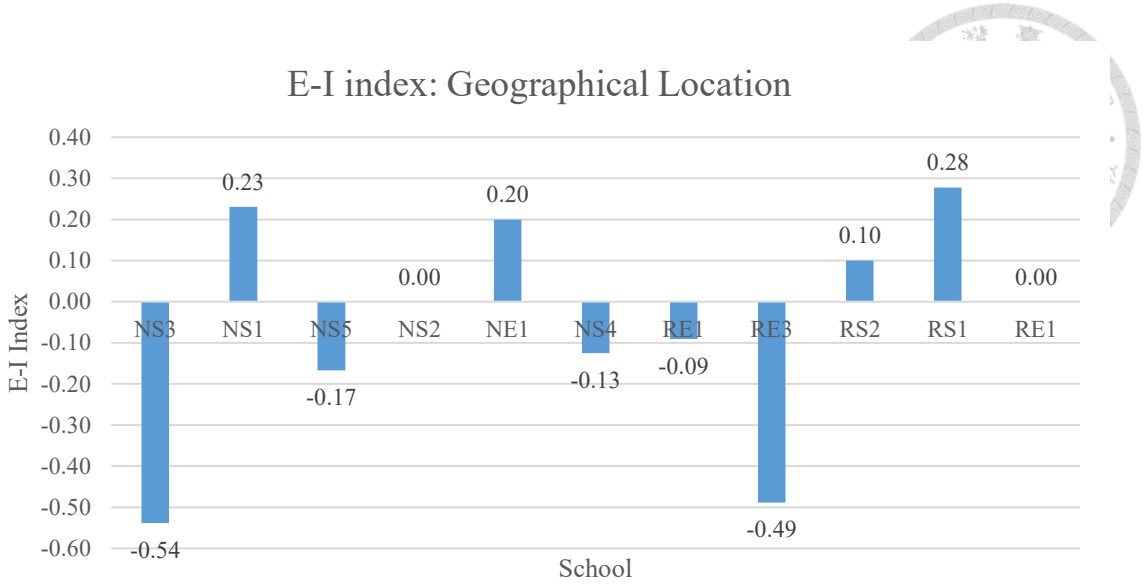

Figure 4.5 E-I Index Calculated Based on the Geographical Location of Alters' Ties

The internal ties represent connections between the ego and alters within the same county, and external ties represent connections between the ego and alters in different counties.

(4) Trait of Background of Environmental Education (EE): True or Uncertain

The final trait examined by the E-I index is the alter's background of Environmental Education (EE) (Figure 4.6), which median is also negative. The overall schools' linkages with alters in background of Environmental Education (EE) shows the slight homophily, with the value of -0.2. Only the school NS3 has the largest E-I index value, indicating that the school's alters are not from the background of Environmental Education (EE).

It should be noted that the identification of alter's EE background is confirmed by this research from first-hand and secondary data on the internet. As for the opposite category, since this research has limitation to fully confirm that alters do not have relevant experiences from EE, this research only can tell they have "uncertain" rather than "no" EE background.

These alters were primarily composed of internal members of the ESD implementing

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schools and external experts. The "EE background" of these school members varies from personnel certification under the Environmental Education Act (e.g., Director S15, Group Leader S01, principals S07 and S12), working experiences on local county Environmental Education advisory teams (e.g., Principals S03, S04, S09), Environmental Education graduate programs (e.g., Principal S05), or training from non-governmental organizations (e.g., S17).

Another significant group of alters with an EE background in the schools' ego-centric ESD networks were advisors from ESD-related programs, including those from educational foundations. Many of these advisors held qualifications in Environmental Education, having studied at graduate schools focused on EE. For instance, an advisor from the corporation-funded educational foundation (PR5) is currently pursuing further education in Environmental Education. They reported that their background in EE allows them to observe schools more sensitively, intuitively identifying blind spots that might otherwise be overlooked, and helping schools recognize both their strengths and challenges due to over-familiarity with their context.

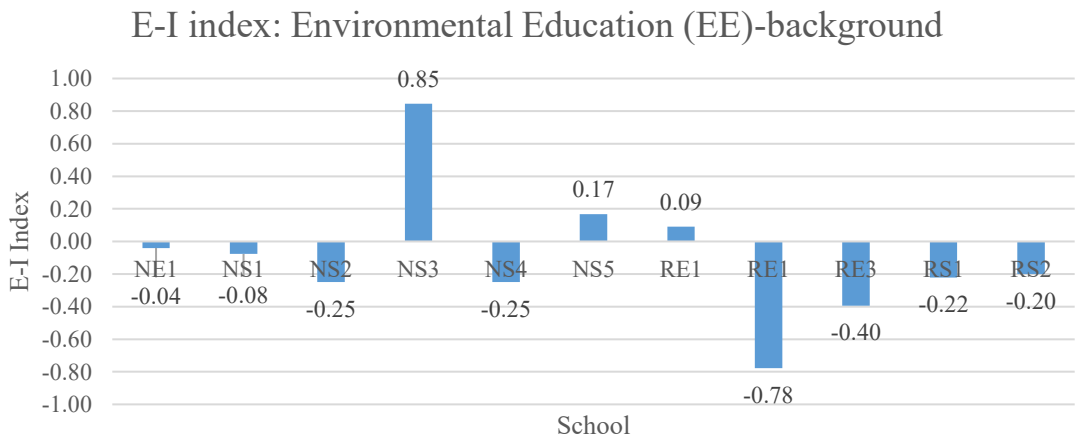

Figure 4.6 E-I Index Calculated Based on the Environmental Education (EE) Background of Alters in the ESD Network

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Interviews with both internal and external members of the school community indicate that EE is a crucial pathway for implementing ESD. Moreover, the competencies associated with EE can be effectively extended to ESD. This finding aligns with the perspective of the expert scholar, Professor E01, who emphasized that EE is not confined to environmental issues alone.

Looking at the historical context, EE and ESD share a common goal of achieving peaceful coexistence between humanity and the environment. However, their approaches differ in terms of the underlying values. While EE focuses on human solutions to environmental problems caused by humanity, ESD acknowledges that human issues also influence environmental challenges, thus requiring a more holistic approach that addresses both human and environmental needs, with a stronger emphasis on fairness and justice. This compatibility between EE and ESD is evident in the interviews with experts E01, E02, E03, and E04, all of whom have received graduate-level training in EE. E01, E02, and E03 are professors specializing in EE, yet all four experts are now engaged in ESD research and initiatives, such as promoting ESD in schools (E04), implementing ESD-related projects (E03, E04), or contributing to policy development for the NEED (E02).

This study suggests that the experiences and social network composition of the respondents reflect Taiwan's reliance on Environmental Education (EE) channels to cultivate and inspire talent on the path toward Education for Sustainable Development (ESD). Notably, Taiwan's education system has evolved from EE towards ESD, with educational stakeholders who are well-versed in EE increasingly engaging with ESD. Moreover, the government has leveraged existing EE institutions to promote ESD. As discussed in Chapter 3 of this study, government-led ESD-related programs are often based on foundations established by EE.

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The advantage of using EE to promote ESD lies in its ability to utilize existing resources and networks, thereby facilitating the diffusion of ESD. However, it is important to consider whether this reliance on EE networks truly leads to a comprehensive ESD approach or merely results in a rebranding—i.e., the superficial change of name while maintaining the same content, since research pointed out that the current state of EE development in Taiwan still mainly emphasized on the environmental aspect (王順美, 2016; 葉欣誠, 2017). This overemphasis on environmental issues notes the gap with the essence of ESD, which encompasses environmental, social, and economic dimensions constructing the broader, integrative perspective.

Besides alters with EE background, this study also found that among educators implementing ESD, some have transitioned from a zero-background in EE to direct engagement with ESD, indicating the existence of other approach to participate in ESD networks. Several of the ESD implementing schools identified in this study, such as teachers (e.g., S01, S14, S16), department heads (e.g., S02, S05, S06), and principals (e.g., S08, S11), had no prior background in Environmental Education. Their involvement in ESD practices stemmed from participating in ESD-related projects within their schools or adapting to the school's educational model, allowing them to learn and contribute to ESD implementation.

4.1.3 Resource Exchange in the ESD Networks

On the basis of the network flow model and the social capital theory, resource flows are deemed as the important results of social networks, as connections between the actors can serve as the channels to return beneficial outcomes (Borgatti & Lopez-Kidwell, 2011);(Lin, 2001). Since this research captured ties in the ESD networks mainly through

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resource exchanges, the plausible resource flow under the social network thus can be tangible, supporting the examination of which kind of resource is mostly exchanged and the most contributed key actors.

Among the intellectual, human, physical, and financial resources, as illustrated by Figure 4.7 and Figure 4.8, intellectual and human resources are the most frequently exchanged resources among the 11 ESD implementing schools included in the study. This observation can be explained by two potential factors. First, the inherent characteristics of intellectual and human resources make them more fluid and abundant compared to physical and financial resources, enabling easier exchange within social networks. Second, these resource flows are foundational to ESD practices, which necessitate frequent exchanges. This assertion is further supported by qualitative narratives from the interviewed educators, as detailed in the following section.

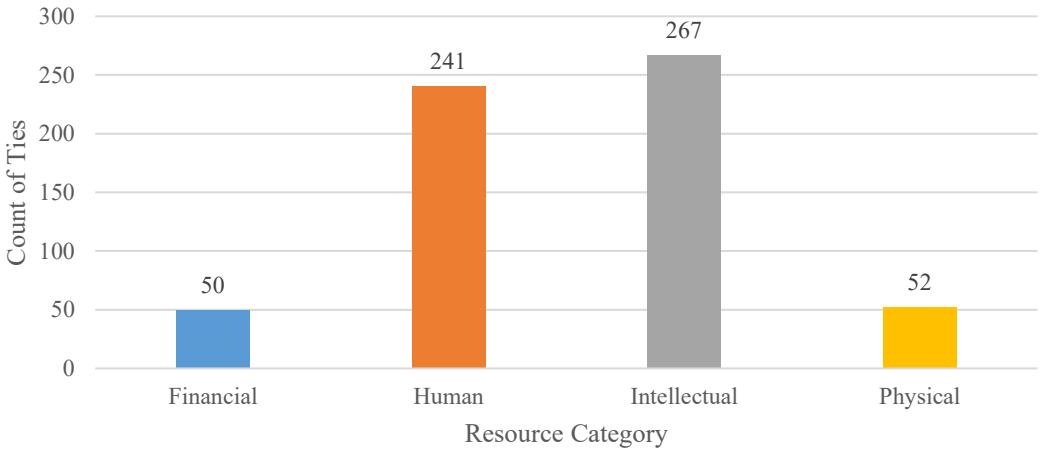

Figure 4.7 Total Ranking of Resource Exchange Ties Categorized by Type (Financial, Human, Intellectual, and Physical), Aggregated from Ego-Centric Network Data of 11 ESD-Implementing Schools

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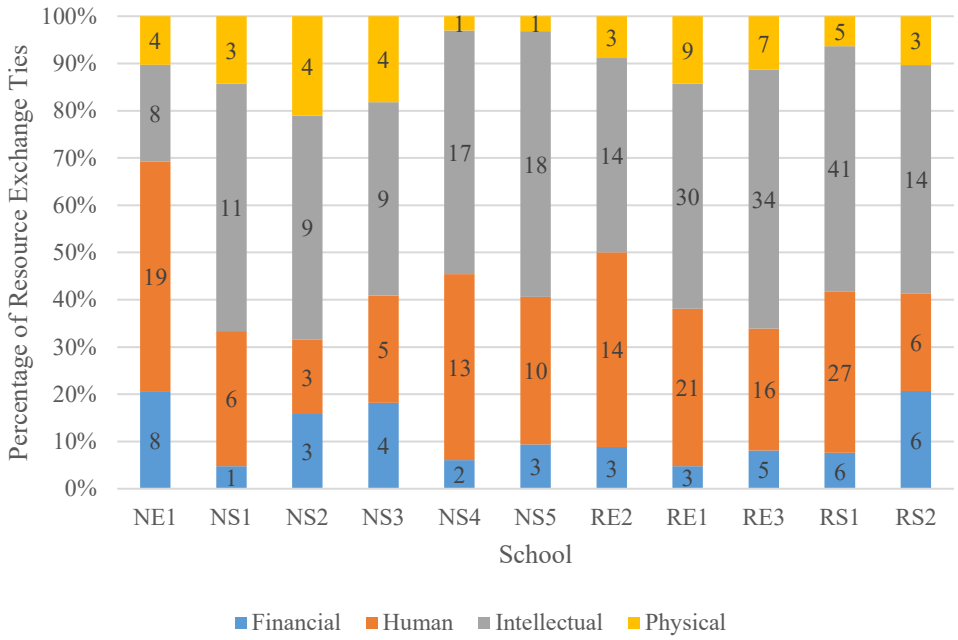

Figure 4.8 Percentage and Count of Resource Exchange Ties by Type (Financial, Human, Intellectual, and Physical) within the Ego-Centric Networks of 11 ESD-Implementing Schools

4.1.4 Potential Key Alters Identified in the ESD Networks

The centrality of a social network indicates the importance of an individual within it and can be measured through various methods, including degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality (Golbeck, 2015). This research adopts degree centrality to identify key alters in the ego-centric ESD networks.

Degree centrality was chosen because the research focuses on ego-centric perspectives, without fully exploring alter-alter relationships within the network. Using other centrality measures, which require comprehensive structural data, could lead to biased interpretations of the ESD network's status.

Degree centrality measures the number of direct ties an actor has, highlighting their activity and connections within the network. While it does not account for an actor's

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structural position or their exact influence on the entire network, it provides insight into which actors are highly contacted or active (Moolenaar & Sleegers, 2015; Tabassum et al., 2018). In this study, central alters with high degree centrality actively participate in resource exchanges related to ESD practices.

The ego-centric networks of 11 implementing school (Figure 4.9) revealed that the alters with the highest degree centrality are typically the school principal or the Ministry of Education, the highest educational authority in the country. Moreover, the interview data also supported that these actors serve as the boundary-spanning roles, connecting with different sectors and types of resources.

These findings can be attributed to the distinct roles these actors play within the ESD network. School principals hold a leading administrative position, as stipulated by Article 13 of the "Primary and Junior High School Act (國民教育法)", which designates them as "responsible for the overall management of school affairs". Additionally, the pre-training for principals includes competencies such as school development and management, curriculum development and instructional leadership, and public relations and communication ("Regulations for the Selection and Training of Principals and Directors in Public Primary and Junior High Schools [公立國民小學及國民中學校長主任甄選儲訓辦法]," 2023). These roles equip principals to serve as key figures in guiding their schools and connecting with external resources.

The Ministry of Education, on the other hand, serves as the primary organizer of ESD-related programs. Schools participating in these programs benefit not only from direct financial support but also from access to expert consultants coordinated by the Ministry. These resources and expertise enable schools to enhance their ESD practices, further establishing the Ministry's centrality in the network.

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Other significant alters, with the second-highest degree centrality, include the school faculty responsible for ESD practices, college professors serving as consultants or lecturers on ESD topics, civil groups such as local communities and NGOs involved in collaborative actions, and business-funded foundations providing financial or other forms of support.

The influence of principals as the central actors is suggested to be beneficial in resource mobilization. Interview data of this research highlighted principals' diverse personal networks which benefit them to become pivotal figures in connecting schools with actors not only in their own schools but external actors: Principal S09 maintained strong relationships with local communities and organizations, which, according to staff member S01, facilitated access to financial support from foundations. Similarly, S13's director described Principal S04's multifaceted role, which extends to serving as the chairman of multiple corporate foundations and a core member of an Environmental Education advisory group, thereby creating opportunities for the school to secure resources. S15's director noted that a former principal (S12) leveraged personal networks to bring in experts and scholars who continue to support the school. These findings align with Hite's research, emphasizing the strategic role of headteacher networks as critical conduits for resources that can enhance school performance.

Moreover, this research synthesized the 11 ego-centric ESD networks to construct an overarching view of the whole ESD network and identify its central actors (Figure 4.10). Despite being collected separately, these networks reveal overlapping alters, allowing for a combined representation of the broader ESD network to analyze central actors.

Within the whole ESD network spanning the 11 implementing schools, the top five actors with the highest centrality (excluding the ego schools) are ranked as follows:

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Principal S09, the Ministry of Education, Professor E04, the K-12 Education Administration under the Ministry of Education, and Principal S04. Similar to the ego-centric networks, the principal and a central governmental sector—the Ministry of Education—emerge as key actors, highlighting their consistent centrality across different schools. Additionally, the whole network analysis introduces a unique aspect: the inclusion of a professor from the academic field (Professor E04) as a top central actor, underscoring the importance of expertise and external academic support in driving ESD practices. This distinction reflects the broader influence of external actors beyond individual school contexts.

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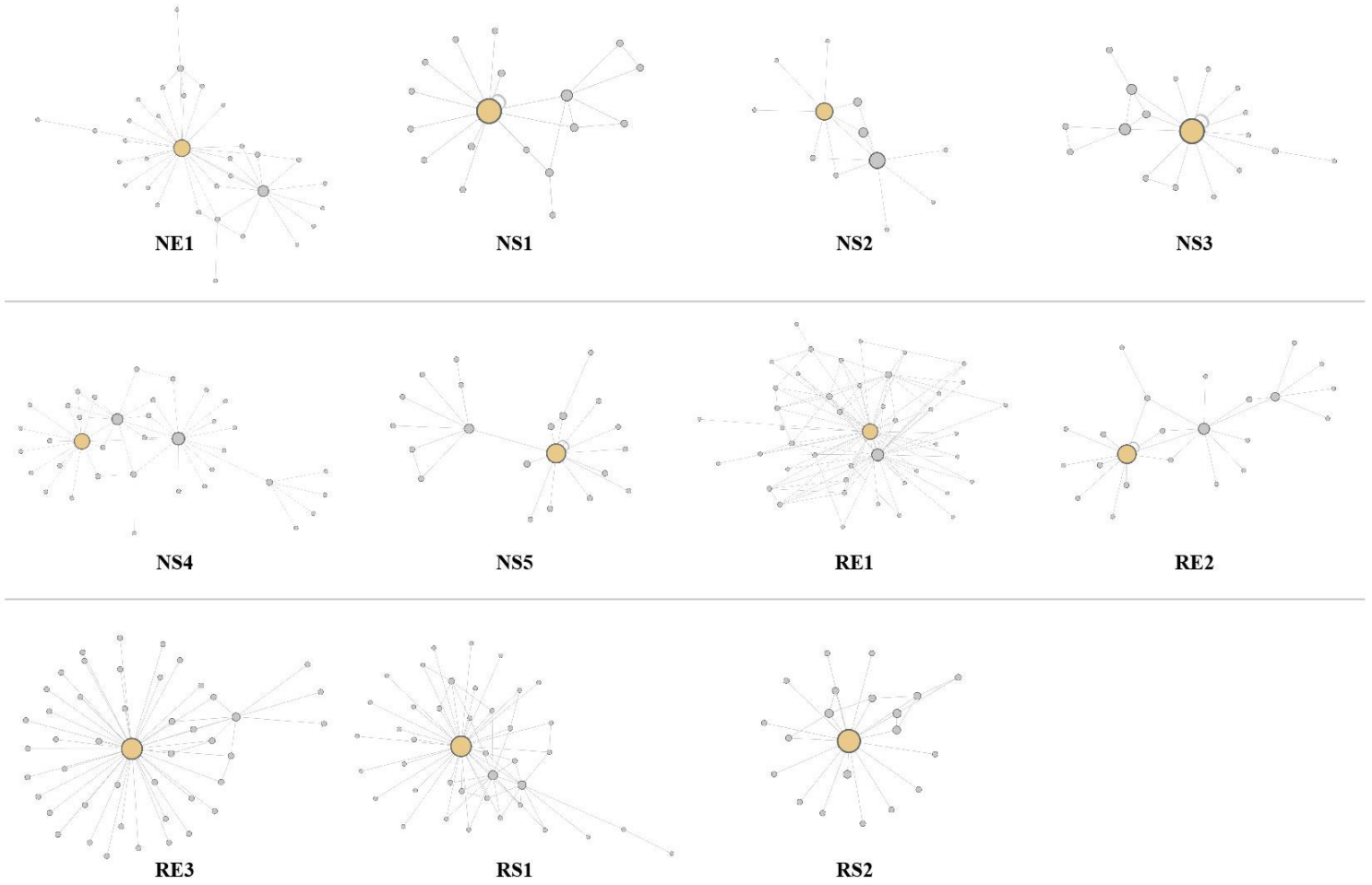

Figure 4.9 Ego-Centric Networks of 11 ESD-Implementing Schools

The yellow node in each ego-centric network represents the ego, which is the interviewed school, and grey nodes represent the other alters.

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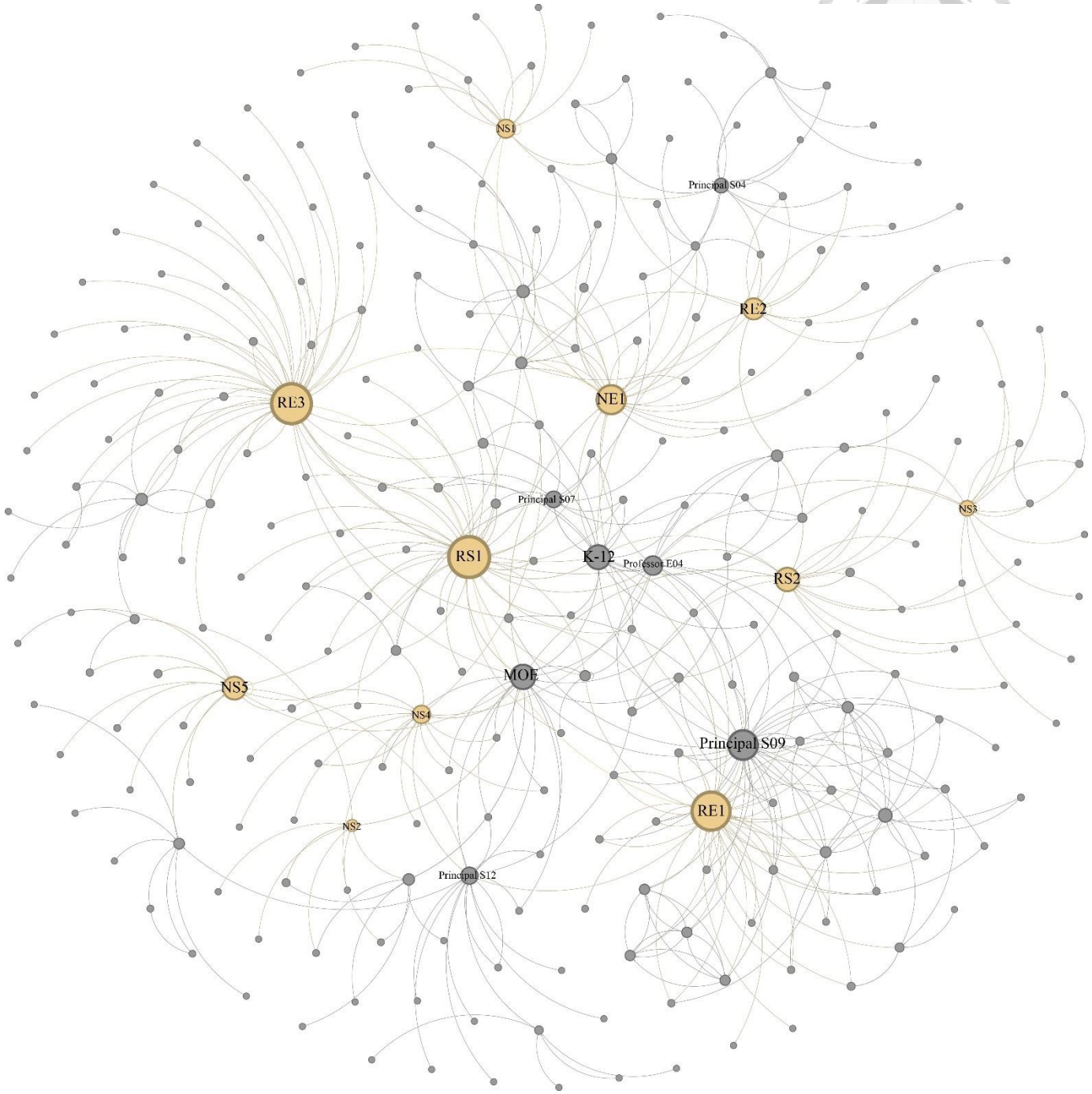

Figure 4.10 The Whole ESD Network of ESD-Implementing Schools in This Research: Aggregated Data from 11 Egocentric Networks in Primary and Secondary Schools

Yellow nodes represent the egos which are the 11 schools, and grey nodes represent the other actors.

