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SOCIAL INCLUSION

Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China

Edited by Huinan Liu and Meng Zhang

Volume 14

2026

Open Access Journal

ISSN: 2183-2803

Social Inclusion, 2026, Volume 14
Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China

Published by Cogitatio Press
Rua Fialho de Almeida 14, 2º Esq.,
1070–129 Lisbon
Portugal

Design by Typografia®
http://www.typografia.pt/en/

Cover image: © Masjid MABA

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Available online at: www.cogitatiopress.com/socialinclusion

Table of Contents

I.

Students' Stories

Social Inclusion
2026 • Volume 14 • Article 10995
https://doi.org/10.17645/si.10995

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ARTICLE

Open Access Journal

Educational Equity for Migrant Children: A Policy Comparison of Shenzhen and Hong Kong

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Submitted: 23 July 2025 **Accepted:** 29 September 2025 **Published:** 13 January 2026

Issue: This article is part of the issue "Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China" edited by Huinan Liu (The Education University of Hong Kong) and Meng Zhang (South China Normal University), fully open access at https://doi.org/10.17645/si.i543

Abstract

This study examined how two contrasting governance systems—Shenzhen and Hong Kong—address educational equity for migrant and immigrant children within the context of China's Greater Bay Area. While both cities have expanded access to compulsory education, their institutional logics diverge sharply. Shenzhen operates a contribution-based model, linking school access to parental contribution to the city. In contrast, Hong Kong guarantees near-universal access under a rights-based regime grounded in legal entitlements. These differences raise fundamental questions about how equity is defined, prioritized, and implemented across jurisdictions. Drawing on Rawlsian principles of justice and Edgar's five-dimensional equity framework, a comparative policy analysis was conducted, using over 40 official documents, including legislative texts, admission guidelines, and statistical reports. Coding was used to trace how each system frames and operationalizes equity across access, input, process, output, and outcome dimensions. The findings show that, while both systems emphasize transparency and capacity expansion, they differ in how they identify target groups, allocate resources, and balance merit with need. Shenzhen's points-based system creates strong incentives for formalized urban integration, but disadvantages low-income migrants structurally. Hong Kong's legal universalism offers broader entitlement but struggles with linguistic exclusion and digital barriers. By linking normative theory with empirical analysis, this study offers a multidimensional understanding of how education systems interpret fairness in contexts of mobility and inequality. It also contributes to broader debates on policy transfer, urban governance, and the role of ethics in educational inclusion.

Keywords

educational equity; Hong Kong; migrant children; Shenzhen

1. Introduction

Ensuring equitable access to education is a global imperative. The UN's Sustainable Development Goals (SDGs) articulate the right of every child to inclusive and quality education, regardless of social origin, legal status, or migration background. Yet, despite this normative consensus, children from migrant and immigrant families continue to face systemic barriers to enrolment, particularly in urban regions where educational resources are scarce and governance systems are fragmented (UNESCO, 2019).

One region where this tension is especially acute is China's Greater Bay Area (GBA), a rapidly integrating zone comprising nine mainland cities and the Special Administrative Regions of Hong Kong and Macau. With over 87 million people and a GDP exceeding RMB 14.5 trillion (approximately US$2.0 trillion) in 2024 (Constitutional and Mainland Affairs Bureau, 2025), the GBA is an ambitious experiment in regional development across divergent institutional systems. However, its education systems remain siloed. Migrant and immigrant children—many of whom are internal migrants in Shenzhen or cross-border arrivals in Hong Kong—face sharply unequal opportunities for accessing compulsory education. In Shenzhen alone, nearly 70% of the population lacks local household registration, and over half the school-age population consists of migrant children from other parts of China (Shenzhen Statistics Bureau, 2024, Section 3–1). In Hong Kong, 14% of the population are new arrival families from mainland China, many of whom face challenges in navigating an unfamiliar education system (Jiang et al., 2021).

Institutional design plays a central role in structuring these educational opportunities. Shenzhen operates a points-based system that allocates school places according to household contributions such as employment history, housing type, and social insurance coverage (Shenzhen Municipal Education Bureau, 2018). This contribution-based model reflects a logic of selective inclusion. In contrast, Hong Kong adheres to a rights-based model rooted in the Education Ordinance and in the Bill of Rights, which guarantees near-universal access to free primary schooling regardless of parents' economic contributions or migration history (Hong Kong Legislative Council, 1971, 1991). While both cities aim to expand capacity and promote fairness, they do so via different normative pathways—raising important questions about what "equity" means.