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Central Actors and the Influence of EE Expertise

Notably, when the whole ESD network is analyzed based on actors' Environmental Education (EE) background, most of the top central actors possess this trait (Figure 4.12). This observation reinforces the importance of EE background, as previously highlighted in the homophily analysis of ego-centric ESD networks. As shown in the Figure 4.11, although the proportion of actors with uncertain EE backgrounds is more than twice that of those with confirmed EE backgrounds, it is the latter who occupy the key roles within the network.

This suggests that actors with an EE background play critical roles in advancing ESD. Since Taiwan's ESD development is rooted in the context of EE, these actors likely possess the relevant expertise to support schools in adopting the ESD approach. Additionally, they are more inclined to align with the evolving focus on ESD, as the principles of EE increasingly converge with those of ESD.

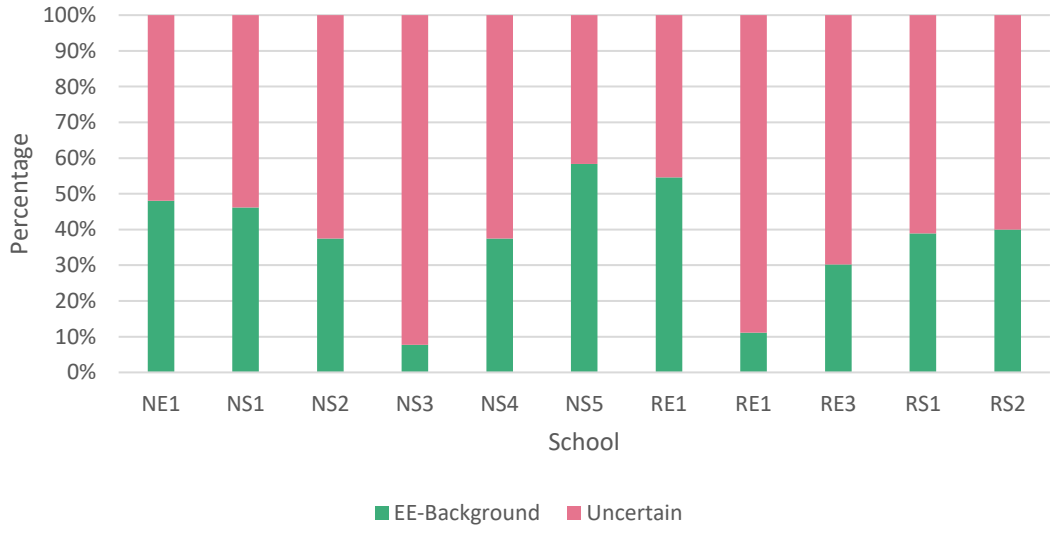

Figure 4.11 Proportion of Alters with Environmental Education (EE) Background within Each Ego-centric Network

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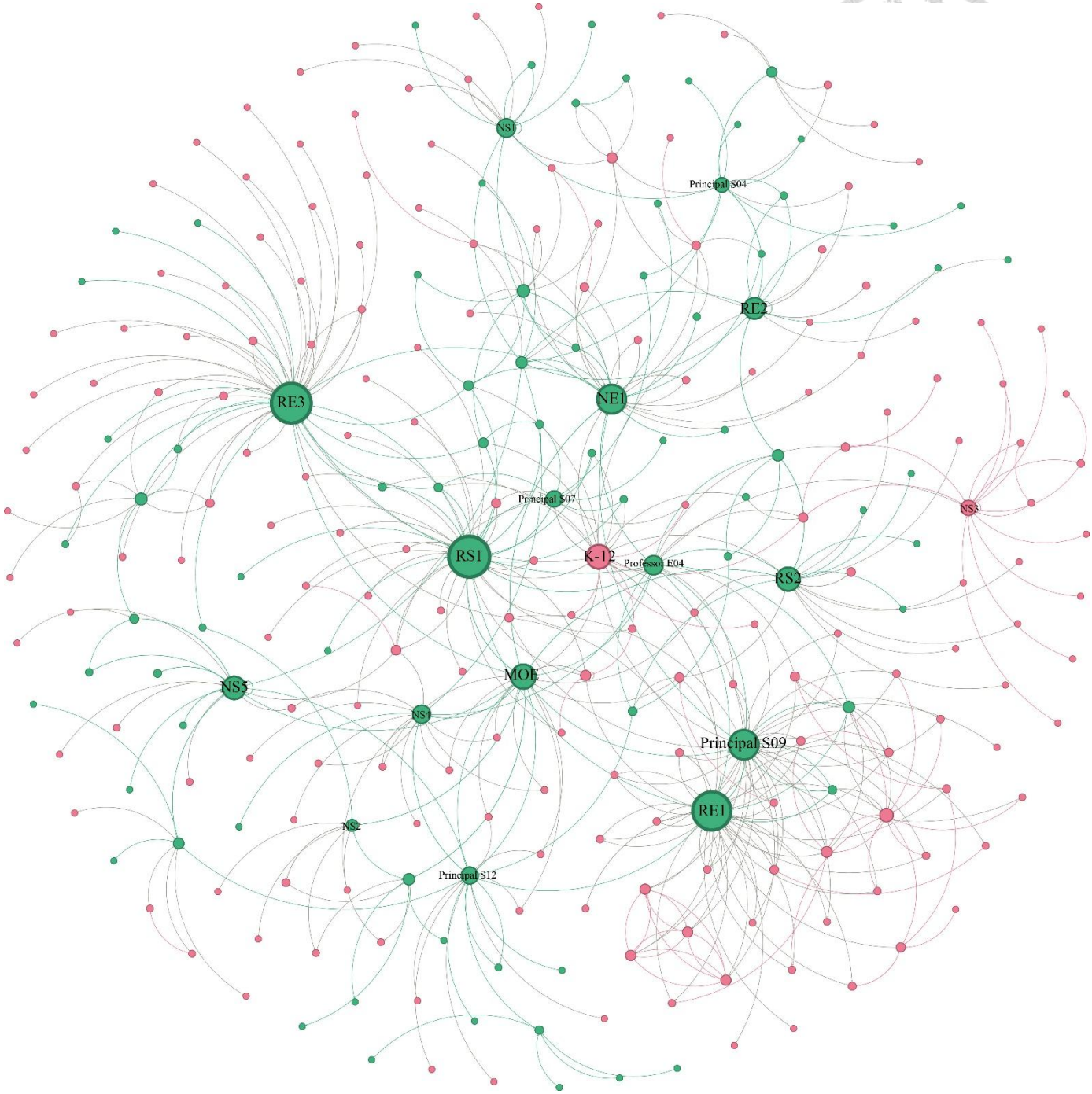

Figure 4.12 Traits of Environmental Education Background in the ESD Network: Aggregated Data from 11 Egocentric Networks of ESD Implementation in Primary and Secondary Schools

Green nodes represent the actors with confirmed EE background, while red nodes represent those with uncertain EE background.

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4.2 Social Network Actors within the Context of ESD in Taiwan

A mixed-method social network analysis revealed that Taiwan's school-based Education for Sustainable Development (ESD) networks involve a wide range of actors—including primary and secondary schools, government agencies, academia, businesses, and civil society organizations. This research identified three key pathways that shape and connect these actors: (1) alignment with international Sustainable Development agendas, (2) the utilization of Taiwan's existing Environmental Education infrastructure, and (3) bottom-up initiatives responding to local, school-level challenges. These pathways provide the contextual foundation for understanding how ESD-related social networks are formed and maintained in Taiwan.

4.2.1 International Sustainable Development Agenda: A Top-Down Pathway

The global sustainable development movement has created a powerful entry mechanism for various actors into Taiwan's ESD networks. The evolution from the 1972 UN Conference on the Human Environment to the 2015 adoption of the Sustainable Development Goals (SDGs) established a framework that catalyzed Taiwan's domestic sustainability initiatives. Despite not being a UN member, Taiwan demonstrated commitment by designating 2003 as the inaugural year for sustainable development initiatives (referred to as 「永續元年」) (行政院環境保護署主任秘書室, 2003), releasing its first Voluntary National Review in 2017 and developing "Taiwan SDGs" by 2019 through the National Council for Sustainable Development. This commitment was further reinforced by Taiwan's 2022 Net-Zero Emissions Roadmap, which explicitly

doi:10.6342/NTU202501048

positioned Environmental Education as central to achieving climate objectives.

This international agenda has served as a channel through which diverse actors have engaged with Education for Sustainable Development (ESD) in Taiwan, though the mechanisms and expressions vary across sectors. At the governmental level, agencies have responded by translating global sustainability goals—such as the SDGs and Net-Zero 2050—into domestic education policies. Notably, the Ministry of Education's 'New-generation Environmental Education Development' (NEED) policy explicitly references both frameworks as part of its guiding context (教育部, 2021; 王順美 et al., 2024). Furthermore, Taiwan's major governmental ESD programs—including the Ministry of Education's Green School Partnership Program and Sustainable Circular Campus Project, as well as the Ministry of Environment's Eco-Campus Partnership Program—have been shaped by global agendas such as SDGs, net zero carbon emission goals and the Decade of Education for Sustainable Development (DESD).

In the academic sector, the interviewee Teacher S01 and Principal S07 from primary and secondary schools noted that their ESD collaborations were supported by partner universities engaging in University Social Responsibility (USR) projects. While the universities' internal motivations were not the focus of this study, the alignment of their activities with sustainability-oriented themes suggests an indirect influence of international sustainability discourse, particularly through peer networks and institutional positioning related to global trends.

On the corporate side, another interviewee Principal S08 reported that a business partner of their school included ESD-related collaboration in its sustainability report. This may reflect the influence of national regulations aligned with international sustainability reporting trends. The Financial Supervisory Commission's (FSC) requirement for listed companies to publish sustainability reports starting in 2025 is a key example. In 2023, the

doi:10.6342/NTU202501048

FSC published its *Sustainability Action Plan for Listed Companies*, outlining goals such as achieving Net Zero, strengthening corporate sustainability governance, improving sustainability disclosure, enhancing stakeholder communication, and advancing ESG assessments and digitalization (Financial Supervisory Commission [FSC], 2023). These objectives aim to help companies meet global sustainability targets and enhance their international competitiveness. The top-down requirements create both an incentive and pressure for private-sector actors to engage with schools through socially responsible practices.

Although these examples are drawn from a limited number of cases, they illustrate how international sustainability agendas are taken up by diverse actors—government, academic, and corporate—through differentiated pathways shaped by policy, networks, and regulation.

4.2.2 Environmental Education Infrastructure: An Institutional Pathway

Taiwan's robust Environmental Education (EE) infrastructure provided a pre-existing foundation for ESD network development. This EE-based foundation enabled the development of multi-level support systems across policymaking, programs and regional agencies. ESD was initially championed by EE experts who strategically engaged in three networks to integrate ESD into Taiwan's educational landscape.

(1) Policymaking Networks

The development of policy networks marked the first strategic approach to ESD integration. Through policy networks, Taiwanese scholars and the Ministry of Education held the domestic "2007 Forum on DESD" to respond to the global DESD. Building on this foundation, the Environmental Protection Administration (now the Ministry of the

doi:10.6342/NTU202501048

Environment) requested Taiwanese scholars to participate in the 2014 DESD Forum in Nagoya. This international engagement brought global ESD perspectives into domestic policy development and contributed to key documents like "Action Strategies for Sustainable Development Education." Furthermore, EE scholars actively participated in the policy-making process for the New-generation Environmental Education Development (NEED) Policy (2022-2025), demonstrating the continued influence of EE expertise in shaping ESD policy.

(2) Program Networks and Cross-Program Collaboration

The second strategic approach involved establishing program networks that emphasized practical implementation. EE scholars designed the Green School Partnership Program based on the UN-advocated whole-school approach, emphasizing partnerships with diverse external stakeholders. Similarly, the US-Taiwan Eco-Campus Partnership program was introduced after Taiwanese principals observed the international Green Flag certification model from the "Eco-Schools" program developed by Foundation for Environmental Education (FEE). These program networks demonstrate significant cross-ministerial collaboration, with experts from both the Ministry of Education and Ministry of Environment participating in multiple initiatives simultaneously.

A particularly noteworthy aspect of EE-related programs' networks is the cross-program synergies. Both the Green School Partnership Program and the Sustainable Circular Campus Project were initiated by the Ministry of Education around the same time, creating significant overlaps in their objectives and approaches. Schools often participate in both programs simultaneously. According to E01, the Sustainable Circular Campus Project offers financial subsidies to participating schools, whereas the Green School Partnership Program does not. As a result, the Green School Partnership Program

doi:10.6342/NTU202501048

team encourages schools to also apply for the Sustainable Circular Campus Project to obtain financial support, as highlighted by Wang et al. (2020).

This cross-program participation creates a unique environment where schools access wider support from different stakeholders across educational and sustainability sectors. The overlap ensures that lessons and practices learned through one program can be shared and implemented in others, reinforcing overall effectiveness. Onsite observation of Eco-Campus Partnership Program workshops in 2024 revealed that many key figures driving multiple initiatives were also involved in the Green School Partnership Program at its inception, as noted by E01. Though interviews with PU1 and PU2 indicated that collaboration between the two ministries is not yet highly formalized, the practical overlap among experts from both ministries is evident, suggesting strong continuity of EE and ESD practitioners in Taiwan.

(3) Regional Support Networks

The third strategic approach emerged as regions developed supplementary support networks to address limitations in central programs. These local initiatives specifically targeted budget constraints and training gaps that central programs could not fully address.

New Taipei City and Tainan City created systematic government-led mechanisms, integrating ESD program participation into faculty performance evaluations and providing tiered financial support (新北市政府教育局 [New Taipei City Government Education Department], 2018; 臺南市政府環境保護局 [Tainan City Environmental Protection Bureau], 2022; 臺南市政府 [Tainan City Government], 2022). New Taipei City's Environmental Protection Department provides tiered financial support, offering between 40,000 to 70,000 NTD based on accreditation levels.

Taoyuan City demonstrates a different approach through corporate-government

doi:10.6342/NTU202501048

partnerships with the HeySong Educational Foundation, whose "Green+ Campus Ecological Program" extends beyond financial subsidies to create comprehensive support ecosystems including inter-school exchanges, professional development, and certification support. Meanwhile, Tainan City leverages unique social capital through the Society of Taiwan Eco-Schools, co-founded by members from Taiwan's first Green Flag certified school, demonstrating how grassroots initiatives can scale up to create broader impact.

Network analysis confirmed the significance of this EE-based pathway: while EE-background actors comprise only 39% (median) of network members (Figure 4.11), most rank among the highest-centrality actors in the aggregated networks of all 11 schools. This demonstrates how EE infrastructure serves as the backbone for Taiwan's broader ESD network development, with established relationships and institutional knowledge facilitating cross-sector collaboration and program integration.

On the other hand, the majority of actors within Taiwan's ESD networks lack explicit Environmental Education backgrounds. This observation aligns with Professor E04's experiences in giving training for frontline educators: many individuals engaging in ESD do not have foundational EE knowledge but still show interest in ESD. Several interviewees exemplify this pattern—Principal S08 and S11, along with Teachers S14 and S16—who began implementing ESD practices without prior EE training. According to 葉欣誠 (2017), ESD's broader conceptual framework offers strategic advantages, as evidenced by survey respondents who perceived ESD as having greater inclusivity, stronger international alignment, and reduced inter-departmental conflicts. These characteristics make "ESD" more effective at attracting diverse participants.

Environmental Education is not the sole entry point for ESD engagement, but its established institutional systems—policies, programs, and expert networks—are

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significantly more developed than ESD's. As discussed in Section 3.2 on Taiwan's ESD institutionalization progress, many aspects of ESD infrastructure remain under development. Consequently, ESD's current reliance on existing EE systems underscores the critical importance of Environmental Education infrastructure in supporting Taiwan's broader ESD implementation.

4.2.3 School-Level Challenges and the Emergence of a Bottom-Up Pathway

The expansion of actor diversity within Taiwan's ESD networks is not solely the result of top-down initiatives; rather, it is also shaped by bottom-up dynamics driven by schools' responses to local and operational challenges. These responses reflect an urgent demand from schools to seek partnerships that address both immediate concerns and long-term sustainability. As such, this school-driven pathway fosters new forms of collaboration, often initiated at the local level.

(1) External Shocks

On the operational side, schools in remote areas were found to confront static resource limitations, including shortages in funding, staffing, and educational infrastructure. These constraints have compelled school leaders to proactively cultivate broader support networks. In some cases, external shocks—such as natural disasters damaging campus facilities—have prompted schools to form new partnerships focused on recovery and resilience. One of the most significant natural disasters in recent years in Taiwan was Typhoon Morakot, also known as the 88 Flood. Two schools in this study, School RE3 and School RE1, were heavily impacted by the typhoon, and for safety reasons, the schools had to be relocated. This event prompted educators (S17, S09), who

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had experienced the impact of the disaster firsthand, to pay closer attention to the sustainability of both the school environment and the well-being of its stakeholders.

(2) Declining Registration Number

A more persistent challenge is Taiwan's declining birthrate, which has contributed to shrinking student enrollment—especially in rural and aging communities. Birth rates have decreased by more than half between 1985 and 2020, with Taiwan's total fertility rate reaching a historic low in 2023. According to the National Development Council (2024), Taiwan's elementary school-age population is projected to decrease by 40-45% by 2040, with middle and high school enrollment declining by 31-34%, threatening the viability of many schools (國家發展委員, 2024).

Located in regions suffering from population aging and migration, schools are forced even more to contend with intense competition for students. As Principal S09 explained: “Unless you open the district boundaries, but even then, it's the same. Why would people from the lowlands come up the mountain to study? There are schools in the lowlands; why would they come here? Unless your school is different. (Principal S09)”

Both School RE1 and School RE2 are located in areas with limited transportation access, placing them at a distinct disadvantage in terms of student recruitment. Faced with this challenge, principals have come to recognize that the unique qualities of their schools' educational offerings could determine whether they are able to maintain sustainable student populations. In a context where the crises facing the community and environment have made sustainability a central educational issue, these educators view sustainable development as a potential solution to their challenges. As Principal S09 remarked, "I can only tell you that, in rural areas, the way to resolve their difficulties is usually through sustainability."

doi:10.6342/NTU202501048

This perspective has led to a fundamental reconceptualization of the relationship between schools and their communities. Principal S05 elaborated on this transformative approach:

> Our school's journey of transforming rural education through ESD is a reflection of the challenges every rural community and school faces in terms of sustainability, as these areas are more vulnerable to disappearing than urban centers. At the time, this program integrated community sustainability development. The theme was how school education could connect with the sustainability of the community, including supporting the community in local regeneration. This involved exploring issues related to community sustainability and finding solutions that balance environmental, social, and economic aspects. The solution not only promotes sustainability in school education but also helps further develop the community. We began incorporating this into our curriculum around five or six years ago. (Principal S05)

This theoretical framework has been translated into practical action through various ESD-based programs. The Community-Based Sustainable Development Program, available only to select schools in remote areas, exemplifies this approach by depicting the mutual influence between school, education, and the community, forming an ecosystem that requires sustainable management. Similarly, the Eco-Campus Partnership Program has provided another avenue for schools to integrate sustainability thinking into their operations. Principal S04's experience illustrates how these programs emerge from both local needs and global inspiration. Through strong relationships with local government officials, Principal S04 discovered the Eco-Campus Partnership Program during visits to foreign educational programs. This action-oriented program, which draws from local contexts, resonated particularly given Principal S04's previous experience in resource mapping. Recognizing the lack of financial resources, Principal S04 saw the Eco-Campus Partnership Program as an ideal, low-cost strategy that could become a distinctive feature of the school's operations.

The success of this approach is evident in schools like RE1, RE2, and RE3, which have all effectively transformed into local community hubs. These schools demonstrate

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how ESD implementation can simultaneously address enrollment challenges while strengthening community ties. Through these initiatives, schools increasingly function as centers that mobilize residents and leverage collective capacities to sustain both educational institutions and the broader community ecosystem. This transformation represents more than a survival strategy; it embodies a comprehensive approach to sustainable development that addresses the interconnected challenges facing rural communities and their schools.

(3) National Policy as a Catalyst for ESD Adoption

In parallel, faculty have become more actively engaged in ESD networks as they navigate curriculum reform pressures. The implementation of Taiwan's 108 Curriculum Guidelines has introduced competency-based learning frameworks that align with core ESD concepts such as critical thinking, interdisciplinary learning, and global citizenship. This alignment has created new incentives for educators to seek external partnerships that support pedagogical innovation and collaborative learning models.

For schools within Taiwan's formal education system, the Ministry of Education (MOE) played a pivotal role in catalyzing ESD integration. Principal S11's experience illustrates this shift: at the 2019 National High School Principals Conference, Deputy Minister Fan Xunlü（范巽綠), led a session on "Energy Transition and the United Nations Sustainable Development Goals (SDGs)," marking a formal elevation of sustainable education as a national priority. As S11 reflects: "The Ministry of Education raised its voice to say that sustainable education is the most important. We agreed with this idea and began to implement it at our school." This policy announcement coincided with the launch of the 108 Curriculum, which emphasized inquiry-based learning, global perspectives, and self-directed research—approaches that naturally aligned with ESD

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principles and made it easier for schools to integrate sustainability topics into students' learning experiences. Other Interviewees (Teacher S14, Director S15, Administrative Officer S17) from schools similarly noted how the 108 Curriculum's emphasis on inquiry and cross-disciplinary learning created a conducive environment for ESD adoption, whether through local engagement, problem-solving competency, or real-life learning experiences.

Thus, 2019 served as a critical juncture where national policy directives and curriculum reform converged to provide both the incentive and framework for schools to advance ESD within their institutional structures, furthering Taiwan's commitment to global sustainability efforts.

These school-level conditions help explain variations in network size and connectivity. For example, one experimental school located in a remote region demonstrated the highest degree of actor connections (42), which is five times greater than that of a formal education school in a non-remote area (degree = 8). More broadly, experimental schools and schools in geographically remote areas maintain networks that are approximately 2–3 times larger than those of formal system schools and schools in non-remote areas, respectively. This pattern indicates that schools facing structural or geographic constraints are more likely to engage in extensive partnerships, using network-building as a strategy to overcome contextual implementation challenges.

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Chapter 5 Resource Flows Within ESD Implementation Networks

In addition to exploring the composition of social networks among ESD (Education for Sustainable Development)-implementing schools, this research examined the types of resources that flow through these networks and how they influence ESD practices in schools. These resources help clarify what schools genuinely need to further develop their ESD efforts and serve as indicators of how partnerships function in supporting ESD implementation.

The analysis revealed four distinct resource categories flowing through schools' ESD social networks: human, intellectual, physical, and financial resources. These resources function as essential enablers for ESD implementation, with each school mobilizing them through connections with diverse stakeholders across multiple sectors (as detailed in Table 4 Resource Types for Education for Sustainable Development (ESD) Across Different SectorsTable 4). The following sections examined how these resource exchanges through social networks specifically enhance and sustain ESD implementation at the school level.

Table 4 Resource Types for Education for Sustainable Development (ESD) Across Different Sectors

	Resource Type			
Sectors	**Intellectual**	**Human**	**Physical**	**Financial**
Primary and Secondary School	Experience-sharing with schools; Organizing school clubs, meetings, field trips Understanding of ESD-SDGs concepts;	Guidance for educational blueprints; Implementation of ESD curriculum and projects; Curriculum and teaching material	Creation of learning spaces; ESD materials; ESD teaching aids and materials	Incentives for ESD efforts

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	Information on ESD resources;	development; Matching resources; Administrative and logistical support		
Government	Organizing ESD-related programs; Information on ESD resources; Knowledge platforms	Assistance with implementations; consultation support of administrative works; Matching resources	Sustainable facility establishment; Technical system for sustainable projects; Off-campus learning venues; Digital platforms	Subsidies for facilities, curriculum and teaching activity, and ESD-related project
Academia	Professional knowledge and conceptual guidance; Collaborations on sustainable projects; Teacher training; Information on ESD resources	Professional development and consultation support; Support for collaborative courses and projects	ESD teaching aids and materials	—
Business	Provide technical advice; Host ESD-related programs contests and other activities	Support for collaborative courses; Staff and technical assistance	Off-campus learning venues; ESD Teaching materials; Sustainable facility establishment	Subsidies for facilities, curriculum and teaching activity, and ESD-related project
Civil Group	Understanding of ESD-SDGs concepts; Inspiration through local/overseas programs; Teacher training	Administrative and logistical support; Provision of volunteer manpower; Matching resources	Social and cultural learning venues; Natural resources; ESD teaching aids and materials	Subsidies for curriculum and teaching activity

5.1 Types of Resources in ESD Networks

5.1.1 Intellectual Resource Flow

The findings highlight the crucial role of intellectual resources in fostering the successful implementation of Education for Sustainable Development (ESD) within schools. Intellectual resources, such as knowledge, information, and ideas, are critical in enabling schools to develop and implement effective ESD programs. When these resources are integrated into the understandings, thoughts, and mindsets of educators, they become the driving force behind ESD implementation. These resources help create

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opportunities to initiate and develop the practices, increase the willingness of educators and school leaders to engage, and elevate the capacity of educators to engage with ESD.

Access to intellectual resources enables schools not only to expand their understanding of sustainability but also to foster a networked exchange of ideas and best practices, which in turn enhances the overall effectiveness of ESD implementation. The flow of intellectual resources within the school network is thus a critical component of the broader process of adoption of ESD. As schools draw on external expertise, engage in collaboration with other institutions, and stimulate internal partners, they strengthen their ability to implement transformative education throughout the entire school.

The following explores how intellectual resources are exchanged within school networks, focusing on the mechanisms through which knowledge, information, and ideas flow. How these resources influence key aspects of ESD practices is examined: broadening opportunities for ESD development, fostering willingness and engagement among stakeholders, and building capacity for ESD implementation.

(1) Initiating and Deepening Understanding of ESD and Sustainability

A key aspect of intellectual resources in ESD implementation is the understanding of what Sustainable Development (SD) and Education for Sustainable Development (ESD) entail. Without this foundational knowledge, schools may not even recognize the need for ESD or the potential benefits it offers. Therefore, fostering an understanding of ESD principles is essential to creating the initial opportunity for its adoption. Once this understanding is established, it opens up further opportunities for integrating sustainability into curricula, school culture, and community partnerships. This knowledge base thus plays a critical role in the initial stages of ESD implementation, making it a key

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intellectual resource that drives further engagement and action.

Principal S11's experience highlights the importance of understanding the Sustainable Development Goals (SDGs) as a catalyst for advancing Education for Sustainable Development (ESD). Although his school already had a foundational commitment to ESD, it wasn't until 2019 that he became aware of the SDGs through the United Nations' "Explanation of Major National Policies (國家重大政策說明)." As he explained, learning about the SDGs was not only a discovery of new knowledge but also "another resource" to strengthen their ESD efforts:

> Because we've always identified with this concept. We just didn't know that the United Nations had established the SDGs. So, for us, learning that the United Nations introduced the SDGs in 2015 and that the world is promoting them, to me, it was just another resource for our ongoing promotion of ESD, and an opportunity for us to push forward even more vigorously. (S11)

This realization reinforced the school's long-standing ESD practices and provided additional momentum by connecting their efforts to global initiatives. However, challenges remain, particularly due to a lack of understanding of both SD and ESD. As Principal S11 noted, if faculty members do not fully understand the SDGs, it hampers their engagement in ESD initiatives. He emphasized that ESD should not be treated as a separate project, but integrated into existing educational goals, ″Don't treat the SDGs as another project; you will never do it well because it cannot connect to what you are already doing." (S11)

Similarly, Principal S08 highlighted that the lack of a deep understanding of the SDGs remains a significant challenge, particularly when it comes to integrating these goals into practical teaching:

> Actually, at the beginning, the biggest challenge was that everyone's understanding of the SDGs was not deep enough. Everyone knew what the SDGs were, but they were not clear about the specifics of what they entailed. Yes, people understood the term, but truly understanding its deeper meaning was not easy." (Principal S08)

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This situation reflects that, although the SDGs concept is widely recognized internationally, many schools and teachers still face significant barriers in understanding its specific content and operational application. There is a substantial gap between theoretical knowledge and practical implementation. This challenge highlights the difficulty of translating concepts into practice in the educational field, particularly when these concepts need to be integrated with existing curriculum structures and teaching practices.

To address these challenges, intellectual resources in the form of training courses for school members have been employed, with the main goal of increasing the understanding of the SDGs among those responsible for implementation in schools.

As demonstrated by the experiences of Principals S08 and S11, training sessions that provided teachers and school leaders with opportunities to learn about and engage with the core concepts of Sustainable Development (SD) and Education for Sustainable Development (ESD) were crucial. Both principals emphasized the importance of beginning with a basic understanding of the SDGs and their implications. For instance, Principal S11 clearly pointed out that successfully integrating sustainable education into the existing educational philosophy of the school, rather than treating it as a separate initiative, was key to the success of their efforts. Similarly, Principal S08 noted that the school's initial understanding of the SDGs was quite superficial, and it was only after inviting an expert to conduct in-depth lectures that teachers began to grasp the deeper meaning of the SDGs and incorporate them into curriculum design.

The breakthrough in the understanding of the SDGs by both principals and faculty came with the guidance and support of external experts.

Principal S08 emphasized that in order to help teachers better understand and implement the SDGs, the school needed to provide adequate support and resources: "Our

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purpose in holding that training session was, first and foremost, to make sure all the teachers knew what the SDGs were." A professor who studies ESD was invited to lead research and training sessions, which helped teachers gain a deeper understanding of the SDGs' meaning and their relevance to the school's educational framework.

The lectures which were conducted by the professor helped teachers gain a deeper understanding of the SDGs. Through specific curriculum design, the SDGs concept was then integrated into the school's teaching practices:

> We brought the teachers together and invited Professor to deliver two lectures, leading us through an understanding of the SDGs concept. Starting with the basics of SDGs, we systematically reviewed our own school-based curriculum to explore how to incorporate SDGs into it. (Principal S08)

This external expert support not only provided the principals and teaching staff with a deeper understanding of the SDGs, but it also offered concrete guidance on how to integrate these principles into curriculum design. Through guidance from the professor, Principal S08 and their team gradually moved from simply "knowing about the SDGs" to "understanding the SDGs" and, ultimately, to incorporating these principles into their educational practices.

Besides the training provided by the external professional, in the case of S13, the knowledge gap of the faculty members was addressed through a systematic and continuous approach to knowledge sharing by the school's leadership. When S13 first joined the school, which was already implementing ESD, she had no understanding of Environmental Education or sustainable development. Her experience mirrors the common challenge faced by many educators who are initially unfamiliar with these concepts. It was from the very first day of her appointment that the school's principal began providing S13 with resources to help her understand the core concepts of ESD. As S13 recalls:

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> I remember that the first day I was hired, the principal asked us for our email addresses. After providing it, he started sending us a lot of materials—about what the Taiwan-American ecological school is, the school's curriculum map, and videos related to our school's curriculum. (S13)

These resources were not one-time introductions, but part of an ongoing and repeated information-sharing process. Over time, this constant exposure helped S13 gradually internalize the principles of Environmental Education and sustainability, despite her initial unfamiliarity. As S13 explains, ″Even though I didn't know anything at first, after hearing it repeatedly, I realized, 'Ah, this is how it works.' I think it's a really clever approach.″

S13's case illustrates how the repeated and continuous exposure to knowledge facilitates foundational understanding of ESD principles, and moreover, when effectively communicated, can transform into a core part of a school's "culture". Her description of the process as a "brainwashing-like approach" underscores the deep and persistent influence of this knowledge-sharing process. Over time, these ideas became internalized, shaping her professional practices and aligning them with the school's ESD mission.

(2) Fostering Willingness and Engagement for ESD

The successful implementation of Education for Sustainable Development (ESD) in schools requires more than just an understanding of its importance and the related background knowledge—it demands a genuine willingness to take concrete action. The critical role of willingness can be underscored by looking at the issue from the opposite perspective. As Principal S11 pointed out:

> We all agree that, because everyone is so busy—teachers are busy, students are busy—while no one denies the importance of sustainable education, many people lack the motivation to actually do something about it. That's the problem. That's it. (Principal S11)

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In educational settings, where there are numerous mandatory demands, educators must possess the willingness to take action on sustainability. Willingness acts as the driving force that transforms motivation into tangible, real-world change. As Principal S07 emphasized, "To implement ESD, the first fundamental concept is whether one is willing to do it." This willingness to commit to sustainability enables schools to build meaningful, long-term ESD programs that go beyond superficial initiatives.

Furthermore, educators' willingness to engage with ESD practices is rooted in their understanding of the need for sustainability in education. Intellectual resources—such as training, knowledge, and expertise—serve as the key enablers of this understanding and are crucial for integrating sustainability into a school's core activities. Oppositely, the missing or ineffective intellectual resources could bring challenges to adopt ESD practices. This research identifies two primary obstacles that impede effective ESD integration in educational settings.

The first substantial challenge stems from the inherent difficulty educators face in contextualizing global sustainability frameworks within local educational environments. The disconnect between United Nations Sustainable Development Goals (SDGs) and local community contexts creates a significant barrier to meaningful implementation. This misalignment often results in resistance from educators who struggle to translate broad sustainability concepts into practical, locally relevant teaching materials. As S17 explained, integrating the SDGs into teaching content feels distant and disconnected from local realities:

> Because these goals were established by the United Nations based on global needs, but I live here, dealing with local issues that may not be as grand, or ones I cannot solve on a global scale. What I can do is focus on and address the problems at hand in my community. If I were to link these global goals with local issues, how should I approach it? Initially, I was really resistant to the concept because I felt the curriculum was too far removed from our context. Although teachers emphasized that the curriculum should be connected to the real world, at that time, I felt it was

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too distant from our lives. Perhaps my perspective was different from that of the teachers, so I wasn't inclined to accept these contents. (S17)

The second critical impediment relates to the methodology of knowledge dissemination. Traditional hierarchical approaches to professional development, particularly those employing conventional lecture formats and administrative presentations, demonstrate limited efficacy in fostering faculty engagement with ESD principles. This pedagogical limitation significantly impacts the successful integration of sustainability concepts into educational practice.

Empirical evidence from educational practitioners supports these findings. In an interview, a teacher-administrator (S17) articulated the challenges of reconciling global sustainability frameworks with local educational needs. Her testimony revealed initial resistance to SDG implementation due to perceived disconnection from immediate community concerns. Furthermore, they observed that conventional workshop formats failed to generate meaningful teacher engagement with sustainability concepts. Corroborating evidence emerged from a school principal's (S07) experience, which highlighted the limitations of traditional top-down instructional approaches. His observations indicated minimal impact from administrative presentations, with documented instances of teacher disengagement during such sessions.

These findings suggest the need for innovative approaches to ESD implementation that better align global sustainability objectives with local educational contexts while employing more engaging pedagogical methodologies.

To tackle the above obstacles, the interview data reveals three key strategies for effectively fostering educators' engagement with Education for Sustainable Development (ESD) through intellectual resource development: collaborative learning communities, experiential learning through school visits, and student-centered reflective practice.

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The establishment of Communities of Practice (CoP) significantly enhances educators' understanding and implementation of ESD principles. CoP are social groups in which individuals with a shared interest in a particular domain engage in sustained mutual interaction, through which they collaboratively shape their goals, deepen their understanding, and build shared knowledge and routines. Such communities are sustained by ongoing participation and are recognized as key social units of learning within broader systems (Wenger, 1998). Through regular collaborative discussions and shared planning sessions, teachers develop localized interpretations of sustainability concepts. As evidenced by S17's experience, sustained dialogue among colleagues, particularly during the pandemic period, facilitated the development of context-appropriate teaching methodologies. Similarly, Principal S07 emphasized that collaborative lesson planning sessions create opportunities for teachers to share diverse perspectives on sustainability, skills development, and educational approaches, thereby fostering consensus through dialogue.

Direct exposure to successful ESD implementations serves as a powerful catalyst for teacher engagement. Organized school visits provide concrete examples of sustainability practices, particularly in areas such as indigenous culture integration. The transformative impact of these experiences is illustrated by an account from Principal S07, where a teacher reported being deeply moved by observing the passion and enthusiasm of colleagues implementing sustainability curricula at other institutions. This experiential learning, when combined with subsequent knowledge sharing among colleagues, creates a sustainable cycle of intellectual resource development.

Lastly, educators' professional development is found enhanced through observation and reflection on student behaviors and responses to sustainability initiatives. This dynamic resource for professional growth is exemplified by S13's experience, who,

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despite lacking formal Environmental Education training, developed deeper insights through student interactions. A particularly illustrative incident involved observing students' spontaneous creation of a memorial for a deceased frog, demonstrating their internalization of environmental respect and care. Similarly, S16 noted how students' voluntary garbage collection during a community running event validated the impact of ESD, even when manifested in small-scale actions.

These findings suggest that effective ESD implementation relies on creating multiple pathways for intellectual resource development, emphasizing collaborative learning, experiential understanding, and reflective practice based on student engagement. This multi-faceted approach appears to more effectively foster educator commitment and competence than traditional professional development methods.

(3) Capacity Building for ESD

Beyond the willingness to engage, intellectual resources are crucial for building capacity in ESD implementation. This includes enhancing practical skills for specific ESD activities, such as sustainable agriculture (e.g., tea planting), and strengthening key competencies like problem-solving for sustainability, resource management, and curriculum development. Teachers benefit from improving curriculum design, pedagogical skills, and innovative teaching methods to address emerging sustainability challenges. School leaders, meanwhile, can enhance their ability to mobilize and manage diverse resources, including human capital.

In implementing ESD, educators require skills beyond traditional teaching competencies. This study explores the multifaceted nature of ESD in schools, focusing on the skills needed, the challenges faced, and the professional development pathways essential for effective implementation.

doi:10.6342/NTU202501048

The implementation of ESD has introduced unprecedented requirements for educator competencies that extend significantly beyond traditional pedagogical skills. This research reveals a distinct transformation in the skill sets required of educators, particularly exemplified through cases where teachers must master specialized abilities such as sweet potato cultivation and mountaineering expertise. These unconventional skill requirements emerge primarily from the necessity to align educational practices with local contexts and resources. These skills are typically developed through collaborative relationships with community members, including local farmers and tea cultivators, thereby strengthening the connection between educational content and the local.

The research demonstrated that such requirements, while initially presenting as challenges, particularly for educators transferring from urban educational settings, serve dual pedagogical purposes. First, they facilitate deep integration with local resources and community practices. Second, they directly respond to ESD's fundamental principle of experiential exposure, providing students with authentic learning experiences grounded in their immediate environment.

As articulated by Principal S07, this approach aligns seamlessly with the Curriculum Guidelines of 12-Year Basic Education, which emphasizes learning within lived contexts. The principal's perspective highlights a crucial paradigm shift in educational methodology, questioning whether students should adapt to teachers' existing capabilities or whether educators should immerse themselves in community contexts to facilitate authentic, situation-based learning experiences.

The development of these specialized skills has fostered meaningful partnerships between educational institutions and local community members. Schools have established collaborative relationships with local farmers and tea cultivators, who serve as knowledge resources for educators. This partnership model has proven particularly effective in two

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ways: it enables educators to acquire necessary skills while simultaneously strengthening the educational institution's connections with the local community.

The integration of local expertise has demonstrated significant positive impacts on educational quality. By leveraging community knowledge and resources, educators can provide more authentic and contextually relevant learning experiences. This approach not only enhances the delivery of curriculum content but also ensures that educational practices remain deeply rooted in and responsive to local contexts and needs.

Nonetheless, the implementation of ESD presents educators with significant challenges, primarily centered around curriculum design uncertainty. School-based curricula, which grant students considerable autonomy in topic selection, create unprecedented demands on teachers' adaptability. As noted by S01, this freedom in project selection often leads to unexpected teaching scenarios, requiring educators to navigate unfamiliar subject matter and develop new expertise continuously.

A significant challenge lies in the insufficient professional training for Project-Based Learning (PBL), a key pedagogical approach in ESD implementation. PBL is a student-centered instructional approach in which learning is organized around complex, authentic projects that encourage inquiry, problem-solving, and knowledge construction across sustained, in-depth engagement (Thomas, 2000). Yet teachers often encounter implementation challenges such as time constraints, classroom management, balancing control and autonomy, providing appropriate scaffolding, and designing effective assessments (Thomas, 2000). As S01 observes, many teachers encounter PBL methodology for the first time during actual implementation, without prior formal training in research methods, inquiry-based learning, or hypothesis testing. This lack of preparation creates considerable anxiety among teaching staff, who must simultaneously learn and implement these new pedagogical approaches.

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In response to these challenges, two distinct patterns have emerged. The first involves intensive self-directed professional development, where teachers commit substantial additional time to lesson preparation and collaborative planning. S01 reports dedicating ten times more preparation time to special topics compared to traditional subjects, with teachers often extending their collaborative planning sessions into evening hours. This approach, while effective, places considerable strain on teachers' work-life balance.

The second pattern reveals a more superficial implementation of ESD curricula, where teachers, unable to overcome these professional development hurdles, resort to basic, experiential activities lacking pedagogical depth. This approach often results in disconnected learning experiences without clear curricular objectives.

The research reveals significant variations in teachers' professional development trajectories, influenced by several key factors. A notable generational divide exists in pedagogical approach and adaptability. Teachers from Generation X (born approximately 1965-1980) received training primarily focused on subject matter expertise, which contrasts sharply with the competency-based approach required by both the 12-Year Basic Education curriculum and ESD principles.

Educational background, particularly postgraduate training, emerges as a crucial differentiator in teachers' ability to manage ESD implementation. S01's observations suggest that advanced academic training provides educators with critical thinking and research skills that facilitate more effective engagement with school-based curriculum development and implementation.

External support systems, particularly Non-Governmental Organizations (NGOs), play a vital role in enhancing professional development. The case of Teach for Taiwan (TFT) demonstrates how specialized training programs can significantly impact teaching

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effectiveness. Despite having less teaching experience, TFT-trained educators demonstrate superior capacity in curriculum planning and community engagement (S01). Their success has created positive spillover effects, inspiring other teachers and elevating the overall quality of school-based curriculum implementation.

(4) Human Resource Development for ESD

Lastly, intellectual resources play a significant role in human resource development for Education for Sustainable Development (ESD). This includes establishing a systematic framework for selecting, training, and deploying personnel for ESD initiatives. It involves training educators and staff to equip them with the necessary ESD-related knowledge and skills, strategically deploying resources to maximize impact, and retaining talent by fostering engagement and motivation. Ensuring that the right personnel are involved in ESD initiatives and providing them with the support and training they need are critical steps toward the long-term success of ESD in schools. For example, Principal S11 was able to draft a comprehensive talent development plan for the school, thanks to the resources provided by the private foundation (KIST) that operates the school, which helped in planning and implementing the school's "Talent Development" strategy.

Looking forward, the enhancement of ESD educator competencies requires a comprehensive approach. This finding suggests that while the requirement for specialized skills initially presents as a challenge, it ultimately serves as a catalyst for developing more integrated, community-connected educational approaches. Creating sustainable partnerships between schools and their local communities could enrich the educational experience for both teachers and students. On the other hand, a systematic talent development framework should be established, incorporating targeted training in ESD-

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related knowledge and skills. Also, the variation in teachers' professional development trajectories highlight the need for differentiated support mechanisms that account for diverse educational backgrounds and generational differences. The utilization of external resources, such as private foundations, can support talent development planning. This suggests the potential value of expanding such external support systems to enhance ESD implementation across the educational sector. Furthermore, strengthening professional support systems with practice-oriented training content would better equip educators for the practical challenges of ESD implementation.