Existing scholarship has documented how urban education systems reproduce inequality through admission rules, bureaucratic requirements, and linguistic expectations (Chan & Buckingham, 2008; Chen & Wang, 2015). However, most studies have examined these issues within single-city contexts, without comparing governance models across jurisdictions. Very few studies have evaluated how different systems conceptualize and operationalize equity when responding to the same policy challenge: how to provide fair and meaningful access to education for migrant and immigrant children.

This study addressed that question by comparing how Shenzhen and Hong Kong govern the educational inclusion of migrant-background students. Through a systematic analysis of policy and legal documents, the study explored how two distinct governance logics—rights-based and contribution-based—produce different interpretations and outcomes of educational equity in an increasingly interconnected region. To guide this comparison, the study drew on Rawlsian principles of justice (Rawls, 1999), with particular attention to how each system prioritizes the needs of the least advantaged, and Edgar's (2022) five-dimensional equity framework, which operationalizes fairness across access, input, process, output, and outcome. Together,

these normative and analytical lenses enabled a multidimensional evaluation of how equity is not only defined, but also enacted through institutional design. This study sought to illuminate how contrasting governance logics shape the interpretation and operationalization of educational equity. Evaluative insights and policy implications are discussed as secondary reflections.

2. Background and Literature Review

Understanding the divergent interpretations of educational equity in Shenzhen and Hong Kong requires attention to their respective legal foundations and governance logics. The contrast between China's civil law tradition and the British common law legacy inherited by Hong Kong has resulted in differing institutional understandings of the right to education, the obligations of the state, and the treatment of non-local or marginalized student populations.

2.1. Mainland China: Constitutional Commitment and Localized Implementation

In China, the right to education is enshrined in the highest levels of legal authority. Article 46 of the Constitution (2018 amendment; National People's Congress of the People's Republic of China, 2018) guarantees all citizens the right and obligation to receive education. The Education Law (2021 amendment; Ministry of Education of the People's Republic of China, 2021), Compulsory Education Law (2018 amendment; Ministry of Education of the People's Republic of China, 2018), and the Law on the Protection of Minors (2020 amendment; National People's Congress of the People's Republic of China, 2020) reiterate the state's responsibility to provide equitable education for all school-age children, regardless of gender, ethnicity, or socio-economic status.

China's pursuit of constitutionally guaranteed universal schooling has long collided with the enduring structure of the *hukou* system, the nationwide household registration system that legally ties an individual's place of registration to eligibility for public services, including compulsory education. Under this system, children without local *hukou* are often required to meet additional conditions—such as parental employment, housing, or social insurance records—before they can access public schooling in their city of residence (Chan & Buckingham, 2008; Zhou & Cheung, 2017). While national laws affirm that every child has the right to education, in reality this right is often geographically constrained. As of 2020, China had approximately 71.09 million migrant children, representing 23.9% of the national child population. Among them, 34.62 million were classified as urban migrant children—those who have migrated with their parents from rural to urban areas without transferring *hukou* registration (National Bureau of Statistics of China et al., 2023). The *hukou* system continues to limit many of these families' eligibility for publicly funded education in their city of residence.

This institutional tension is especially pronounced in China's mega-cities such as Beijing, Shanghai, Guangzhou, and Shenzhen, where local governments—tasked with providing education but operating under decentralized fiscal responsibilities—have developed mechanisms to prioritize access for registered residents (Deng & Gao, 2024; Kwong, 2011). In Beijing, for instance, public school enrolment for non-local children typically requires the so-called "five certificates" (*wu zheng*), including documents proving stable employment, legal housing, residence permits, and continuous social insurance—each linked to parental legal status and duration of stay (S. Liu et al., 2017; X. Zhang et al., 2021). Similarly, Shanghai operates a multi-tiered points-based admission

system, in which migrant families are scored and ranked based on indicators such as residence length, job type, education level, and tax contributions (Chen & Wang, 2015). These mechanisms reflect how *hukou* functions as a de facto gatekeeping tool, enabling city authorities to ration access to limited educational resources while managing local fiscal risk (Chan & Buckingham, 2008).