(5) Sources of Intellectual Resources

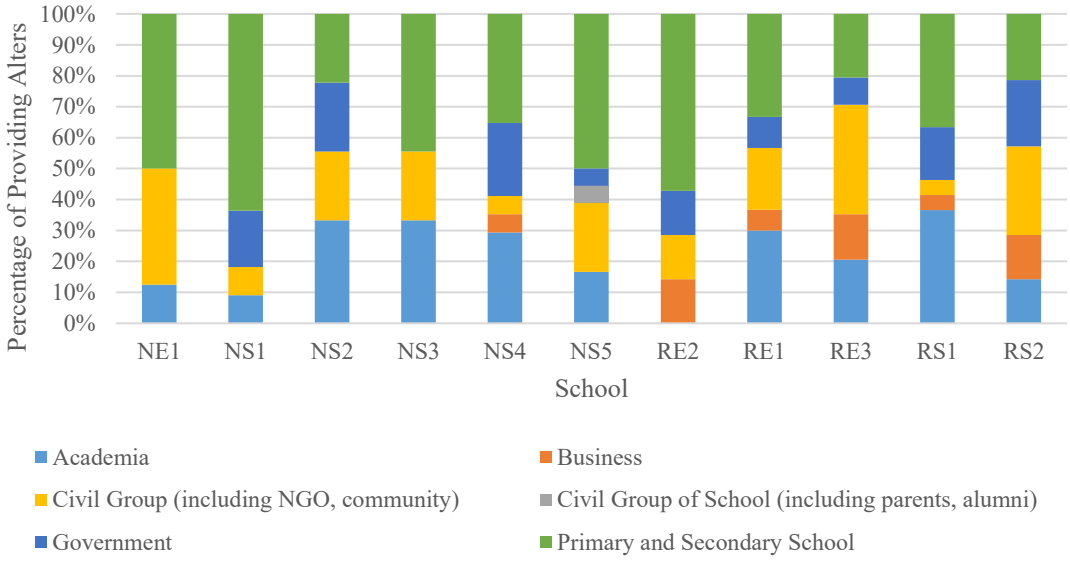

Figure 5.1 Percentage of Alter's Sector Types Providing Intellectual Resources in the Egocentric Network of 11 ESD-Implementing Schools

The primary providers of intellectual resources are primary and secondary schools (Figure 5.1), with principals and cross-school interactions emerging as the most

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significant contributors, according to the analysis of interview data. Principals play a central role as key providers of intellectual resources, a finding consistent with the discussion in Section 4.2 on the "value-driven" motivation for initiating ESD practices. These values, which drive schools to adopt ESD, are often rooted in the principals' personal beliefs. This study identifies principals with strong ESD aspirations as pivotal figures in disseminating ESD-related knowledge and ideas within their schools.

For instance, Principal S04, through a top-down leadership style, consistently shared concepts, materials, and curriculum designs related to Environmental Education. Over time, the principal's values became foundational to the school's cultural framework. This approach represents more than the transfer of knowledge; it is a deliberate strategy for cultural transformation. The principal functions not only as a transmitter of knowledge but also as a shaper of values, embedding ESD principles into the school's identity.

As S13 (2024) described, "The principal resembles an evangelist for Environmental Education, frequently sharing insights on environmental knowledge and the school's teaching philosophy with others." This leadership approach can be characterized as a top-down leadership style, where leaders influence the overall operation and culture of the school through regular and repeated information sharing. Principals S09 and S11 exemplify this approach by first developing a clear vision of integrating sustainable development values into education. They then took the lead in advancing ESD within their schools, embedding these values into teacher training, school curricula, and organizational governance.

Through the integration and dissemination of both internal and external resources, principals gradually transformed their personal commitment to Environmental Education into a shared cultural foundation for their schools. This process underscores the role of schools as socialized institutions, where leaders' actions shape collective cultural values.

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For instance, Principal S11 articulated their commitment to fostering a sustainable culture within the school, while Principal S09 was described by staff (S01) as someone who places significant emphasis on cultivating and establishing the school's culture.

As such, principals, as primary providers of intellectual resources, do not merely influence curriculum implementation but also act as disseminators of school-wide ethos. Their efforts extend beyond specific educational programs to shaping the overall atmosphere and cultural identity of the school.

One of the primary sectors providing intellectual resources is the academic sector (Figure 5.1). Scholars and experts are not only knowledge providers but also serve as bridges, facilitating the understanding and application of new knowledge by educators. This is particularly crucial when addressing complex concepts such as the Sustainable Development Goals (SDGs). The specific guidance and practical strategies offered by experts can effectively help educators overcome barriers to understanding and integrate theoretical frameworks into actual curriculum design.

In Taiwan, Education for Sustainable Development (ESD) and sustainability are emerging topics. Given the nature of sustainability, which emphasizes real-world issues, knowledge and information in this field are continuously evolving. As a result, scholars and academia dedicated to researching ESD play a central role in advancing this area, offering not just supplementary resources but core support throughout the implementation process.

Furthermore, as these scholars are at the forefront of ESD research, it is hypothesized that their established ESD-related social networks enable them to provide valuable connections. This enriches the intellectual resources available to schools. For example, as mentioned by Principal S05, a professor introduced the school to opportunities for applying for ESD-related programs, which subsequently led to expert guidance and

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assistance, as well as opportunities for the school to collaborate with other institutions actively engaged in ESD implementation.

5.1.2 Human Resource Flow

Education for Sustainable Development (ESD) requires the coordinated effort of multiple stakeholders, each contributing expertise, resources, and support to ensure its effective integration at all levels of the educational process. Human resources are central not only to shaping the strategic vision of ESD but also to its successful implementation within schools.

The contribution of human resources directly determines the depth and success of educational practices (S09), and well-prepared staff can integrate ESD into teaching regardless of contextual challenges (S10). Without sufficient human resources, ESD cannot be effectively implemented, nor can schools secure financial support or disseminate sustainability knowledge. However, simply having personnel is not enough; they must be adequately trained and prepared to contribute meaningfully to ESD initiatives. Moreover, not all individuals are suited to the specific human resource needs of ESD.

The role of human resources in advancing ESD can be examined through the various roles they play. These roles are not limited to positional titles; for example, this study found that principals may not always serve as group leaders, and school administrators may not only handle administrative tasks but also directly influence educational outcomes. Focusing solely on faculty positions, therefore, would fail to capture the full scope of contributions. This research identifies three key, interconnected roles in ESD implementation: leaders, practitioners, and facilitators.

These roles may overlap, which can highlight the heavy workloads of ESD

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implementers. Understanding these roles and their associated responsibilities is crucial for understanding how human resources contribute to ESD. The following sections outline these roles, supported by examples and insights from the interviewees.

(1) Leaders

Leaders play a crucial role in the implementation of Education for Sustainable Development (ESD). Given that ESD practices span multiple areas of school operations, they require integrative planning that encompasses both smaller initiatives, such as specific ESD programs, and larger efforts, such as the overall functioning of the school.

In the context of Taiwan's current ESD framework, which has yet to be fully developed, leaders are especially critical in ensuring that schools effectively implement the core principles of ESD. As Principal S09 notes, while the Environmental Education Act mandates a certain number of training hours for educators and the inclusion of Environmental Education topics in the 12-Year National Curriculum Guidelines, this does not guarantee that schools will actually implement these practices. (Note: Although Principal S09 refers to Environmental Education and includes the concept of Education for Sustainable Development. the term “Environmental Education” is used throughout the interview to maintain the original wording used by the principal.) As S09 points out, for ESD to be meaningfully integrated, it must become part of the school’s core educational planning:

> If you want to align Environmental Education with your school’s overall vision, you must reorganize both systems and integrate Environmental Education into all aspects of the school’s operations. Otherwise, it will remain a slogan or a one-off initiative within certain subject hours. (S09)

Furthermore, schools can actively engage in Taiwan's existing whole-school ESD-related programs as a way to begin the process of implementing the ESD approach. As

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Director S15 explains, under the guidance of a previous principal, their school initiated the Eco-Campus Partnership Program. S15, initially assigned to lead the program, became more acquainted with ESD, and later, after the previous principal was reassigned, took on the role of leading the implementation of the Eco-Campus Partnership Program. Thus, initiating and sustaining school action is a key responsibility of leaders within the ESD framework.

The research found that when school principals act as leaders, their involvement is more beneficial than that of other staff members in ensuring the deepening and expansion of ESD initiatives within the school. An example of this is Director S15, who, although not the principal, took on a key leadership role after the previous principal (the main leader) left due to the completion of their term. The new principal did not take an active leadership role and instead adopted a more supportive position. Director S15 stated that, "He didn't have the time to discuss or execute things with you. But he knew what you were doing, and he could support the relevant funding plans."

As a result, Director S15 took on the main leadership responsibilities for ESD initiatives, including planning the school's curriculum to incorporate sustainability concepts and leading the implementation of the Eco-Campus Partnership Program. S15 also had to organize the necessary human resources for these projects. However, without the support previously provided by the principal, S15 faced challenges in mobilizing staff:

> The team that we ended up with was really pitiful. The current team consists of just me and another director, and for other teachers, we had to pull in people based on their administrative roles—like the head of the sanitation team, for example. It became almost mandatory; since they held these positions, they had to take on the tasks. (S15)

S15 resorted to recruiting staff for the Eco-Campus Partnership Program based on administrative roles, such as the sanitation coordinator. While these positions aligned with some of the program's tasks, this strategy led to challenges, as S15 observed that the staff

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members involved lacked enthusiasm:

> What's the difference? It's the difference between proactivity and passivity. If you have passion, you'll be proactive, eager to get involved. If you don't, then it's just a matter of doing what you're told: do this, and you do it; do that, and you do it. (S15)

This highlights the challenge of mobilizing human resources for ESD when leadership is not fully engaged, and the importance of fostering passion and commitment in the staff to ensure the success of such initiatives.

When school principals take on the role of leaders in ESD implementation, the research finds that they often adopt more ambitious approaches to human resource planning. Rather than simply organizing existing staff to support ESD practices, principals actively plan and allocate dedicated personnel. For instance, Principal S09 appointed an administrative staff member as the "Sustainability Coordinator," while Principal S05 renamed the environmental sanitation coordinator as the "Sustainable Environmental Sanitation Coordinator." In addition, schools like NS3 have established Sustainability Promotion Committees, responsible for policy formulation, and organized action groups such as the "SDGs Ambassadors," composed of seed teachers and administrative staff, to implement sustainability-focused teaching initiatives.

Such human resource planning is a critical task for school leaders. As Principal S11 states, "Success depends on people," where "people" refers to teachers, administrators, and students. Thus, the task of leaders is to focus the attention and limited energy of these individuals on ESD, ensuring that the school's resources are effectively mobilized to advance sustainability goals.

(2) Practitioners

Practitioners, particularly teachers, are responsible for the daily implementation of

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ESD in schools. They develop curricula, deliver lessons, and engage with students and the local community, translating the strategic vision set by leaders into concrete actions.

Teachers serve as the primary implementers of ESD, directly engaging with students and enriching the curriculum through interactions with external resources. For example, Principal S09 notes that teachers align with the strategic vision set by the principal, integrating ESD concepts into lesson plans and curriculum design. Similarly, Principal S11 organized a team of "seed teachers" across various disciplines, all of whom received training on SDGs. These teachers incorporate SDGs into their teaching, thereby embedding sustainability goals into the broader school curriculum and influencing their colleagues to promote ESD school-wide.

In addition to internal staff, external lecturers are also a critical resource for teaching and implementing ESD. Both S16 and S17 highlighted the importance of external experts, and their collaboration with local communities has led to closer interactions and further integration of community knowledge into the school's ESD initiatives.

In schools that prioritize community engagement, there are also staff members specifically responsible for maintaining relationships with the local community. These schools, often involved in the National Primary and Secondary Schools' Community-Based Sustainable Development Program (國民中小學結合社區永續發展計畫), not only view the community as a resource but also aim to activate and empower it, fostering mutual benefits for both the school and the community. Schools that seek to influence community perspectives typically invest in dedicated personnel to manage these relationships over the long term. Establishing strong community ties is not an overnight achievement; it requires consistent visits and ongoing interaction (S01). Furthermore, these roles are grounded in trust built through long-term engagement with the community (S17).

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For example, S17 describes how the school has developed a close working relationship with community leaders:

> This is actually a long-term collaboration. The principal is very involved in community affairs, attending both large and small events. Additionally, some of our teachers are also members of the community. Our program activities often take place in the community as well. This is truly a process of long-term development. (S17)

Therefore, as noted by S01, S14, S16, and S17, the success of these community-building efforts often depends on financial support from external funding, such as subsidies for dedicated staff roles. These schools are able to invest in community engagement and collaboration thanks to the financial resources allocated through *community partnership programs*, which cover the salaries of full-time staff responsible for managing these interactions.

Findings reveal that principals also take on the role of practitioners rather solely leaders within their schools. For instance, principals have been observed co-developing lesson plans (School S08), personally leading Eco-Campus Partnership Program student teams in ecological action initiatives (Schools S03 and S15), and maintaining long-term interactions with local communities, even fostering collaborative projects (Schools S09 and S17). This involvement extends beyond curriculum and instruction. Principals are also actively engaged in community initiatives, playing a pivotal role in fostering school-community interactions (Respondents School RE2 and School RE1), thereby laying a critical foundation for sustainable collaboration.

By taking a hands-on approach as practitioners, principals contribute directly to the front-line execution of tasks. Interviewees highlighted two key benefits of this involvement: alleviating the workload burden on other staff and enhancing the principal's credibility as a leader. As noted by Principal S08, "The importance of principals leading by example lies in the fact that if we do not practice what we preach, others might say the

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principal is all talk and no action."

(3) Facilitators

Facilitators, often school administrators, play a crucial role in alleviating the workload of practitioners and ensuring the smooth operation of Education for Sustainable Development (ESD) initiatives. Their responsibilities include offering guidance, providing training, managing resources, and occasionally assuming leadership roles in the absence of principals. By supporting practitioners directly and addressing barriers to effective implementation, facilitators are instrumental in maintaining the momentum of ESD efforts.

Both administrative staff and external teams provide vital logistical support in advancing ESD, enhancing the feasibility of ESD initiatives. This support includes resource acquisition, sharing non-teaching responsibilities, and strengthening the willingness of stakeholders to continue their efforts. Effective implementation of ESD often requires diverse resources, which rarely enter schools spontaneously. An exceptional case, such as School NE1, demonstrates how successful ESD practices can attract external interest, exemplified by external lecturers proactively offering to participate in school programs. However, in most cases, resources must be actively sought and secured to create opportunities for ESD implementation.

External facilitators, such as parents and foundations, contribute by leveraging their networks to introduce additional resources into schools. Internal facilitators, primarily administrators, also play a significant role. This research identifies principals as the core coordinators of resources within schools. This role is closely tied to their administrative responsibilities, as they are inherently central to supporting the school’s teaching

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operations. Moreover, principals often act as key planners of ESD initiatives, with their ability to conceptualize and implement actions frequently contingent upon the resources they have already secured.

The case of School RE1 demonstrates the tangible benefits of collaboration between teaching and administrative roles in advancing Education for Sustainable Development (ESD). At School S17, a teacher overseeing community projects reduced the teaching workload of other educators by preparing lesson plans and instructional materials. Concurrently, the coordinator of the Eco-Campus Partnership Program at School S06 assumed responsibility for the administrative tasks associated with the initiative. The teacher at School S17, who transitioned into a more teaching-focused role, highlighted that because the coordinator managed all administrative operations, her participation in the program required no additional administrative burden. This allowed her to concentrate solely on daily teaching responsibilities, significantly improving her instructional focus. With the support of these facilitative roles, ESD implementation became more efficient at the organizational level.

In some schools, administrative staff not only shared workloads but also proactively addressed practical challenges in teaching to enhance the productivity of practitioners. At School RE3, the coordinator (S13) emphasized that the primary goal of administrative support is to meet instructional needs. She regularly identified the difficulties faced by teachers in implementing ESD, worked collaboratively with them to find solutions, and escalated issues to the principal for further discussion. Through her active involvement, the school was able to adapt curricula flexibly based on teachers' challenges, effectively strengthening the feasibility of ESD practices within the school.

In regions where the effectiveness of the Eco-Campus Partnership Program is prioritized, local governments commission external teams to assist schools. These teams

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often provide more detailed support than the program's central governing body, reducing potential obstacles for schools participating in the initiative. For example, NS1School benefited significantly from the support of a consultancy team commissioned by the local government while participating in the Eco-Campus Partnership Program. This team simplified administrative procedures and even assisted in drafting final reports, enabling the school to focus more on teaching and the program itself. Such external administrative support greatly increased local schools' participation and commitment. When recalling why NS1applied for the highest-level Green Flag certification of the Eco-Campus Partnership Program, Principal S03 surprisingly admitted that achieving the certification was easier than anticipated. According to S03, the school simply continued its regular activities, which encouraged the ongoing implementation of the program and motivated the school to pursue subsequent Green Flag certifications.

In addition to alleviating practitioners' workloads, facilitators as a type of human resource also strengthen educators' willingness to sustain their efforts through a sense of "accompaniment." Principal S08 of School RS2 highlighted the unique advantages of the corporation-funded educational foundation over other foundations. Unlike foundations that cease interactions with schools after providing funding or other resources, the corporation-funded educational foundation has consistently offered a variety of resources and has continued to "accompany" the school in its growth since School RS2 began participating in its initiatives.

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(4) Sources of Human Resources

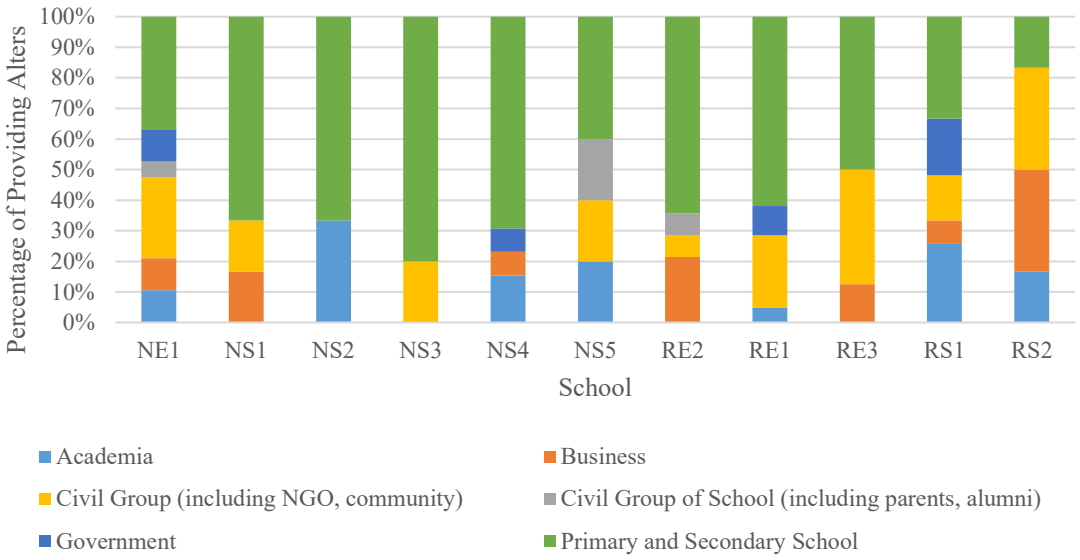

Figure 5.2 Percentage of Alter's Sector Types Providing Human Resources in the Egocentric Network of 11 ESD-Implementing Schools

Among the providers of human resources, schools themselves as alters, which could be the internal faculties, rank the highest (Figure 5.2). This can be attributed to the central role of internal faculties—leaders, practitioners, and facilitators—in sustaining Education for Sustainable Development (ESD) efforts. The prominence of internal faculties indicates that ESD work is becoming increasingly internalized, with principals, teachers, and administrators within the ego schools serving as the primary contributors to ESD implementation.

This research particularly highlights the multifaceted roles principals often assume. For instance, principals such as those in Schools S04, S05, and S09 take on the responsibility of resource acquisition. The principal of School S08 contributes by co-developing lesson plans and setting an example for teachers. Similarly, the principals of Schools S09 and S17 have established long-term relationships with local communities, fostering collaboration and mutual support.

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When principals simultaneously serve as leaders, practitioners, and facilitators, distinct advantages emerge. As leaders, principals possess strong influence and authority, enabling them to effectively manage personnel. Acting as practitioners allows principals to gain firsthand understanding of ESD practices, reducing perceived hierarchal gaps between themselves and staff. Finally, as facilitators, principals leverage their seniority and official title to negotiate with corporations and secure resource sponsorships.

This research documents examples where principals successfully take on all three roles, such as in Schools S04 and S09. The synergistic effect of their involvement is notable—they embody comprehensive understanding and active participation in all aspects of ESD. Consequently, principals in such cases become iconic leaders, driving ESD initiatives. Interviews with respondents from schools led by these principals revealed frequent references to their leadership, with mentions ranging from 20 to 50 times per interview session.

However, when principals are the core drivers of ESD efforts, it is crucial to ensure effective delegation. Both Schools S04 and S09 demonstrate successful planning in this regard, recognizing the need to prepare for scenarios where the principal might be unavailable. These schools have implemented talent training programs to build capacity among other staff members. Such proactive planning ensures the continuity of ESD initiatives even in the absence of the principal, thereby sustaining momentum and operational stability.

The study identified a particularly mature delegation structure in an experimental elementary school located in a remote area. This insight emerged from interviews with two staff members, S06 and S17, who demonstrated a clear understanding of the school's educational philosophy and the implementation of its initiatives. Interestingly, neither respondent mentioned the principal playing a critical leadership role. This absence should

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not be interpreted as a lack of involvement or concern from the principal. On the contrary, through field visits, this study confirmed that the principal holds strong views on ESD. However, due to time constraints, direct interviews with the principal were not possible.

Despite this limitation, the school's ESD achievements are highly regarded. For example, S07, a principal from another school, expressed being deeply impressed by the enthusiasm of the teachers at this remote school. Additionally, during earlier interviews, when project manager PR1 was asked to recommend notable schools, they praised this school's students, highlighting their "sparkling eyes" as a testament to their engagement and passion for learning.

Beyond internal human resources, the school actively integrates external resources from the community and professional organizations to address internal resource limitations. By leveraging the "connections" of these external personnel, the school has successfully secured additional resources across various domains.

Community members and civil groups, including local external experts, play a vital role in supporting ESD implementation. When internal teachers face heavy workloads or lack specialized knowledge, these external practitioners assist in delivering professional courses. Such external contributions enrich the school's curriculum and enhance its ability to address the diverse challenges associated with ESD implementation flexibly and effectively.

5.1.3 Physical Resource Flow

Physical resources are tangible assets essential for Education for Sustainable Development (ESD). Since ESD emphasizes "practices," promoting real-world engagement beyond classroom knowledge acquisition, ranging from local community interactions to international collaborations, the significance of physical resources lies in

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providing direct experiences, without which educators struggle to effectively teach ESD or enable students to contribute to sustainable development. These tangible assets bridge theoretical concepts with practical, hands-on experiences, allowing learners to engage in sustainability in meaningful ways. This section explores how physical resources contribute to ESD through their application in real-world engagement, content delivery, and the creation of ESD-focused learning environments. Additionally, it investigates the sources of these resources and the relationship of physical resources and environmental literacy.

(1) Tangible Assets for Real-World Engagement

According to UNESCO (2018, 2020), connecting learners with real-world issues is key to fostering both empowerment and compassion. “Experiential exposure” to these issues deepens learners' understanding and, when personally relevant, cultivates empathy. This empathy can evolve into compassion, ultimately motivating learners to engage actively and become empowered.

This research revealed several roles of physical resources in facilitating ESD. Primarily, these resources can create tangible impacts aligned with sustainable development goals. For instance, School RE1 distributed rice to resource-scarce neighborhoods and schools, while NS1 sold their vegetable harvests to generate funds for donations. Such utilization of physical resources not only provides hands-on experiences but also empowers individuals to implement sustainable practices in their daily lives.

Designing Education to Align with Students' Lived Contexts

To design education that resonates with students' lived experiences, S07 Principal's school effectively integrates local agricultural practices into the curriculum, creating a meaningful connection between classroom learning and the surrounding environment.

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S07 Principal's school, situated near agricultural fields, leverages its unique local resources to enrich the curriculum. By collaborating with local farmers, the school has integrated the region's agricultural landscape—specifically the sweet potato fields—into its educational framework. This approach provides students with opportunities to engage directly with the land while fostering character education, particularly promoting cooperation and respect. The curriculum at S07 extends beyond traditional agricultural practices, aligning with the Sustainable Development Goals (SDGs). Under Principal S07's leadership, the school emphasizes climate change adaptation and sustainable farming methods. Through partnerships with the Council of Agriculture, the local education bureau, and a university's USR (University Social Responsibility) program, the school has secured funding and equipment to advance smart agriculture initiatives. These efforts allow students to participate in climate monitoring by establishing a weather station, where they can analyze meteorological data, address challenges such as excessive rainfall affecting crop growth, and apply sustainable development principles in real-world contexts.

Physical Resources Supporting ESD through Community Engagement

Physical resources play a pivotal role in supporting Education for Sustainable Development (ESD) by linking students to both local and global communities. These resources are often integrated into community-driven initiatives, such as food distribution to underserved populations or the creation of collaborative spaces for joint projects. For instance, S09 Principal and S01 Teacher engage students in a hands-on project by distributing rice to local communities in need, directly aligning with sustainable food distribution practices. Similarly, S03 Principal shared how her school funds donations by selling harvested vegetables, thereby teaching students about sustainable agriculture while fostering a sense of community responsibility and collaborative problem-solving.

doi:10.6342/NTU202501048

Through such initiatives, students not only contribute to their communities but also gain practical experience in applying ESD principles to real-world challenges.

(2) Content Delivery through Tangible Objects

Before individuals can take meaningful action and accumulate experiences related to the Sustainable Development Goals (SDGs), it is essential for them to understand their roles and develop the motivation and skills necessary to become responsible, sustainable citizens. In this context, physical resources play a vital role in facilitating content delivery. By using tangible objects and providing hands-on experiences, students are better able to grasp the complex concepts associated with sustainability.

For example, in NE1, students were positively influenced by an activity where they filmed and observed hermit crabs, fostering a closer connection to nature. Similarly, School RE1 Teacher S01 introduced sustainability concepts directly through a project-based curriculum, ultimately linking these activities to the SDGs. These approaches not only engage students in active learning but also help them connect theoretical knowledge with real-world applications, enhancing their understanding of sustainability.

(3) Creating ESD-Focused Learning Environments

Through the strategic investment of physical resources, schools can create "sustainable" learning environments where both students and staff are immersed in a space that promotes sustainability. The ability of schools to implement sustainability throughout their learning spaces is a key component in achieving a systemic approach to Education for Sustainable Development (ESD), and is a crucial aspect of the whole school approach to ESD (王順美 et al., 2024). The physical environment of a school serves as a powerful tool for reinforcing the ESD curriculum. By leveraging available resources, schools can design spaces that not only reflect sustainable practices but also foster

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environmental awareness and responsibility among students.

Beyond utilizing existing natural resources, schools can actively create their own ESD-focused learning environments. The schools have incorporated sustainable technologies, like solar panels, rainwater collection systems in NE1 and School RS1, along with ecological facilities such as herb gardens at School RS2.

These schools mentioned all participated in the Sustainable Circular Campus Project, which goal is to turn the school campus into a more sustainable learning institution. Just as Principal S05 said, “The school campus is a teaching aid”. Through this initiative, it simultaneously enhances environmental sustainability and provides practical teaching materials.

For schools like School RE1, where cultural resources are present but require enhancement, dedicated spaces have been developed to promote cultural understanding and sustainable practices. Through community collaboration, they have created areas for teaching indigenous culture and sustainable agriculture, utilizing resources such as land, buildings, and farming materials. Both the development and utilization of these learning environments contribute to ESD.

Furthermore, physical resources can catalyze and nurture the ESD culture within campus communities. To introduce and familiarize the entire school with SDGs, Principal S11 strategically integrated them into daily school life through visual elements including banners, posters, and faculty ID badges, thereby creating an environment of continuous awareness and engagement.

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(4) Sources of Physical Resources

Figure 5.3 Percentage of Alter Sector Types Providing Physical Resources in the Egocentric Network of 11 ESD-Implementing Schools

The distribution of physical resource providers for ESD implementation reveals a

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significant reliance on civil groups and government support, each serving distinct but complementary roles (Figure 5.3). Civil groups (including NGOs and community organizations) emerge as major contributors, particularly in providing real-life learning environments. Their involvement typically involves granting schools access to practical learning spaces like tea fields and farmland, which directly supports ESD's emphasis on experiential and context-based learning. This is evident in multiple schools' networks (RS2, RE3, RE1, and others).

The government's contribution, primarily through the Ministry of Education's Sustainable Circular Campus Program, takes a different but equally important form by funding sustainable facilities within schools. This systematic support through infrastructure development is reflected across several schools' networks (RS1, NS5, NS4).

This combination of support, with civil groups providing authentic learning environments and government funding the physical infrastructure, creates a strong foundation for ESD implementation. The relatively smaller contributions from other sectors, such as businesses and academia, suggest that the physical resources for ESD primarily come from this community and government partnership.

(5) Environmental-Specific Resources and Resource Recognition

The sources of physical resources used in ESD are diverse and often environmental-specific. These resources can be drawn from the local environment, cultural heritage, and community engagement. On the other hand, resource recognition and environmental literacy in ESD practices are also important.

The study identified various environmental-specific physical resources, including natural resources like local flora and fauna, significant landscapes such as wetlands and mountains, and cultural and historical sites that offer rich insights through engagement

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with indigenous tribes. This diversity explains the varied implementation of ESD across schools, as their inherent resources differ based on their geographical locations.

Notably, even schools with abundant physical resources may fail to recognize their educational potential. principal S12shared that despite teaching for two years, she had never noticed the campus's rich biodiversity until a new principal drew attention to the frog sounds. This experience illustrates how educators may overlook valuable physical resources without proper awareness and identification skills, underscoring the importance of resource recognition training.

This observation is further corroborated by principals S04 and S05, who emphasize the importance of conducting a resource inventory. Principal S04 remarks:

> Every school is unique in terms of its location and resources, so there is no need to make a distinction between urban and rural schools. Each school has its own strengths. The key is resource inventory, which is crucial for all schools. This inventory should encompass both internal and external resources, including natural and cultural resources. Only by thoroughly understanding the resources available to a school can one determine the most effective direction for development, thereby ensuring that efforts yield greater results. (Principal S04)

Their background in Environmental Education, through governmental training and academic degrees respectively, enhanced their sensitivity to identifying special resources around their schools. This awareness aligns with environmental literacy, a key indicator of Environmental Education effectiveness.

Physical resources are vital in bridging the gap between abstract sustainability concepts and real-world applications in ESD. Through the thoughtful integration of these resources into school environments, content delivery, and community collaborations, educators can foster a culture of sustainability that extends beyond the classroom. Recognizing and leveraging local resources, while also ensuring that educators are equipped with the necessary environmental literacy, are essential steps in achieving the goals of ESD.

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5.1.4 Financial Resource Flow

(1) The Complex Role of Financial Resources in ESD Network Development

The relationship between financial resources and Education for Sustainable Development (ESD) implementation reveals a nuanced landscape where educators hold divergent views on the necessity of monetary support. This complexity emerges from varying institutional contexts, leadership philosophies, and implementation approaches, suggesting that the role of financial resources in ESD networks is neither uniform nor straightforward.

Analysis of interview data reveals two distinct perspectives on the role of financial resources in the implementation of Education for Sustainable Development (ESD). One view, expressed by several school leaders, emphasizes the fundamental importance of financial resources for the successful execution of ESD initiatives. As S17 remarked, "I believe that financial resources are certainly the most important, because without funding, it is often very difficult to proceed".

This perspective highlights the essential role of financial backing in ensuring the viability and continuity of ESD programs. Another interviewee (S16) further supports this argument, emphasizing that without sufficient funding, it is nearly impossible to secure external resources or maintain essential activities. As S16 explained, financial resources are necessary to support various programs, such as community elder-led tours and eco-friendly culinary events, which require substantial funding for materials and operational costs.

However, an alternative perspective emerges from educators such as S04 and S06, who argue that while financial resources can be beneficial, they are not indispensable for

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the successful implementation of ESD. These educators highlight the potential for integrating ESD into existing curricula, thereby fostering self-sustaining practices within schools without the need for significant financial investment. S06, for example, suggests that financial resources are primarily useful for "expanding the depth and breadth of the school's promotion of sustainable education", rather than being an essential requirement. This view is further illustrated by Principal S04, who advocates for a "subtractive" approach—returning to nature and leveraging existing resources rather than relying on external funding. Principal S04's philosophy is encapsulated in the statement, "Environmental education generally does not cost much. So, it's not a bad idea to start with Environmental Education and ESD in your school because it is relatively inexpensive."

Principal S04's skepticism towards financial dependence of ESD practices is also evident in his rhetorical question: "How can something that relies on money be sustainable?".

The structural context of school funding plays a crucial role in shaping these perspectives. S03 校長 outlines the rigid categories of public school funding, primarily divided into "operating expenses (經常門)" and " capital expenditure (資本門)". These structural constraints often necessitate seeking additional funding through external projects to support ESD initiatives, particularly for schools aiming to develop special features or incorporate external expertise. This institutional framework helps explain why some schools heavily emphasize financial resource acquisition while others seek alternative approaches.

The interconnection between financial resources and other forms of capital emerges as a significant theme in the data. As detailed by S17, financial resources facilitate access

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to multiple resource types, including intellectual resources (through external experts and lecturers), physical resources (teaching materials and equipment), and human resources (community involvement and expertise). This interconnectedness suggests that while financial resources might not be strictly necessary, they can serve as a catalyst for accessing and mobilizing other forms of capital essential to ESD implementation.

The maturity level of a school's ESD system appears to influence the relationship between financial resources and implementation success. Principal S04's school exemplifies how advanced ESD system maturity can reduce financial dependency through well-established operational frameworks and efficient resource utilization. However, even in such cases, as noted by S13, financial resources remain valuable for enhancing teaching quality and improving campus infrastructure, suggesting that while schools can operate with minimal financial input, additional funding can still contribute to program quality and scope.

These findings suggest that the role of financial resources in ESD implementation is highly context-dependent, influenced by factors such as school maturity, leadership philosophy, and existing infrastructure. While financial resources can facilitate ESD implementation and network development, they are not uniformly essential across all contexts. Success appears to depend more on the school's approach to resource utilization and existing infrastructure than on financial resources alone. However, for schools still developing their ESD programs or those preferring more resource-intensive approaches, financial support remains a crucial factor in program sustainability and development. This complexity underscores the need for flexible and context-sensitive approaches to resource management in ESD implementation.

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(2) Sources of Financial Resources

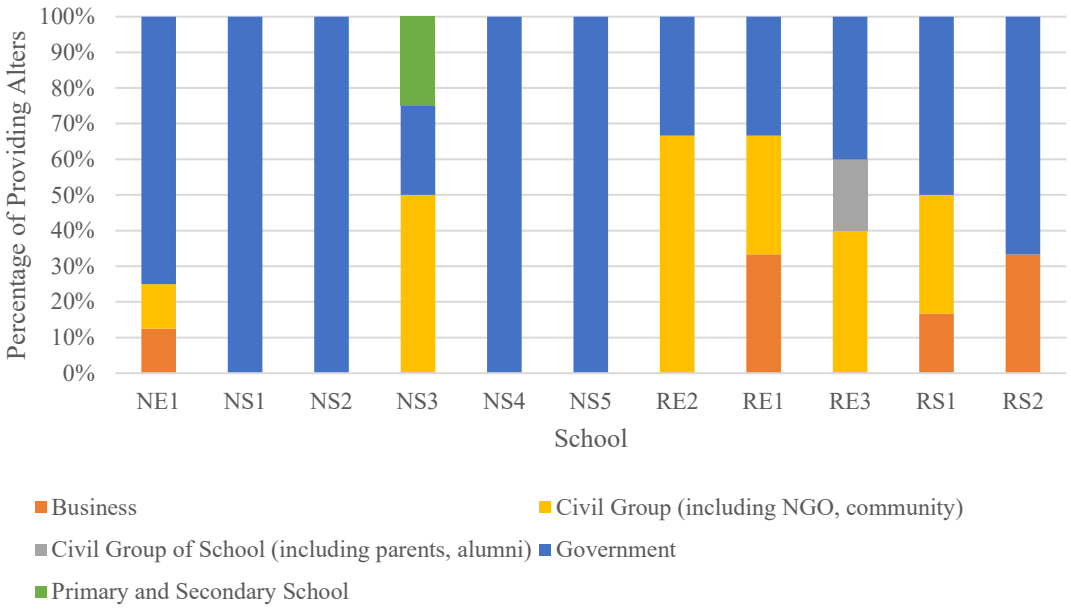

Figure 5.4 Percentage of Alter Sector Types Providing Financial Resources in the Egocentric Network of 11 ESD-Implementing Schools

The financial resources for implementing ESD in schools vary across different types. Project funds are the most dominant financial resource, far outpacing other categories such as school operation funds, donations, grants, and revenue. Among the various actors providing financial support (Figure 5.4), Central Government funding is the most utilized, followed by contributions from Local Government and Industry. Civil groups, such as NGOs, are also frequently mentioned as sources of funding, while support from School-Related Civil Sources—like parent and alumni associations—and local Community contributions remain comparatively minimal. These differences in funding sources not only reflect the distribution of resources but also underscore the varying levels of flexibility, challenges, and intended uses associated with each source. Such variations play a crucial role in how financial resources are allocated to ESD practices.

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Government funding plays a crucial role in supporting ESD, as highlighted in the figure. The prominence of both Central and Local Government funding, along with the dominance of project funds, underscores the critical role that government-backed programs play in driving ESD implementation. Interviewees identified several key funding sources, with the Ministry of Education being the most frequently mentioned, followed by other governmental agencies such as the Education Bureau (教育局), Environmental Protection Bureau (環保局), Council of Agriculture (農委會), and additional agencies that contribute to ESD financing.

Corporate foundations and organizations focused on sustainability often provide grants with fewer restrictions, allowing schools to innovate and implement unique Education for Sustainable Development (ESD) projects.

For instance, Principal S08 highlighted that the program funded by the corporate-funded educational foundation awarded the school a "bonus" for achieving the Green Flag certification. This bonus is unrestricted and can be used flexibly, making it easier for the school to allocate resources where needed. Similarly, S01 emphasized that funding from foundations is more flexible and easier to manage compared to government project funding. He particularly values this support for its simplicity and efficiency. As S01 explained:

> Funds donated by foundations are easier to manage than government grants, particularly in terms of reimbursement procedures. If you've ever helped a teacher prepare a project proposal, you'll know that accountants are very strict about government fund reimbursement. For example, you cannot use the funds for snacks or other items that don't meet specific guidelines. If the expenditure does not match the approved categories, it's very difficult to get reimbursement.
>
> In contrast, community-related expenses often involve things like attending events, which may require purchasing lunch boxes or other materials. These types of expenditures are much easier to reconcile and reimburse. Foundation donations offer greater flexibility in this regard, allowing us to use the funds more efficiently and effectively. (S01)

The flexibility and ease of fund management significantly contribute to the

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successful implementation of ESD initiatives.

Although the primary source of financial resources for schools does not come directly from within the institution, the study finds that principals play a crucial role. Beyond their administrative position, the principals in this study have developed a resource network through their prior experiences in other schools or organizations, and they effectively channel these external resources into their schools.

Principal S01 emphasized that the school relies heavily on the principal to secure financial resources, noting that the principal has an advantage in gaining the trust of external organizations:

> As soon as the principal steps in, the problem is resolved. The Foundation, for example, is very willing to accommodate the principal. Since the principal is a business owner, he may not be deeply familiar with the community, but he entrusts all authority and resources to the principal, who, along with the school team, drives the initiative forward. (S01)

Furthermore, the principal's diverse background allows the school to access a wide variety of resources suited to its needs. Principal S12, for instance, leveraged their previous experience with the Environmental Education (EE) Center, a government agency promoting Environmental Education, to identify and utilize relevant resources:

> I make sure not to miss out on any of the programs available. I spent five years on secondment at the Education Bureau, so I'm familiar with many of their programs. As a member of the Environmental Education Center, I wrote many of the projects during my time there. When I was at Mican Village, I knew which programs to apply for, and I knew there was funding available to support the school. These resources can really make a difference, so whenever possible, I apply. (Principal S12)

Principal S12's example illustrates how the principal's background in Environmental Education (EE) enables the strategic use of EE resources to promote Education for Sustainable Development (ESD). This suggests that there is significant overlap between EE and ESD in the practical implementation of these initiatives in Taiwanese primary and secondary schools.

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Director S13 explained that the school has been able to secure financial support from a corporation-funded foundation by virtue of Principal S04 maintaining a strong collaborative relationship with the foundation. This claim was corroborated by secondary data, which confirmed that Principal S04 holds a board member position at the foundation. Moreover, the interview with Principal S04 was conducted at the foundation's headquarters, coinciding with a workshop on ESD-related initiatives. During this fieldwork, it was observed that Principal S04 maintains a close working relationship with the foundation, as evidenced by their familiarity with and greetings to the teachers, professors, and the foundation's executive director attending the event.

Additionally, Teacher S16 highlighted that the school's financial concerns are alleviated through grants from the corporate foundation, which was established by Principal S05. Principal S05 elaborated that, due to regulations under Taiwan's experimental education laws, the school was required to seek funding from a legal entity in order to establish the institution. This regulatory framework compels schools operating under experimental education provisions to form partnerships across various sectors, thereby expanding their social networks and fostering greater diversity in their resource base.

Financial support from local communities is a rare source of funding for schools. In most cases observed in this study, schools typically utilize project funds to provide resources to the community or hire community members, thus maintaining a reciprocal relationship. These donations are highly flexible, allowing the school to tailor initiatives that directly address local needs and contexts, thereby strengthening the relevance and impact of the ESD programs.

However, an exception is found in the case of School RE1, where a deeper connection with the local community led to individual contributions from the community

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leader. The community leader voluntarily donates funds to support the school's annual ESD-related courses. This successful partnership exemplifies Alkaher and Gan (2020) recommendations for establishing stable school-community partnerships, particularly their emphasis on including partnership development as part of the school agenda and identifying common goals between schools and communities. Under the leadership of Principal S09 and Teacher S01, School RE1 has effectively positioned itself as a center for community revitalization, making community engagement and service core elements of the school's mission. This strategic alignment between school objectives and community needs has resulted in the community leader's recognition of the school's educational value, leading to additional financial support for ESD implementation. The case demonstrates how embedding community partnership into the school's fundamental agenda can create lasting, mutually beneficial relationships that support ESD implementation.

The above passage highlights the significant differences between government funding and private donations in the reimbursement process, particularly in terms of flexibility. Government funding typically requires strict audits and specific regulations, which can limit the flexibility of fund usage. In contrast, private donations, such as those from the Foundation, tend to be more lenient in the reimbursement process, offering greater flexibility.

In ESD practices, the flexibility of fund usage is crucial for the smooth execution of projects. When government funds come with strict reimbursement standards, they can limit the operational space of project teams, especially for small expenses (such as meals, materials, etc.) or for unforeseen needs. This forces implementers to waste time navigating complex administrative procedures, and they may even fail to reimburse certain expenses due to minor non-compliance with regulations.

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On the other hand, donations from private organizations like the Foundation provide more freedom in the use of funds. This flexibility allows for quicker responses to unexpected or emergent needs, which is especially important for the timely implementation of projects. This also reflects that, in certain situations, private funding can offer greater efficiency and lower administrative burdens compared to government funding.

(3) Governmental ESD Funding: Contextual Variation and School Strategies

The Role of Local Government

While central government funding dominates ESD financial support, local governments emerge as the second most significant funding source. However, the analysis reveals substantial variations in local government support across different districts, creating an uneven landscape of resource distribution among schools. This disparity is exemplified by cases such as the Pingtung Education Bureau, which offers financial rewards to schools participating in the Eco-Campus Partnership Program, while educators from other regions report no such incentives from their local authorities.

The support from local governments manifests through both direct financial assistance and indirect administrative aid. Some districts have developed innovative approaches to program management, as seen in Changhua and Kaohsiung, where external teams have been outsourced to manage program promotion. These teams provide valuable expertise and reduce schools' administrative burdens, as evidenced during the Eco-Campus Partnership Program workshops. In these sessions, team members actively facilitate program implementation and guide schools through application processes, demonstrating how indirect support can significantly enhance program effectiveness.

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Local governments' commitment to ESD programs is often reflected in their Key Performance Indicators (KPIs). According to PR1, these authorities establish specific targets for each program cycle, ranging from registration numbers to certification levels. These KPIs serve as guiding metrics for resource allocation and program promotion strategies, typically implemented through a structured, top-down approach by outsourced teams. This performance-driven approach shapes how resources flow to schools and influences program implementation strategies.

The selective nature of resource distribution becomes particularly apparent in programs like the Community-Based Sustainable Development Program, which operates through a closed application system. Professor E03's insights reveal how education bureaus select "suitable" schools for participation, often favoring institutions with established government relationships. This selection process creates varying opportunities for schools to access ESD resources, with some districts securing additional program spots through proactive government engagement. Such practices highlight how local government involvement can either facilitate or limit schools' access to ESD resources.

The impact of local government support extends to school-level implementation efficiency. When local governments provide financial support, schools can enhance their programs by hiring external experts and improving teaching materials. Furthermore, administrative support through outsourced teams allows school staff to focus on practical program implementation rather than administrative tasks. This dual support system—financial and administrative—creates an environment where schools can more effectively implement and sustain their ESD initiatives, though access to such support remains uneven across different districts. Regardless of local government support levels, schools must navigate various challenges in managing governmental funding sources.

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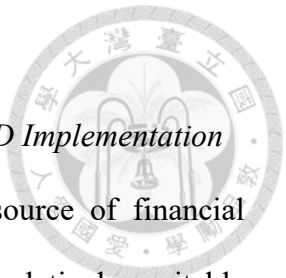

Challenges and Strategic Responses in Government-Funded ESD Implementation

Government funding emerges as the most frequently cited source of financial support for ESD implementation, primarily due to its accessibility and relatively equitable distribution compared to other sources, despite the variability in local government support, as noted previously. However, this funding, whether from central or local governments, presents several significant challenges, including the temporary nature of programs, restrictions on the use of funds, and substantial administrative requirements. As a result, schools have been compelled to develop strategic approaches to resource management.