Among these cities, Shenzhen stands out not only for the scale of its migrant population but also for how starkly it illustrates this dilemma. At the provincial and municipal levels, Guangdong and Shenzhen have introduced specific policies aimed at promoting equity, such as the Measures for the Administration of Compulsory Education for Non-Hukou Children (see Shenzhen Municipal Government, 2018, document revised in 2024) and annual admission guidelines that emphasize transparency in school placement. These frameworks signal a strong local commitment to ensuring more equitable access while managing high levels of migrant inflows. As a city where almost 70% of residents lack local *hukou* (Shenzhen Statistics Bureau, 2024, Section 3–1), Shenzhen exemplifies the challenge of extending educational rights in a governance structure that still ties entitlements to household registration. Its policy responses, while innovative, remain shaped by this structural constraint—a dynamic explored further later in the article.

2.2. Hong Kong: Common Law Protections and Rights-Based Logic

In contrast, Hong Kong's legal framework is rooted in British common law, which prioritizes individual rights and judicial remedies. The Education Ordinance (Hong Kong Legislative Council, 1971) mandates school attendance for children aged 6 to 15 and positions the government as responsible for ensuring education for all residents with legal status. Drawing from the International Covenant on Civil and Political Rights, the Bill of Rights Ordinance (Hong Kong Legislative Council, 1991) further enshrines education as a protected right. This framework emphasizes equality before the law and non-discrimination, independent of income, race, or immigration background.

While Hong Kong does not operate a household registration system, access to public education is tied to lawful residence. Children of asylum seekers or undocumented migrants may face limitations, but the education system generally avoids linking school eligibility to parental tax contribution, housing ownership, or employment status. Instead, administrative mechanisms such as randomized school allocation and multilingual support services for non-Chinese-speaking students reflect a compensatory and inclusive approach.

2.3. Governance Logics and Their Implications for Equity

At a structural level, Shenzhen embodies a utilitarian and welfare-allocation logic that treats education as a scarce resource to be distributed based on merit and contribution. Educational equity is understood through the lens of "qualified inclusion"—rights are extended conditionally based on one's integration into the local socio-economic fabric. In contrast, Hong Kong adheres more closely to a rights-based logic in which education is a guaranteed service for all lawful residents, regardless of their families' socio-economic input.

This contrasting logic has deep implications. In Shenzhen, children of precarious or informally employed migrants may effectively be excluded from mainstream education, despite constitutional protections. In Hong Kong, the system strives to accommodate linguistic, ethnic, and geographic diversity through targeted policies, even though challenges such as the digital divide and residual socio-economic gaps remain.

Any comparison of educational equity in Shenzhen and Hong Kong must be contextualized within their distinct legal and institutional paradigms. These paradigms shape policy design, and access mechanisms and broader societal expectations about fairness, entitlement, and the state's role in inclusive development.

2.4. Evolving Concepts of Educational Equity

The notion of educational equity has undergone important transformations in recent decades. Earlier frameworks often equated equity with equality of opportunity, where all individuals, regardless of background, should have the same chances to succeed (Jencks et al., 1972; Rawls, 1999). However, as critics have pointed out, equal opportunities at the starting line rarely compensate for structural inequalities accumulated over time. Consequently, more recent theories have shifted toward a capability-based understanding of equity—what learners are actually able to achieve in real-world contexts given their contexts and constraints (Gale & Molla, 2015; Walker, 2006).

Among the most policy-relevant models, Edgar's (2022) five-dimensional framework has been adopted widely in both academic and international policy circles (e.g., OECD Education Policy Outlooks). It disaggregates educational equity into five interlinked components: (a) access and opportunity, (b) needs-based input, (c) process fairness, (d) minimum performance standards, and (e) outcome distribution. These dimensions move the equity conversation beyond simple access or funding toward a more comprehensive assessment of what education systems actually deliver for different learners.

In parallel, Rawls' (1999) theory of justice continues to serve as a normative benchmark for assessing whether institutions are ethically justifiable. His equal-liberty principle requires that everyone has equal rights to basic freedoms—including access to education—while the difference principle allows for inequalities only if they benefit the least advantaged. Rawls' framework, when considered alongside Edgar's dimensions, offers a promising normative lens to examine whether equity policies not only exist, but also attend to the needs of the most disadvantaged. This study drew on both Edgar and Rawls to systematically evaluate the policy architectures of Shenzhen and Hong Kong.