The administrative burden of government funding presents a particular challenge for schools. As Principal S07 notes, "The more programs there are, the busier the administrative staff becomes." This administrative load stems from the need to meet specific Key Performance Indicators (KPIs) and produce detailed accountability reports. Principal S03 elaborates on this challenge: "For each program, there must be a results report... each program typically has its own KPI." This reporting requirement significantly impacts schools' human resources and can influence their capacity to pursue additional funding opportunities.

In response to these challenges, schools have developed strategic approaches to program management. Rather than pursuing disparate funding sources, schools focus on programs with aligned goals and complementary requirements. Principal S07 exemplifies this approach, explaining that their school strategically selects programs that can be integrated to maximize impact while minimizing administrative strain. This strategy is captured in Principal S03's metaphor of "one fish, many meals (一魚多吃)," though they caution against overextending staff resources.

The case of Principal S07's school illustrates a successful implementation of this

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strategic approach. By focusing on food and agriculture education, the school has successfully integrated multiple funding programs to support their educational vision. This strategic alignment allows them to enhance their curriculum while efficiently managing resources, demonstrating how schools can leverage multiple funding streams to achieve their educational objectives.

However, this strategic approach raises concerns about resource distribution equity. While some schools successfully integrate multiple programs around a single focus, others may lack the human or financial resources to implement such strategies effectively. This disparity could potentially exacerbate existing inequalities in educational resource access, particularly affecting schools with limited capacity for program management and implementation.

Understanding the Interplay of Context and Response in ESD Resource Management

The analysis of governmental ESD funding reveals a complex relationship between regional contexts and school-level responses. At the structural level, varying levels of local government engagement create distinct implementation environments across districts, leading to different opportunities and challenges for ESD initiatives. These contextual conditions are further shaped by the characteristics of program-based funding mechanisms, including their temporary nature and administrative requirements.

Schools demonstrate considerable adaptability in navigating these varying contexts. Their strategic responses, particularly in managing multiple funding streams and utilizing available local government support, illustrate how educational institutions actively develop approaches suited to their specific circumstances. The case studies of principals like S07 exemplify how schools can strategically align multiple funding sources with their

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educational vision, while others highlight the challenges faced when such strategic integration is constrained by limited human resources.

This dynamic relationship between contextual variation and school adaptation in ESD resource management suggests that effective support for ESD implementation requires attention to both regional differences and school-level capacity building. While some schools successfully navigate the complex funding landscape, the varying levels of local government support and differences in schools' capacity to manage multiple programs indicate the importance of considering local contexts in program design and implementation.

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5.1.5 Synthesis of Findings

(1) Financial Resources: Limited Provider Diversity

Among the four resources, it is interesting to discover that financial resources are channeled through a narrow range of providers, primarily governmental agencies and business foundations. This concentration grants these actors significant influence within ESD networks. However, such centralization introduces systemic vulnerabilities, particularly in contexts like Taiwan, where ESD initiatives remain highly program-dependent and lack institutional permanence. As schools rely on short-term project grants, shifts in policy priorities can abruptly terminate both financial and logistical support, leading to unstable and fragmented implementation efforts.

In light of the identified vulnerabilities in Taiwan's ESD networks—particularly the dependence on program-based financial resources—this study finds that voluntary governance mechanisms within schools can serve as a key buffer against disruptions. This is not merely a theoretical recommendation but is grounded in empirical findings from interviews with both experimental and standardized schools.

All four experimental schools included in this study demonstrated practices that help institutionalize ESD within their daily operations, thereby reducing dependence on external program cycles. In experimental schools, they possess more regulatory flexibility that allows for customized curricula. This feature facilitates these schools to articulate ESD as part of the school's core educational philosophy. These schools have leveraged their structural autonomy to integrate ESD content and practices into regular planning processes, assigning designated personnel to oversee sustainability initiatives. For instance, the remote experimental school (RE1) has a position titled *Sustainability Group*

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Leader (永續組長), while the non-remote experimental school (NE1) designates a *Sustainability and Environmental Hygiene Group Leader* (永續環衛組長).

Standardized schools, though more constrained, also exhibit capacity for governance innovation. One principal (S10) described how their school strategically leveraged the curriculum development committee—a structure formalized under Taiwan's 108 Curriculum Guidelines—to negotiate additional class periods for subjects willing to integrate sustainability content, particularly in areas like science where teaching hours had been reduced. As supported by recent Taiwan-based research (劉怡華 & 蘇玲慧, 2024), these committees function as extensive social networks reaching over 90% of school members, facilitating both coordination and the diffusion of intellectual resources throughout the faculty.

These empirical cases suggest that institutional structures already in place—such as curriculum committees or school development planning mechanisms—can be leveraged to embed ESD sustainably, independent of external programmatic support. Such practices offer a practical model for increasing school-level resilience and should be considered a priority in future ESD policy development.

(2) Intellectual Resources: High Exchange Diversity

In contrast, intellectual resources are exchanged more frequently and through a broader array of actors, encompassing expert advisors, peer educators, NGOs, and international collaborators. Schools rely heavily on these resources—such as professional knowledge, expert mentorship, and collaborative learning opportunities—to build educator capacity and sustain engagement with ESD practices. This broader exchange base supports network flexibility but also reflects a deeper issue: the unclear

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conceptualization of ESD in Taiwan.

The conceptual ambiguity surrounding ESD in Taiwan contributes to the widespread search for intellectual resources. Despite active engagement in ESD-related initiatives, many educators lack a clear understanding of the term's meaning or practical implications. The absence of standardized frameworks across government programs exacerbates this uncertainty. While international literature highlights the importance of shared visions in ESD (Tilbury, 2011), Taiwan's current approach places the burden of interpretation and capacity development on individual schools. This diffused responsibility leads to inefficiencies in resource use and dilutes the potential impact of ESD programming.

Interestingly, this ambiguity may also stimulate knowledge exchange by encouraging educators to seek guidance from a variety of sources. The high exchange frequency of intellectual resources could thus be interpreted as a symptom of both conceptual fragmentation and adaptive network behavior. However, without stronger institutional coordination, such adaptive efforts may remain limited in scale and sustainability.

(3) Mediating Role of EE Background in Resource Utilization

A notable finding is the mediating role of Environmental Education (EE) backgrounds in educators' ability to effectively mobilize and utilize both financial and intellectual resources. Principals with strong EE experience demonstrated greater capacity to interpret ESD goals, coordinate internal efforts, and engage with external support networks. These individuals often drew on experience gained through sustained professional development—such as participation in environmental advisory boards or graduate education in EE—rather than formal training mandated by Taiwan's Environmental Education Act (EEA). This aligns with critiques of EEA that fail to build meaningful

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professional expertise (Huang et al., 2021).

The findings highlight a key limitation in Taiwan's teacher training system: current environmental education (EE) training requirements are inadequate for developing leadership in Education for Sustainable Development (ESD). Schools lacking personnel with deep EE experience often compensate by seeking external support, such as consulting ESD scholars, partnering with private foundations, or participating in online training offered by the Global Schools Program—an initiative of the UN Sustainable Development Solutions Network supporting UNESCO's Global Action Program on ESD. On the positive side, this gap encourages schools to expand their social networks. However, it may also further disadvantage under-resourced schools, reinforcing inequalities in their capacity to implement ESD effectively.

(4) Interwoven Relationships within Four Types of Resource Flow

The four categories of resources—intellectual, human, financial, and physical—form a web of interdependencies that drive successful ESD implementation (Figure 5.5). This interconnectedness manifests in multiple reinforcing cycles. When intellectual resources enhance human capacity through skill development and motivation, these empowered individuals generate innovative ideas and create teaching materials, thereby enriching both intellectual and physical resources. Financial resources, managed effectively by human resources, enable the acquisition of physical infrastructure and external expertise. These improvements in the physical learning environment and human capability then feed back into strengthening intellectual resources through enhanced learning experiences and knowledge creation.

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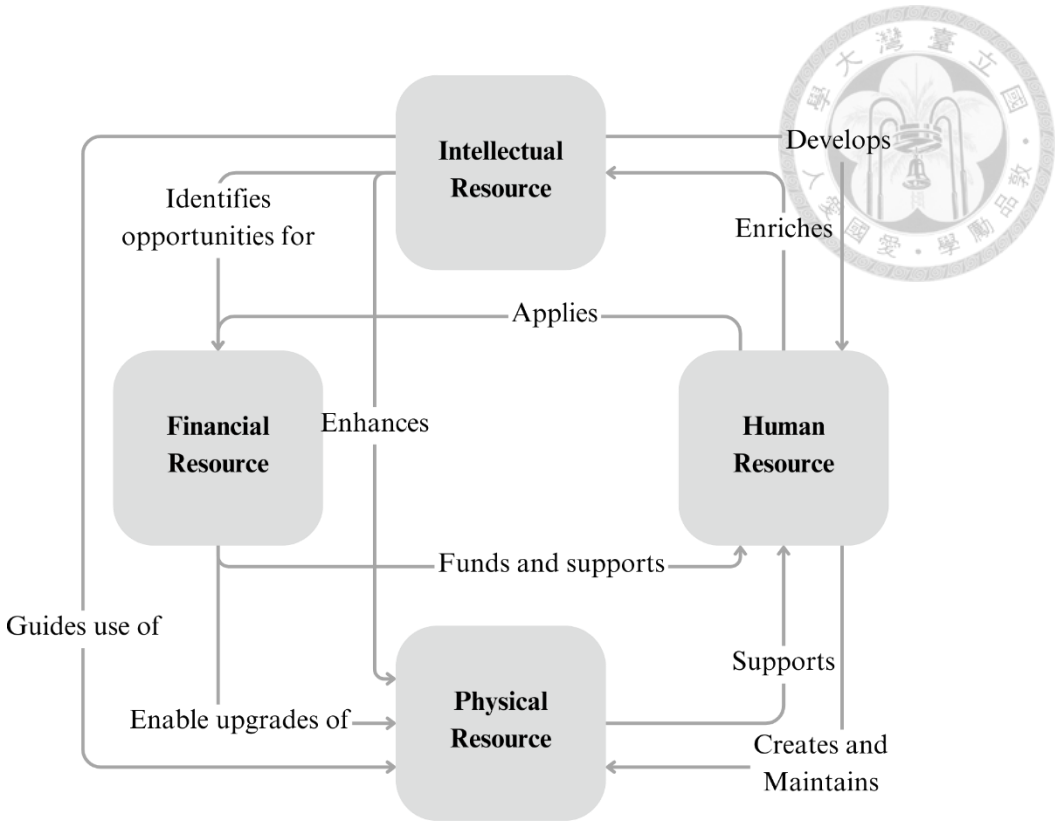

Figure 5.5 Resource Exchange Conceptual Diagram for ESD Implementation

The circle shape represents the primary driver, "Intellectual Resources." The dark grey shading denotes the main resource categories.

Among the four resources, this research identified that intellectual resources stand as the critical initiating force, particularly in the voluntary context of ESD adoption. When educators possess strong ESD willingness and understanding, they naturally prioritize ESD implementation and actively seek ways to activate other resources. This intellectual foundation demonstrates through three key pathways: initial willingness that drives implementation priority, ongoing capacity building that develops resource management capabilities, and information access that identifies valuable ESD programs. These programs, in turn, provide comprehensive support across all resource types, creating reinforcing cycles of improvement.

The system's interconnectedness means that while financial resources can fund

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facilities and human resources can create materials, these contributions only become meaningful when guided by strong intellectual resources. When schools recognize intellectual resources as the primary driver, they can more strategically channel other resources to amplify their ESD implementation efforts, creating positive feedback loops that strengthen the entire system.

Understanding these interconnections is crucial for schools implementing ESD, as it enables strategic resource allocation and helps identify potential cascade effects. The cyclical nature of these relationships means that investments in one resource category create ripple effects throughout the system, where strengthening one resource category can amplify the entire system's effectiveness.

However, disruptions in one category can cascade through the network, jeopardizing the overall stability of ESD operations. Given the dynamic and variable nature of resource networks, schools must adopt integrated strategies to mitigate risks and maximize the benefits of these interconnected systems. These complexities were explored further in the next section.

5.2 Interruptions and Adaptive Strategies for Sustaining Resource Flow

In the context of Education for Sustainable Development (ESD), ensuring a consistent and uninterrupted flow of resources—human, intellectual, financial, and physical—is critical for the long-term success and impact of sustainability initiatives. However, various factors, including systemic, organizational, and individual disruptions, often hinder this flow and pose significant challenges to the sustainability of ESD programs. These interruptions can occur due to factors such as temporary project-based funding, resistance from faculty members, or leadership turnover, such as the transfer of

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principals, all of which can destabilize the continuity of ESD efforts.

This section explores the diverse challenges that disrupt the flow of resources in ESD and identifies adaptive strategies to mitigate these issues. In order to ensure that ESD initiatives remain resilient in the face of such challenges, it is essential to integrate ESD more deeply into institutional frameworks and foster interconnectedness between resource streams. Key strategies include strengthening human resources through identity building and professional development, diversifying sources of financial support, enhancing stakeholder flexibility and engagement, and institutionalizing ESD practices to promote long-term stability. By adopting these approaches, schools can not only address the disruptions they face but also establish a robust foundation for the continued growth and success of ESD programs in the future.

5.2.1 Challenges and Causes of Resource Flow Disruptions

(1) Impact of Program Termination

One of the significant disruptions to resource flow in Education for Sustainable Development (ESD) arises from the termination of external programs that schools rely on for resource provision. When these programs end, schools face the immediate challenge of losing financial support and intellectual resources that were essential for sustaining ESD practices. Additionally, the cessation of these programs often results in the loss of external expertise and mentoring, which are crucial for supporting the ongoing implementation of ESD initiatives.

As noted by Professor E03, in some cases, the termination of a program may be seen as a natural conclusion after the successful achievement of its objectives. In this case, the program's success led to a feeling of accomplishment, as the Professor E03 described,

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"Our program can be considered a success. We've reached our goals, and it's time for us to step back. The participating schools, however, felt that we did such a great job and were reluctant to end the program."

Despite the seemingly positive outcome, the schools involved still faced challenges when the program's resources were withdrawn. For instance, Administrator S17 highlighted that while the curriculum developed during the program was internalized within the school, the loss of other program resources created additional burdens. Although the curriculum itself continued to be implemented, administrative staff, such as S17, were forced to take on teaching responsibilities that were not part of their original job descriptions. S17 explained:

> In our school, this situation is somewhat on the edge of what is typically expected. As an administrative staff member, I am not supposed to be involved in curriculum planning. My role should have been much simpler—just managing administrative tasks. But due to the school's development goals, the principal assigned me some additional responsibilities. For the past two years, my salary and duties have been set by the school, but when it comes to teaching, I'm not supposed to be directly involved because I am not a teacher. However, because we had developed a curriculum during the program, I collaborated with local youth and teachers to design it. After the program ended, there was no extra funding to hire local youth, so eventually, it became the responsibility of our school staff to manage the curriculum. As a result, I found myself involved in teaching in the classrooms. (S17, 2024).

This case illustrates how the end of external program support, while initially framed as a success, can inadvertently lead to resource gaps and increased workload for school staff. The termination of funding and expertise creates a situation where schools must either absorb additional responsibilities internally or risk losing the momentum generated during the program. The lack of financial resources to continue engaging external personnel, such as local youth mentors, highlights the critical role that sustainable funding and resource management play in the continuity of ESD initiatives.

Some schools experience significant challenges related to turnover and lack of continuity in human resources when transitioning between different programs. Although

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the school remains the same, the personnel involved in these initiatives change frequently, preventing the formation of a stable, cohesive team. As described by Director S15:

> No, there wasn't really a team formed. It was just the two of us because everyone else kept changing. Like I said, when the person responsible for the administrative work leaves, they simply stop doing it because they no longer feel it's their responsibility. They leave the work behind. You see. There's nothing we can do about it. We can't force them to stay engaged or take leadership. It's really about their attitude and mindset, and we can't really impose that. It's quite sad, actually. The team we have now is completely different from the team that was here 15 years ago. The only people still here are me and the other Director. We don't have a permanent team. (S15)

This example illustrates that while programs can initially bring together staff and form a working group, without establishing these teams as part of a permanent institutional structure or, at the very least, fostering a shared collective mindset during the program's execution, the sustainability of these efforts is difficult to maintain. For other school staff members, this lack of continuity can result in challenges in implementing ESD initiatives, as there is no long-term team or agreed-upon framework to support them. This emphasizes the importance of not only providing short-term resources but also creating lasting structures or shared goals that can sustain momentum beyond the life of the program.

(2) The Challenge of Unsustainable Support

External partnerships can offer valuable resources for schools, particularly in the context of community engagement and sustainability efforts. However, these partnerships have shown to lack the long-term continuity required to make a lasting impact. One example of this is the collaboration with external partners from the university, which provided assistance to schools through community research conducted by college students. While their contributions were well-intentioned, they faced a significant

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challenge in sustaining their efforts beyond the completion of their courses. As described by S01:

> Actually, the University, they are really well-meaning in wanting to help the community. But there's a major issue. The problem is, as I mentioned, these students are only involved because they're taking a course. So, once they finish the course, a new group of students come in. It's like a cycle where they complete their assignment, but there's no lasting impact on the community. Do you get the concept? It's like when university students come to your school to hold a camp, and after it's over, nothing happens. Next year, they'll come again, but the interim is empty. There's no follow-up. The community doesn't know what was done, and the school doesn't know either. It's as if it's just a one-off. What we really need is long-term management, a sustainable culture—not just 'this is done for this year' and then it's over. (S01)

In this case, the external partners' contributions, though valuable in the short term, were not sustained over time. The lack of long-term engagement left gaps in both the school and community's ongoing efforts to implement sustainable practices. As the interviewee noted, sustainability requires consistent and enduring efforts, not just one-time engagements. This example underscores the importance of ensuring that external partnerships are not only about completing isolated tasks but also about fostering long-term, continuous collaboration that supports sustained growth and impact.

(3) The Challenge of Faculty Turnover on ESD Practices

The departure of internal faculty members, particularly those directly responsible for leading or implementing Education for Sustainable Development (ESD) initiatives, can have a profound impact on the continuity and sustainability of ESD practices within schools. When key individuals leave, the risk of disruption in the school's ESD efforts becomes significant, especially in areas such as community engagement, which often relies on personal connections and continuity of leadership.

As S01 described, the departure of a key staff member who had been responsible for

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community engagement created a crisis for the school's ongoing work with local communities:

> As I mentioned earlier, we had a director who left this year. This director had been in charge of community-related activities for the past few years. The school had always assigned someone to coordinate with the community. But after the director left and transferred back home, the new director was completely unable to take over. The new director had never been involved in social welfare work, and didn't know the locations of elderly people in the community, nor did they understand what needed to be done. For instance, they didn't know who to buy tea from or how to continue building these relationships. This is the issue that arose after the departure of the previous director. The new director simply couldn't manage the community outreach and engagement that had been built up. This is a problem caused by the departure of a core team member. (S01)

This situation illustrates how the absence of key individuals can disrupt not only the operational continuity of ESD programs but also the broader, long-term relationships that are essential for sustaining such initiatives. The knowledge, trust, and networks built by a single staff member can be difficult to replicate, particularly when the new person lacks prior experience or background in the relevant areas.

Additionally, when practitioners in other areas leave, it places a significant burden on remaining faculty, leading to additional strain and potential burnout. S01 recounted the constant cycle of recruiting and training new staff members, which diverted attention from the core goals of the ESD programs:

> Every year, we almost have to retrain new teachers, helping them understand the core values of the seasonal curriculum and what exactly we're trying to achieve. But over time, I've realized that the new teachers come, and after a year, they leave. Then the principal or teachers like me, who have been here longer, have to take on the task of training the newcomers. Eventually, we've noticed that this situation is moving away from our original direction. We've become exhausted, because we're constantly guiding new teachers, and by the time they're ready to take over, they leave. (S01)

This ongoing turnover not only disrupts the cohesion of the teaching team but also challenges the sustainability of ESD practices, as new teachers must continuously be brought up to speed, often without the opportunity to deeply engage with the philosophy

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and goals of ESD. The constant need for reorientation limits the effectiveness and long-term impact of these initiatives.

Together, these examples highlight the critical role of stable, experienced faculty in ensuring the continuity of ESD practices. When key individuals leave, it can lead to a loss of momentum, overload the remaining staff, and undermine the overall effectiveness of the school's sustainability efforts.

In remote regions, the high turnover rate of personnel—whether principals, full-time teachers, substitute teachers, or project specialists—poses a significant challenge to sustaining long-term educational development. This phenomenon is exacerbated by the unique limitations faced by these areas, including poor transportation infrastructure, limited social opportunities, and harsh living conditions, all of which contribute to the reluctance of qualified teachers to remain in or move to these locations.

As S01 explained, the high proportion of substitute teachers in rural schools is a direct result of these ongoing challenges. Many teachers who have passed the certification process are reluctant to work in remote schools due to the difficult living conditions:

> I think the high proportion of substitute teachers is largely due to the challenges faced by rural schools. Across Taiwan, almost all rural schools are dealing with this issue of having too many substitute teachers. These substitute teachers are typically hired on a yearly basis, or even if they have a teaching certificate, their contracts are only renewed every three years. If they cannot pass the formal certification exam, they choose to work in places like ours. The problems in rural areas—such as inconvenient transportation, poor living conditions, and limited social opportunities—make it very hard to attract teachers. Even if they have a formal teaching qualification, many teachers prefer not to work in remote areas. This means they have to leave their families and live alone in these areas. Although the government has policies encouraging formal teachers to work in rural schools, such as requiring them to commit to a certain number of years, once their contract period is over, they usually leave. (S01)

S01 further highlighted that the burden of living and working in remote areas is not limited to the challenges of transportation and high costs. Even teachers with official certifications may prefer more convenient and better-paying positions in urban schools,

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which offer greater amenities and ease of commute. The following quote illustrates the dilemma faced by teachers who must choose between working in a rural school and staying in a more urbanized setting:

> As for why formal teachers are not stable, I think this is a very strange phenomenon—it may be a human nature issue. Because I already have a formal teaching certificate, why would I want to work at this school? Even though the salary is the same across Taiwan, I can earn 50,000 to 60,000 NTD in Taipei, so why come to a rural school, where the salary is the same, but I have to endure inconvenient transportation? In Taipei, I can start teaching at 8 a.m. and finish at 4 p.m. After class, I can go home at 4 o'clock. But here, not only do I have to teach, I also have to climb Hehuan Mountain, and the workload is much higher than in other places. So, it's understandable why formal teachers don't want to come, but I also wonder, if I'm getting the same salary, why would I choose to teach in such a remote place? The cost of commuting is very high. (S01)

These insights shed light on the unique struggles that rural schools face in recruiting and retaining qualified staff. Despite government policies intended to encourage teachers to work in remote regions, the logistical and personal challenges—combined with relatively comparable salaries—often make these positions less attractive. This, in turn, contributes to the high turnover rates and makes it difficult for these schools to build a stable and consistent teaching staff, further complicating efforts to implement long-term educational reforms and sustainability practices.

In remote areas, the reliance on substitute teachers in junior high and elementary schools is compounded by the region's economic and systemic disadvantages. One major issue is the low salary and limited benefits offered to substitute teachers, which further exacerbates the already difficult conditions in these areas. The broader education salary structure, coupled with local government budget constraints, exacerbates these challenges, making it particularly difficult for schools in remote regions to attract and retain qualified teachers.

As S01 explained, the financial struggles of substitute teachers are directly linked to the policies of local government, which often fail to provide adequate compensation for

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teachers' transportation costs. Moreover, certain regulations fail to reflect the true needs of rural schools, leading to inconsistencies in the support available to these educators. For instance, although the school S01 serves is located in a remote area, the county government does not provide the expected subsidies for transportation, simply because the school is within a 5-kilometer radius of a bus stop:

> Our county government does not provide transportation subsidies for remote areas. Why? Because the county regulations state that if a school is within 5 kilometers of a bus stop, it is not considered a remote area and therefore doesn't qualify for subsidies. Our school happens to be near a bus stop with two buses a day. As a result, we do not receive the subsidy. The government, in an effort to save money, has come up with such loopholes to avoid providing subsidies. This is a systemic and legal issue. (S01)

These examples illustrate how systemic issues—particularly policies that fail to address the specific needs of rural schools—create further barriers to supporting substitute teachers. While these schools face the challenge of low salaries and limited resources, they are also subject to local government policies that do not accurately reflect the realities of remote education.

S01 offered a candid reflection on the difficulty of working in such conditions, noting that many teachers in remote areas approach their work as a form of personal sacrifice, acknowledging the challenges as part of a larger sense of duty:

> Working in a rural school is quite difficult. Many people who come here to work may see it as a kind of spiritual training, or they feel like they are here to repay a debt from a past life, accumulating virtue through their work here. (S01)

This comment reflects the broader challenges faced by educators in rural schools, where financial compensation and support structures are inadequate, and the systemic barriers only serve to amplify the difficulties inherent in remote education. Such conditions not only discourage retention but also hinder the ability of these schools to build a stable, long-term educational foundation.

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The Continuity of School Leadership

In the context of Taiwan's educational system, the role of the school principal is pivotal, particularly when it comes to implementing and sustaining programs such as Education for Sustainable Development (ESD). Taiwan's educational governance remains largely centralized, which means that the authority and influence of school principals extend significantly over the overall educational planning and human resource management within the school. Regardless of whether a principal is actively engaged in the day-to-day leadership of ESD initiatives, their position of power within the school's organizational structure shapes the direction and effectiveness of these programs. As S15 explained, "The principal is always at the top of the team. Yeah, if they don't support you, it's really difficult to proceed, isn't it? Even if they don't participate, they are still the leader."

Although the principal's support is crucial for integrating internal and external resources to effectively implement ESD, the challenge of leadership continuity remains a significant issue. Under Taiwan's educational regulations, *Primary and Junior High School Act* (國民教育法) and the *Senior High School Education Act* **rotation** (高級中等教育法), principals are subject to rotation, and public schools are particularly impacted by this policy. Principals are typically appointed for a term of four years, with a maximum tenure of eight years at a single school. Once their term ends, they must either transfer to another school or relinquish their principal position if they wish to remain at the current school. This system, rooted in Taiwan's educational structure, creates challenges for the long-term consistency of leadership, which is vital for the sustainability of initiatives like ESD.

The rotation of school principals can serve as a catalyst for revitalizing and

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diversifying leadership approaches, injecting fresh ideas and perspectives into the school environment. For schools that initially lacked an ESD (Education for Sustainable Development) focus, the arrival of a new principal can trigger the introduction of related actions and initiatives. Conversely, schools already engaged in ESD may benefit from the new principal's distinct network of resources, sparking innovation and further development.

For instance, in schools facing the crisis of consolidation or closure, the arrival of a new principal can lead to the integration of sustainability principles into teaching and educational philosophy, resulting in the emergence of a new school identity (e.g., School RE2, NE1).

Similarly, at schools where significant progress had been made under the previous leadership, such as the development of ESD action teams and the integration of ESD into the official curriculum, the new principal often continues to build upon these foundations. In cases where the new principal’s strengths lie in the domain of information technology, for example, they may enhance the school’s capacity and resources in other areas. As Director S15 noted, cooperation between principals can be a powerful force for positive change, helping to improve the school overall.

Nevertheless, the sustainability of ESD initiatives also shows their highly vulnerable aspect during leadership transitions, as changes in principals can disrupt the continuity of programs and even lead to the abandonment of previously established efforts.

The impact of leadership transitions on the sustainability of ESD initiatives is evident in cases where new principals lack support for ongoing programs. For instance, PR05 revealed that the new principal at a school failed to recognize the value of the Eco-Campus Partnership Program, viewing it as an additional burden on staff. As a result, the lead teacher lost support and was reassigned, leading to the discontinuation of the

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program. Similarly, due to the departure of the original principal, one green-flag accredited school failed to renew its certification of the Eco-Campus Partnership Program (PR04).

Principal transitions can significantly disrupt the continuity of ESD practices, particularly when new leaders fail to prioritize or recognize the value of previous efforts. For instance, Principal S10 shared a personal experience where, after the departure of an ESD leader, even with available resources, the school ceased promoting Environmental Education and sustainable development. S10 regretted that the initiatives that had been put in place were eventually viewed as unnecessary and abandoned, illustrating how leadership changes can lead to the erosion of established ESD efforts. Similarly, Director S15 emphasized that it is not uncommon for new principals to completely discard the previous leadership's work, making smooth transitions of ESD initiatives a rare "blessing." This highlights the challenge of ensuring that ESD actions are sustained despite shifting management priorities and changing resource networks.

The study also reveals that the response of educators to leadership changes tends to be passive. As Principal S03 explains, the school is viewed as an "organism," where leadership changes are inevitable, and the principal has little control over the new direction of the school. According to her, after assuming the role, the primary focus is to fulfill the assigned duties, with the belief that the school will naturally evolve and develop the model it requires.

The continuity of ESD practices following a principal's departure often depends on external factors and is not guaranteed. Several key factors contribute to the difficulties in sustaining ESD initiatives after leadership transitions: differences in the expertise of the incoming principal, the absence of a formal transition mechanism, and the performance evaluation system for principals. These factors often result in the discontinuation of

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previous initiatives, highlighting the challenges in maintaining long-term educational reforms within the context of frequent leadership changes.

One of the key findings of this study is that the difference in expertise among school principals often hinders the effective transition of ESD practices. Some principals (S03, S10) openly acknowledge the challenges of such transitions.

However, this research argued that a principal's background in environmental or ESD is not a prerequisite for the successful implementation of ESD initiatives. Principal S08, for example, acknowledged that she initially lacked knowledge in this area but gradually understood the principles of the Eco-Campus Partnership Program through hands-on involvement. Similarly, although the newly appointed Principal Mi, who specializes in information technology rather than Environmental Education, did not have relevant expertise, she still provided strong support for the continuation of ESD initiatives. Principal Mi actively assisted in securing resources and ensuring the integration of ESD courses into the school curriculum.

In fact, the wide scope of ESD allows for diverse expertise among school leaders to enrich the development of the school, and the continuity of ESD practices does not require high-level specialization. This suggests that while a principal’s expertise may influence the direction of ESD, it does not necessarily limit the capacity for effective implementation or the sustainability of such initiatives.

Secondly, the lack of a formal handover mechanism between principals contributes to challenges in the continuity of ESD initiatives. The study revealed a customary practice where outgoing principals refrain from meeting with or intervening in the leadership style of their successors. This is seen as a form of respect for the new principal’s autonomy in guiding the school. Principals S03, S08, and S12, for instance, all emphasized that they would not "disturb" the incoming principal or interfere with their approach to leadership.

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However, without a structured transition process, it becomes unclear how new principals can fully understand and build upon the strengths and initiatives established by their predecessors. In such cases, a leadership change may not represent a seamless continuation of the school's educational vision, but rather a disruption or reorientation of its focus. This lack of continuity can significantly hinder the sustainability of prior efforts, particularly when a new leader lacks an understanding of the school's prior initiatives and achievements. Instead of building on the existing foundation, a new principal may choose to initiate reforms in areas they are more familiar with, potentially leading to wasted efforts and human resources as previous work is either abandoned or radically altered. This tradition of non-interference in principal transitions thus increases the uncertainty regarding the continuation of educational policies and initiatives. Without effective communication and a clear handover of responsibilities and achievements, it becomes more difficult for schools to maintain a consistent educational vision, leading to inefficiencies and challenges for teachers who have invested time and effort into the existing framework.

Furthermore, the performance evaluation system for principals may also contribute to the difficulties in ensuring continuity of ESD practices. Director S15 noted that new principals often feel pressured to demonstrate visible, tangible results in a short time. As a result, they tend to prioritize actions that are easily measurable, such as physical infrastructure improvements, rather than initiatives like ESD, which require long-term commitment and gradual implementation. This focus on short-term gains can hinder the sustainability of ESD efforts, as they do not align with the immediate performance expectations placed on new leaders.

However, Principal S12's experience demonstrates that it is possible for new leaders to still prioritize long-term initiatives, even when faced with these pressures. Principal

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S12 chose to invest in projects that would take time to yield results, recognizing the value of sustained action. This highlights a crucial factor in determining whether ESD efforts continue after leadership transitions: the personal commitment and awareness of the principal. As Principal S05 emphasized, the key to successful ESD implementation is not just the availability of resources or support, but the principal's genuine awareness and commitment to the cause. Without this awareness, ESD initiatives are more likely to be sidelined in favor of more immediately rewarding actions.

In summary, this study suggests that the key challenge lies in the lack of resonance among principals regarding the importance of ESD. Often, ESD is viewed merely as an "additional" task or a "unique" feature of the school, rather than an integral part of the educational philosophy. This perception explains why cases like the ones described by PR1 and PR5 occur, where new leadership leads to the abandonment of previous ESD initiatives.

Therefore, the transfer of intellectual resources is crucial in shaping the understanding of ESD and motivating both internal and external stakeholders to actively engage in this educational approach. As discussed in the previous chapter regarding educators' pathways to understanding ESD, if each educator has sufficient exposure to ESD and forms their own interpretation, it is likely that they will develop a sense of ownership and recognition of its value. This, in turn, could increase the likelihood that new principals will support the continuity of ESD initiatives and integrate them into the school's long-term goals.

(4) The Push of Ideological Disagreements

A critical challenge to sustaining the long-term success of Education for Sustainable

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Development (ESD) is the ideological alignment and cohesion among staff members. As schools evolve and face external and internal pressures, the alignment of values and vision among the faculty becomes essential to maintaining momentum and ensuring the continuity of educational programs. However, when internal ideological differences arise, they can create significant barriers, not only affecting the work environment but also undermining the broader goals of the institution. S09, a principal, shared:

> I cannot control the comings and goings of people, nor can I manage their changing personal inclinations." This statement reflects the significant challenges S09 faced in managing the school, particularly during a period of declining student enrollment. Between 2011 and 2017, the student population peaked at 170, but by 2018, enrollment began to steadily decrease. (S09)

S09 attributed this decline to growing ideological divisions among the faculty, which significantly affected their commitment to their work. Some teachers began to lose their enthusiasm, becoming less willing to invest in the school's mission. Additionally, teachers transferred from other schools often brought with them different perspectives and practices, which disrupted the cohesion within the school community. This lack of unity among staff led to a decline in morale and energy, negatively affecting the overall functioning of the school.

The internal ideological conflict also had far-reaching consequences on the operations of the school's foundation. These compounded internal and external tensions led to a rapid deterioration in the school's stability, culminating in a dramatic drop in student enrollment, which eventually fell below 100. This marked the beginning of a downward spiral for the school, as it struggled to maintain its footing both administratively and educationally.

This case exemplifies how ideological rifts within the staff can create significant barriers to organizational stability and educational continuity. The challenge of aligning diverse perspectives and fostering a shared vision is crucial for sustaining educational

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initiatives, particularly those aimed at long-term goals such as Education for Sustainable Development (ESD).

5.2.2 Resource Transfers and Reorganizations

In the context of public sector projects with limited resources and the inevitable changes in policies, it is understood that these initiatives will eventually come to an end (S07 Principal). As S07 explains, while these changes may be beyond the school's control, the key challenge lies in how the school responds to such shifts. The ability of schools to retain their agency, reorganize networks, and seek out new resources for implementing Education for Sustainable Development (ESD) is essential for navigating various uncertainties.

One factor contributing to the sustainability of resources from previous projects is the continued communication between the school and the stakeholders involved in these initiatives. For example, during a visit to a school that had previously participated in a community-based project (School RE1), the researcher observed that although the event was not directly related to the community initiative, four advisory members who had been involved in the project were present to support the activity. According to the staff, this was due to the proactive invitation of the school's principal, S07.

Both S07 and the advisory committee members from the community project have maintained their communication, which has allowed the school to retain access to the knowledge and human resources associated with the project even after its official termination. This continuity of resource networks, facilitated by the school's leadership, provides the school with flexibility in acquiring new resources and maintaining the momentum of its ESD efforts despite the discontinuation of the original program.

doi:10.6342/NTU202501048

(1) Adaptations and Responses to the End of Funding

While the cessation of a program undoubtedly results in a reduction of available financial resources for schools, their responses vary.

At the instructional level, some schools have opted to internalize the roles of external lecturers. For instance, S17 Teacher explained how the school adjusted by having teachers take on the responsibility of delivering courses themselves when it could no longer afford to hire community youth or elders as instructors. In contrast, other schools have sought alternative funding sources to fill the financial gap. For example, a public school in a remote area participates in numerous public sector projects each year, some of which align with the school's ESD initiatives, such as food and agriculture. These projects provide an opportunity to allocate external funds to support the school's ESD actions. Similarly, NE1 found other programs to help fill the financial void after the original project ended. However, the school's most significant financial gap was addressed through a foundation established by the school principal in collaboration with local entrepreneurs to support experimental education. By seeking new programs or shifting the focus of existing resources, these schools have managed to maintain financial stability.

The continued search for external lecturers rather than discontinuing them can be attributed to the belief held by some teachers, such as S14, that hiring external instructors is a form of "giving back" to the community, contributing to mutual development between the school and the local area. This perspective aligns with School RS1's interpretation of community development through ESD. Additionally, S16 emphasized that maintaining the external lecturer model is crucial for reducing the teaching burden on internal staff, especially when the ESD curriculum involves specialized knowledge, such as bird identification. For these schools, the stability of external resources is seen as essential for

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sustaining the ESD curriculum and ensuring its effective delivery.

(2) The Importance of Transferring Principal and Staff Networks

The professional networks of principals and other school staff must also be effectively transferred to ensure continuity in school initiatives. As Director S15 noted, even after the previous principal left, the experts and scholars introduced by that principal continued to serve as valuable advisory resources for the school. This highlights the importance of institutionalizing the personal ties of headteachers within the broader school network. According to Hite et al. (2010), headteacher networks are fundamentally based on personal relationships, which can be crucial for securing resources and support. When headteachers move to other schools, these personal connections can help maintain continuity, provided that the relationships are institutionalized at the school level. Without this institutionalization, schools are vulnerable when leadership changes occur. Therefore, ensuring the transfer and maintenance of these networks is crucial for sustaining educational programs, particularly in resource-constrained environments

5.2.3 Consolidating the Sustainability of Resource Flow

In the face of disruptions to external resources, schools can focus on consolidating their internal human resources. While the inability to hire external personnel presents a challenge, the real issue lies in how to mobilize existing staff effectively to contribute to the continued implementation of Education for Sustainable Development (ESD). This approach aligns with the finding from (Mogren et al., 2018) that schools implementing ESD should prioritize strengthening their internal faculty before seeking external partnerships, as this sequence has been shown to facilitate stronger collaborative

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relationships with the community.

This can be achieved through two key approaches: aligning educational values and institutionalizing practices. First, it is essential to cultivate a shared understanding and commitment to ESD among faculty, ensuring that they recognize its value and relevance. Second, schools must institutionalize ESD by embedding it into activities, curricula, and broader educational policies. These measures help ensure that ESD becomes a sustained, integral part of the school's educational framework, even in the absence of external resources.

(1) Commitment and Practice in ESD Implementation

The extent to which educators identify with the principles of Education for Sustainable Development (ESD) plays a crucial role in the success of its implementation. When teachers are genuinely committed to the values of ESD, their level of engagement and dedication to its practice is significantly enhanced. This is particularly evident in remote areas, where issues such as high turnover rates among formal teachers and low wages for substitute teachers often limit educational resources.

However, this research highlighted a strong commitment to the school's educational mission among educators in these areas, including both substitute teachers and permanent staff. For example, S01, a substitute teacher at a remote school, has more years of service than many permanent teachers. Despite being a substitute, S01 is one of the few core implementers of ESD at the school, and it is his personal identification with the school's educational philosophy that motivates him to continue his work: "In the process of teaching, I developed a kind of revolutionary emotional connection with the students, a sense of empathy. I believe this is the kind of education I want to impart to the children—

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an education that comes from the world, not just from textbooks."

In addition, educators involved in ESD find value in their community interactions, which offer new challenges and opportunities. As S01 explains, "Now, I am also responsible for community engagement. My role involves connecting the community to the school, creating a learning environment that links the community with our educational objectives."

It is interesting to find that S01criticized lots of challenges for the school faculty at the school in remote area, but S01's words contradictory reflect his deep sense of fulfillment and attraction to the work. This case underscores the transformative potential of ESD when educators are truly engaged and committed.

The establishment of strong social networks is crucial for sustaining Education for Sustainable Development (ESD). One important factor that consolidates these networks is the connection between educators and their local communities. Place identity, familial ties, and personal investments in the school environment foster a sense of belonging and commitment, strengthening the foundation for long-term ESD efforts.

Educators often demonstrate a deep commitment to their hometowns, as seen in their decisions to return and contribute to local education despite opportunities elsewhere. Director S06 exemplifies the deep connections educators often have with their hometowns. Despite having worked in schools elsewhere, S06 chose to return to School RE1, citing a strong emotional attachment to the education of their local community. This trend is not uncommon in School RE1, where many teachers are Indigenous and regard the school as part of their own community. These connections contribute to the low turnover rate among staff, even in this remote area.

Strong familial ties and historical connections to schools create a profound sense of belonging and responsibility among educators, as shown in Teacher S14’s case. She

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highlights how familial legacies create strong ties to the school. Her grandparents lived near the school, her grandfather once taught there, and her family donated part of the land for the campus. For S14, the school is more than a workplace; it is a cherished community. She reflects, "Someone once wrote, 'If the bell no longer rings in the community, the community will decline.' This deeply influenced me. I believe that when the school thrives, the community will gradually improve as well."

When educators' personal lives intersect with their professional roles, it enhances their investment in the school's success and creates opportunities for unique feedback and growth. Principal S05's decision to enroll their own children at the school demonstrates how personal investments strengthen professional commitment. By observing their children's experiences, S05 could directly evaluate the impact of the school's education and refine programs to better serve students. This dual role as both an educator and a parent offered unique insights into the school's progress. S05 noted:

> When I started here in 2007, I transferred my son to the school. My daughter was starting first grade, so they both attended this school. I have always regarded this school as a second home. As educators, we must run a school in a way that we would feel confident sending our own children here. That mindset makes a difference. (Principal S05)

Although not originally from the area, some educators, such as Administrator S17 and Teacher S01, have developed high levels of engagement with the local community. Initially, their involvement was mandated by the ESD-related program that their schools participated in, which required these practitioners to lead local engagement initiatives. However, even after the program's termination nearly two years ago, these educators—who were primarily hired to implement the program—chose to remain in the area.

This research infers that their dedication to the schools' local action during the program's implementation facilitated the development of their personal social networks within the community. These networks, often grounded in emotional support and mutual

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trust, created bonds that deepened their sense of belonging to the place where the school is located. For instance, Administrator S17 established her new family in the local community and launched a small educational business in partnership with her spouse. This enterprise not only serves the local area but also collaborates directly with her serviced school, further strengthening her ties to the community. Similarly, Teacher S01 found a profound sense of achievement and emotional attachment through his work with the children and broader community, reinforcing his commitment to the region. From their cases, the local engagement is suggested to formulate personal bonds that integrate educators into the fabric of the local community.

The experiences of S01, S06, S14, S05, and S17 demonstrate that strong personal and emotional ties to a school or community can significantly strengthen the social networks necessary for sustaining ESD. These connections, whether rooted in hometown pride, family legacy, or a shared sense of belonging, provide a resilient foundation for long-term engagement. Future ESD strategies can benefit from fostering such ties through intentional community-building efforts and inclusive practices.

(2) The Role of Recognition and Motivation

In remote schools, where high teacher turnover and low community involvement can often lead to a lack of motivation for continuous professional development. There is thus a risk of stagnation, as teachers may lack the motivation to improve their teaching methods—especially if parents are indifferent to the quality of instruction.

Creating platforms for recognition plays a pivotal role in fostering teacher engagement and ESD practice. S08, the principal of School RS2, exemplifies how

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creating opportunities for teachers to be recognized can enhance their commitment to ESD. Specifically, S08 implemented a school-based curriculum reporting system that allows teachers to exchange ideas and best practices, fostering professional dialogue. Additionally, S08 encouraged teachers to participate in external competitions and seek external recognition, further motivating them to engage with sustainable education practices.

Also, an effective award system plays a crucial role in motivating educators and fostering a sense of accomplishment, especially in challenging roles. S08, who commutes daily from an urban area to a remote school, often experiences the fatigue of long travel, which at times leads her to question her decision to remain in her role. However, the success of the Eco-Campus Partnership Program, which culminated in the school earning Green Flag certification and ESD awards, provided a significant sense of achievement and helped establish a unique identity for the school. This recognition not only motivated the principal but also reinforced his sense of responsibility, highlighting the value of awards in sustaining morale and commitment.

This case highlights the importance of creating systems of recognition within schools to motivate teachers, especially in challenging remote settings.

(3) Institutionalizing ESD: From Activities to Curriculum and Education

The importance of institutionalizing Education for Sustainable Development (ESD) has been highlighted in the final report of the UN Decade of Education for Sustainable Development (2005-2014) (Buckler & Creech, 2014). While the report primarily focuses on national-level institutionalization, such as the "investment of staff and financial resources," this concept is equally relevant at the school level, particularly in contexts like

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Taiwan, where the system for ensuring the personnel and prioritization of ESD is still developing. This research found that schools, in the absence of a fully constructed national system, have created their own networks and systems to anchor their ESD initiatives.

A significant challenge in the institutionalization of ESD is ensuring that it becomes an integral part of the school's curriculum, especially in light of staff turnover. As Principal S04 explains, many schools, even those participating in the Eco-Campus Partnership Program, still limit their efforts to occasional activities rather than embedding ESD into their regular curriculum and teaching practices.

> Even with the Eco-Campus Partnership Program, many schools remain at the action level. These actions might include a few events over the course of a year, but they do not advance to the level of curriculum and instruction. Activities are isolated events, whereas curriculum and instruction are embedded in the school's schedule. If it's in the curriculum, it must be taught. There must be teachers, teaching materials, and designated class time. (Principal S04)

Thus, simply following the Eco-Campus Partnership Program does not automatically ensure that a school will internalize its principles into the broader educational framework. To transform ESD from a set of isolated activities into a sustainable, school-wide practice, schools need to institutionalize these efforts by incorporating them into the curriculum, which is also supported by Principal S09, Principal S08, and Director S16. This requires not only defining clear educational goals and frameworks but also ensuring that ESD is integrated into the school's regular teaching schedule, with committed staff and appropriate resources in place. Without this institutionalization, ESD will remain a transient activity, subject to the fluctuations of staffing and external funding, rather than becoming a lasting part of the school's educational identity.

Noted that the 108 Curriculum Guidelines advocate for "school-based curricula,"

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this educational reform offers schools the opportunity to integrate ESD into their regular curriculum. School-based curricula emphasize interdisciplinary learning and address local issues, making them a core feature of a school's distinctive offerings. According to the findings of this study, all the schools interviewed have incorporated ESD into their school-based curricula, as outlined in the 108 Curriculum Guidelines. This suggests that such integration serves as the foundational strategy for schools that have successfully implemented ESD.

While school-based curricula have the potential to serve as a foundational mechanism for institutionalizing ESD, challenges still exist in ensuring that ESD is integrated into the regular curriculum. Even if a school establishes a school-based curriculum, the allocation of sufficient class time for ESD remains uncertain. Principal S10 pointed out that the 108 Curriculum Guidelines reform, which altered the teaching hours for various subjects, resulted in a reduction of available time for ESD courses. This adjustment underscores the importance of not only finding suitable subjects for ESD but also securing dedicated time through effective negotiation.

Successfully embedding ESD into the curriculum requires careful selection of subjects where sustainable development can be naturally integrated. However, beyond identifying appropriate subjects, it is the negotiation with the Curriculum Development Committee that plays a pivotal role in ensuring that ESD is included in the school's regular timetable. Principal S10 emphasized that this process often involves navigating the "politics" of the school environment, where teachers from different disciplines advocate for the importance of their subjects, and cooperation is needed to allocate time for ESD lessons.

Principal S10 described their strategic approach of working through the Curriculum Development Committee to identify subjects willing to integrate sustainability content.

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The negotiation process often centered around addressing teachers' concerns about limited class hours, particularly in subjects like science where teaching periods had been reduced. By offering additional class periods in exchange for incorporating sustainability topics, the school successfully integrated ESD into the existing curriculum structure.

These incremental changes led to securing dedicated sustainability periods for grades seven through nine. As Principal S10 reflected, "It may not sound like much, but it's a significant achievement. Many schools don't have the chance to offer such courses." This exemplifies how school-based curricula can evolve gradually through small but strategic additions to create a distinctive educational approach.

This example highlights that integrating ESD into the curriculum is not only about identifying suitable subjects but also requires skillful negotiation with the Curriculum Development Committee. Research by (劉怡華 & 蘇玲慧, 2024) underscores the Committee's strategic importance, revealing that its network reaches over 90% of school members. This extensive reach aligns with Principal S10's experiences, which demonstrate the Committee's crucial role in promoting and spreading ESD throughout the school. Overall, the ability to advocate for ESD within the school's existing curricular structure is a key factor in overcoming the logistical and political challenges that may hinder its inclusion.

While school-based curricula are inherently flexible and subject to change, the integration of ESD into the curriculum is not a one-time achievement; it requires ongoing commitment to both execution and refinement. As S16 Director noted, the school's previous principal had established a school-based curriculum that included ESD initiatives. However, upon the departure of the principal, the newly appointed director made significant modifications, replacing part of the original curriculum with a reading unit. Director S16 expressed concerns, stating, "At that time, I was genuinely worried that

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our school-based curriculum would be altered." The curriculum was revised back again by Director S16 when she returned to the position in the Educational Affairs Division.

This example underscores a critical point: the sustainability of ESD implementation is heavily dependent on the continuity and capacity of the human resources responsible for carrying it out. Even if ESD is initially integrated into the school-based curriculum, the long-term success and evolution of this integration are contingent upon the ability to maintain and further develop the curriculum with capable and committed personnel. In this sense, it is not only the curriculum content that must be secured but also the personnel who can sustain and improve it over time.

While the school-based curriculum may offer a valuable starting point for ESD implementation, it is typically delivered through one or a few individual lessons (S10). Such an approach essentially treats ESD as a standalone subject, isolated from the broader educational framework. If ESD is pursued in this manner, relying solely on a few hours of instruction each week, this study argues that it differs significantly from the transformative educational shift envisioned by the United Nations. The limited scope and fragmented nature of such curriculum integration may lack the momentum needed to drive systemic educational change, as it fails to embed ESD comprehensively across all levels and subjects within the school.

School Culture: Creating a Space for Awareness and Discussion

This study reveals that shaping school culture must go hand in hand with the development of internal systems and structures. A well-established culture not only garners the support of the school community but also shapes the institution’s norms, facilitating the continuity of the school’s ESD initiatives.

For instance, Teacher S01 provides an insightful interpretation of "culture,"

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emphasizing that it can be cultivated through sustained action and teaching practices. This process requires empathy from all participants involved:

> This kind of culture is essential for fostering genuine sustainability. Otherwise, even in practical lessons, I've realized that when core figures, like the principal or those of us who have been long engaged in community care, leave, the initiative falters. Once I'm gone, who will care for the elderly living alone? Other teachers won't know. Our hope is that, with the principal, we can guide teachers to incorporate seasonal curricula—embedding empathy into lesson plans to encourage both students' and teachers' emotional engagement. This process helps form the school culture and drives the development of meaningful concepts. (S01)

Teacher S01 further argues that through the cultivation of this "culture," ESD can achieve true sustainability, where the departure of key figures does not disrupt the organization's mission. By embedding sustainability in the culture of the school, future educators—regardless of leadership changes—can continue the work of community sustainability and ESD, finding guidance within the school's established ethos.

Director S13's experience illustrates the profound impact of school culture on the implementation of ESD. Even though S13 initially entered the school with no prior knowledge of ESD, the pervasive school culture quickly shaped their approach to ESD. As S13 reflects:

> When you are constantly surrounded by these things every day, how can you not become familiar with them? Yes, aside from teaching Mandarin and mathematics, there are many other programs. The school has collaborated with local businesses on numerous projects, and there are a wide variety of initiatives I participate in. So, once a teacher starts working here, all the messages they receive are related to these things. Whether it's the tasks they are assigned or the activities organized by the school, as long as it's not during Mandarin or mathematics class time, everything else is connected to these efforts. How can one not be influenced? It's impossible because this is a very well-established atmosphere. Once you step into this school, you immediately understand—it's a very supportive environment. (S13)

S13's example underscores the power of school culture in shaping the perception and practice of ESD. From the school environment and the information absorbed daily, to the curriculum and teaching tasks, everything is intricately linked to ESD. This case demonstrates how school culture influences the integration of sustainability practices into

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the fabric of the school's daily operations.

The construction of a school culture that effectively integrates ESD requires careful consideration of its alignment with the school's overall educational goals. Principal S11 emphasizes that the promotion of the SDGs should not be viewed as a standalone "project" or "additional task," but rather as an integral part of the school's existing educational framework. This perspective underscores the importance of aligning ESD with other core school priorities, such as international education, bilingual education, and gender equality education. From this viewpoint, the SDGs should not be treated as a separate, isolated initiative but should be embedded within the broader educational development of the school (S11).

This perspective not only addresses the issue of fragmented curriculum design that teachers may face but also emphasizes the universal relevance of ESD to various educational themes within the school. By integrating SDGs into the core of the school's operations, it helps establish sustainability as a fundamental and ongoing aspect of the school's educational ethos. In other words, the key to promoting ESD lies in integrating it into the school's existing initiatives and operations, thereby creating synergies.

> ESD is connected to everything we promote. So, from the beginning, I told everyone to incorporate the concept of sustainability into what you're already doing. Don't treat the SDGs as just another project. You will never do it well because it cannot connect to what you're already doing. (S11)

This strategy by Principal S11 reflects a crucial perspective in educational reform: effective ESD must align with the school culture and existing educational framework in order to have a lasting impact. By embedding sustainability within the school's established practices, it becomes a seamless and integral part of the educational experience, ensuring its continuity and relevance across time.

On the other hand, the integration of ESD into classroom practice can be achieved

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through subtle, context-driven approaches and a strong culture of collaboration among educators. Understanding the complexity of the SDGs, S01 does not believe it is necessary to directly teach students about the SDGs in the context of a project that embodies the principles of ESD. Instead, he guides students to first observe the problems around the school and begin implementing a project. If the project aligns with any of the SDGs, they are introduced at the appropriate point. To put it simply, technical jargon is avoided in the classroom, allowing students to engage with the concept of ESD through practical action rather than abstract theory.

This is why the respondents, including Principal S12, Teacher S14, Director S15, and Teacher S16, all emphasized that the concept of "taking it slow" is crucial. The notion of "slowness" they referred to does not pertain to the actual pace of implementation but rather highlights the importance of acknowledging and respecting the feelings of the faculty and staff. It underscores the need for gradual acceptance rather than forced compliance, which ultimately contributes to the long-term success of implementation.

This research also found that the culture of discussion within certain schools (S01, S14, S17) plays a significant role in promoting ESD. As noted in the case of S17, the collaborative culture of teacher discussions and lesson planning at School RE1 fosters a space for continuous reflection on the implications of integrating the SDGs into education. This collegial approach allows educators to explore and refine the meaning of ESD as it is applied in practice, contributing to its effective implementation.

To conclude, it is shown that a well-established school culture serves as both the foundation and the catalyst for lasting ESD implementation, ensuring its continuity and effectiveness across generations of educators and students.

doi:10.6342/NTU202501048

Chapter 6 Conclusion

This research has examined the social networks supporting Education for Sustainable Development (ESD) implementation in Taiwan's basic education system, capturing a crucial period of transition from environmental education to a more comprehensive ESD framework. Through interviews with 29 participants, including 17 educators across 11 schools, this study addressed two fundamental questions: First, what types of actors and relationships form the social networks that support ESD implementation in Taiwan's basic education? Second, what kinds of resources flow through these networks, and how do they influence ESD practices in schools?

6.1 Composition of ESD Implementation Networks in Taiwan

The social network analysis reveals a diverse multi-stakeholder composition supporting ESD implementation. These networks demonstrate high heterogeneity (Figure 4.3), incorporating actors across government education agencies, academia, school leadership, civil society organizations, community stakeholders, and business partners (Table 4). The findings indicate that effective ESD implementation extends far beyond the boundaries of primary and secondary schools, requiring coordinated engagement from a diverse ecosystem of actors with complementary capabilities.

The context of ESD building upon Environmental Education (EE), Sustainable Development (SD), and the educational change challenges in Taiwan is clearly reflected in these schools' ESD networks. While EE-background actors comprise a smaller proportion of the overall network, they maintain significant influence through strategic

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positioning with high betweenness centrality in certain resource categories. Notably, actors with uncertain EE backgrounds constitute the numerical majority. These actors engage within the context of sustainability trends and contemporary challenges, providing most of the essential resources required for schools' ESD practices.

6.2 Resource Flows and Their Influence on School ESD Practices

With these actors composing the schools' ESD networks, schools are able to acquire intellectual, human, financial, and physical resources—all of which were confirmed by interview results as essential for ESD implementation. These resources demonstrate cyclical relationships (Figure 5.5), where fluctuations in one resource category could affect others, collectively maintaining sustainable ESD practice. Each resource category features a distinct composition of stakeholders making different contributions (Table 4.1).

Financial resource-providing actors are discovered to be the fewest in number, while intellectual resource providers are the most abundant. The pattern of resource exchange reflects Taiwan's specific context. Currently, Taiwan's ESD funding relies heavily on a program-based mechanism, which creates potential vulnerabilities in the ESD networks—particularly the dependence on temporary program-based financial resources. Educators' backgrounds in Environmental Education were found to mediate their ability to mobilize these resources effectively. However, the insufficiency of formal EE training points to a structural gap in Taiwan's education system. Moreover, the lack of a clear, shared conceptualization of ESD complicates implementation, prompting schools to seek support through diverse but often fragmented external networks.

doi:10.6342/NTU202501048

6.3 Strategic Implications and Recommendations

Based on the analysis of ESD networks in Taiwan, several strategic implications emerge for enhancing the sustainability and effectiveness of ESD implementation. First, schools should intentionally establish connections with actors beyond traditional environmental education circles to access a comprehensive range of resources. As ESD has substantial differences from EE, it offers a broader framing that can engage partners not limited to pro-environmental actors (葉欣誠, 2017). This suggests the need for new collaborative frameworks rather than simply adapting existing EE systems. The most effective support for ESD emerges from the complementary contributions of stakeholders with different backgrounds and expertise domains. Second, in the absence of robust institutional systems, social networks are critical in mobilizing resources and sustaining ESD practices. While Taiwan's environmental education legacy provides a foundation of experts, professional training, and promotional organizations, these collaborations aren't guaranteed for schools providing compulsory education. Instead, they depend on schools actively seeking resources or external entities approaching schools—typically those already performing well. This creates inequity in ESD implementation across different schools.

This research also suggests strengthening the resource-linking capabilities of boundary-spanning actors within schools, particularly principals who serve as network brokers. Schools should develop voluntary governance mechanisms to integrate ESD into routine operations rather than relying on temporary programs. National programs should increase connectivity to reduce redundancy and ensure comprehensive support. Additionally, sustainable mechanisms for schools to connect with external partners would reduce administrative burden and ensure continuity of ESD implementation. Most

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critically, Taiwan needs a consistent, contextually relevant ESD framework—either by localizing international models or refining existing national policies—to guide school-level implementation and capacity building. This framework should acknowledge the distinction between EE and ESD while building upon Taiwan's environmental education legacy, ultimately providing clearer direction for the diverse stakeholders identified in our network analysis.

This research has several limitations reflecting practical constraints and its exploratory nature. First, the purposive sampling may not have captured all ESD-implementing schools, particularly those with less visibility or outside established Environmental Education networks. Consequently, findings may not represent the full spectrum of schools engaged in ESD. Additionally, while this research identified schools actively implementing ESD, implementation quality was not directly assessed. This decision reflects the study's primary goal of mapping the ESD social network and providing foundational insights into network structure. Future research could examine relationships between network patterns and ESD quality. Finally, the use of ego-centric network data was necessary given the absence of comprehensive research on social networks in Taiwan's ESD context. The whole-network data collection was impractical, as defining a complete set of ESD-implementing schools remains challenging. While ego-centric networks have limitations in capturing structural dynamics, they offer scalability and depth by focusing on individual actors and their immediate networks (Tabassum et al., 2018). This approach provides valuable school-level insights and groundwork for future studies exploring broader network structures.

Despite its limitations, this research showcased how social network approach contributes to the ESD study. This research contributed to a clearer understanding of Taiwan's current adoption of ESD in basic education. It highlights the social network

doi:10.6342/NTU202501048

status and factors influencing ESD dissemination. The application of social network analysis has revealed crucial insights into Taiwan's ESD implementation. Beyond its focus on Taiwan, this study's significance extends to other educational systems that are similarly transitioning from Environmental Education (EE) to ESD.

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APPENDICES

Appendix 1 Interviewee List of Preliminary Interivews

Category	Interviewee ID	Organization Description	Role Description	Gender
Public sector	PU1	Ministry of Environment	Environmental Protection Officer	Female
Public sector	PU2	Ministry of Education	Project Manager	Female
Public sector	PU3	Ministry of Education	Project Manager	Male
Private sector	PR1	Environmental NGO	Project Manager (Contractor for central government)	Female
Private sector	PR2	Environmental Company	Project Manager (Contractor for central government)	Female
Private sector	PR3	Environmental Consultancy	Senior Manager (Contractor for central government)	Male
Private sector	PR4	Environmental Company	Project Manager (Contractor for local government)	Female
Private sector	PR5	Corporate-funded educational foundation	Program Officer	Female
Expert	E01	University	Academic Expert	Female
Expert	E02	University	Academic Expert	Male
Expert	E03	University	Academic Expert	Male
Expert	E04	University	Academic Expert	Male

Appendix 2 Interviewee List of Primary and Secondary Schools

Interviewee ID	Serviced School ID	Location Type	Education Model	School Level	Role Description	Gender
S01	RE1	Remote	Experimental	Primary and Secondary School	Substitute Teacher	Male
S02	RE1	Remote	Experimental	Primary and Secondary School	Former School Director	Male
S03	NS1	Non-remote	Standardized	Primary School	Principal	Female
S04	RE2	Remote	Experimental	Primary School	Principal	Male
S05	NE1	Non-remote	Experimental	Primary and Secondary School	Principal	Male
S06	RE3	Remote	Experimental	Primary School	Principal	Male
S07	RS1	Special Remote	Standardized	Primary School	Principal	Male
S08	RS2	Remote	Standardized	Primary School	Principal	Female
S09	RE1	Remote	Experimental	Primary and Secondary School	Principal	Male
S10	NS2	Non-remote	Standardized	Secondary School	Principal	Male
S11	NS3	Non-remote	Standardized	Primary School	Principal	Male
S12	NS4	Non-remote	Standardized	Primary School	Principal	Female
S13	RE2	Remote	Experimental	Primary School	School Director	Female
S14	RS1	Special Remote	Standardized	Primary School	Substitute Teacher	Female
S15	NS5	Non-remote	Standardized	Primary School	School Director	Female
S16	NE1	Non-remote	Experimental	Primary and Secondary School	Substitute Teacher	Female
S17	RE3	Remote	Experimental	Primary School	Administrative Officer	Female

doi:10.6342/NTU202501048

Appendix 3 Developmental Stages of ESD in Taiwan

	Year	Taiwan ESD Events and Key Developments	Non-Educational Events in Taiwan/Globe	Global ESD Events
Initial Stage: Environmental Education Predating ESD	1972			1972: United Nations Conference on the Human Environment in Stockholm; Establishment of UNEP.
	1977			1977: The Tbilisi Declaration, marking the beginning of Environmental Education.
	1987	1987: Taiwan Environmental Protection Administration (EPA) established.		1987: Publication of the Brundtland Report ("Our Common Future"), introducing the definition of sustainable development and emphasizing the need for broadening education.
	1990	1990: Taiwan Environmental Protection Administration (EPA) established.		
	1992			1992: Adoption of Agenda 21 at the Earth Summit (UNCED), calling for education's role in promoting sustainable development (Chapter 36). *Emergence of the Green School Movement as a direct response to Agenda 21, emphasizing the whole school approach to sustainability.
	1997		1997-Taiwan: Establishment of the National Council for Sustainable Development (NCSD).	
	1999	1999: The Green School Partnership Program initiated.	1999-Taiwan: “921 Earthquake”.	
	2000	2000: Establishment of the Green School Partnership Program, aligned with the global green school movement.		

doi:10.6342/NTU202501048

Initial Stage: Environmental Education Predating ESD	2001	2001: Launch of the Ministry of Education's Sustainable Circular Campus Project (following the 921 Earthquake).		2001: Millennium Development Goals (MDGs) were proposed in the "Road map towards the implementation of the United Nations Millennium Declaration".
	2002	2002: Taiwan releases its Sustainable Development Action Plan and designates 2003 as the year for sustainable development initiatives.		2002: Johannesburg World Summit on Sustainable Development (WSSD); Proposal for the Decade of Education for Sustainable Development (DESD).
	2003	Taiwan's Sustainable Development Action Plan adopted, marking the first year for sustainable development initiatives (referred to as 「永續元年」).		
	2004	National Development Council (NDC) publishes Taiwan's Agenda for the 21st Century: National Sustainable Development Vision and Strategic Framework.		
	2005-2009	2009: The National Council for Sustainable Development (NCSD) devised and published the "Policy Guidelines for Sustainable Development" (永續發展政策綱領).		**2005-2009**: First phase of the Decade of Education for Sustainable Development (DESD), focused on raising awareness and building capacity globally.
	2010	2010: Enactment of the Environmental Education Act in Taiwan.		**2010-2014**: Second phase of the DESD, focusing on integrating sustainability deeply into education systems and practices.
Intermediate Stage: Environmental Education Growing Alongside ESD	2011	2011: Environmental Education Act officially implemented; National Environmental Education Guidelines published in Taiwan, promoting environmental awareness and sustainability practices.		
	2014	2014: Taiwan-U.S. Eco-Campus Partnership Program formally launched under collaboration with the U.S. government.		2014: Launch of the **Global Action Programme (GAP)**, aiming to promote the incorporation of sustainability principles into education systems worldwide.
	2015		2015-Globe: the adoption of the Paris Agreement at the UN Climate Change Conference (COP21) in December.	September 2015: United Nations Sustainable Development Summit adopts the "2030 Agenda for Sustainable Development" with 17 SDGs.

doi:10.6342/NTU202501048

	2016	2016: The National Council for Sustainable Development (NCSD) revised the “Policy Guidelines for Sustainable Development”.		
	2017	2017: Voluntary National Review was published for the first time, responding the advocacy of “2030 Agenda”.		2017: UNESCO publishes *Education for Sustainable Development Goals: Learning Objectives*, reinforcing the link between ESD and SDGs.
Recent Stage: Environmental Education Transitioning to ESD	2019	2019: Taiwan officially completes development of the "Taiwan Sustainable Development Goals" (Taiwan SDGs), established by the National Council for Sustainable Development (NCSD) under the Executive Yuan. 2019: Taiwan launches the Twelve-Year National Basic Education Curriculum, which, while not explicitly focused on ESD, incorporates themes related to sustainability. 2019: “SDGs Education Handbook” was published by Ministry of Education		
	2020	**2020:** Taiwan proposed the NEED (New-generation Environmental Education Development) Policy, expanding on Environmental Education (EE) during the 30th anniversary of the Ministry of Education's promotion of Environmental Education.		
Recent Stage: Environmental Education Transitioning to ESD	2021			**2021**: UNESCO announced Berlin Declaration on Education for Sustainable Development at World Conference on Education for Sustainable Development.
	2022	**2022-2025:** Taiwan implements the NEED (New-generation Environmental Education Development) Policy, promoting sustainability-oriented Environmental Education, aligned with ESD.	2022: Taiwan officially published “Taiwan’s Pathway to Net-Zero Emissions in 2050”.	**2022:** The ESD for 2030 Global Network (ESD-Net 2030) was launched. **2022:** Greening Education Partnership launched at the UN Secretary General's Transforming Education Summit to accelerate climate change education in response to the climate crisis.
	2024			**2024:** UNESCO published the Green School Quality Standard as part of its contribution to the Greening Education Partnership.

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