2.5. Immigrant and Migrant Children: Definitions and Challenges

Across jurisdictions, the category of "immigrant children" or "migrant students" is far from uniform. Legal and administrative systems define these groups differently, which in turn shapes what support they are entitled to receive. In Sweden, for instance, "newly arrived migrant students" are defined as those entering after age seven and are tracked as such for up to four years (Tajic & Bunar, 2023). In Italy, "immigrant children" includes both first-generation (foreign-born) and second-generation (born in Italy to non-citizens), with a focus on guiding high-performing students into academic tracks (Carlana et al., 2022). These varying definitions illustrate how social and legal contexts shape who is seen as "at risk" and what kind of support is deemed necessary. In this article, we use "migrant children" as an umbrella term, while recognizing that in Shenzhen it refers mainly to non-*hukou* internal migrants, and in Hong Kong it encompasses New Immigrant Students (NIS), Cross-Boundary Students (CBS), and Non-Chinese-Speaking (NCS) students.

In mainland China, the dominant term is "migrant children" (*liudong ertong* or *suiqian zinv*), referring to children of rural parents who move to cities for work. Due to the *hukou* system, these children are often denied access to public schools in their new urban homes. Many studies (T. Liu et al., 2018; S. Zhang, 2025; Zhou & Cheung, 2017) have documented how exclusion from public education pushes many migrant children into under-resourced private schools, often with unqualified teachers and inadequate facilities. Although national policy has gradually shifted from promoting "equal opportunity" to ensuring "equal quality" (Guo et al., 2019), in reality many urban school districts still use points-based admission systems that effectively tie access to parental employment, housing, or social insurance status. Moreover, beyond the classroom, migrant children also face barriers to social integration, mental health support, and extracurricular participation—areas rarely captured by conventional equity metrics (Qi et al., 2022; Yuen, 2010; Zhu & Shek, 2020).

In Hong Kong, the classification of immigrant children is uniquely shaped by the city's postcolonial identity and proximity to mainland China. Recent studies have distinguished between NIS from the Mainland, CBS who live in Shenzhen and commute daily, and NCS students, largely from South and Southeast Asian backgrounds. These groups face distinct but overlapping challenges. Wu et al. (2021) highlight the academic and psychological stress that NIS and CBS face when adapting to a new curriculum, often with weak Cantonese proficiency. Jiang et al. (2021) noted that NIS youth comprised 12.36% of Hong Kong's 0–14 population by 2018—far from marginal. Meanwhile, Karim and Hue (2023) drew attention to NCS students' systematic underperformance in public exams, language exclusion in a Cantonese-dominant system, and limited social integration despite official trilingual policies. These studies together paint a picture of deep-rooted structural barriers in Hong Kong's education system, particularly for linguistic and cultural minorities.

These challenges are not just logistical or administrative—they are fundamentally ethical, in Rawlsian terms. By denying access or under-providing support to children based on their legal status, birthplace, or language backgrounds, education systems may violate both the equal-liberty and difference principles. As Gabrielli and Impicciatore (2022) argued, immigrant children often exist between two cultures and two legal identities, and this in-betweenness magnifies their vulnerability. Thus, equity for migrant and immigrant children must be understood as both a structural and a moral imperative.

2.6. Equity Reforms in Shenzhen and Hong Kong: A Comparative Research Gap

Both Shenzhen and Hong Kong have taken active steps to address educational equity—but through very different governance logics. In Shenzhen, recent policy efforts have focused on expanding access through supply-side reforms: building new schools, increasing public-school seats, and refining the points-based admission system that governs entry for non-*hukou* children (Bo & Wang, 2025; Trémon et al., 2025). Although these reforms have increased public-school enrolment rates among migrant children, critics point out that complex documentation requirements continue to exclude the most precarious families (T. Liu et al., 2018; Zhou & Cheung, 2017).

By contrast, Hong Kong operates under a rights-based legal framework that guarantees education for all legal residents. Rather than building more schools, its equity efforts have centered on process-oriented reforms, such as random-number-based school placement (Education Bureau [EDB], 2025), trilingual curriculum development, and targeted subsidies for NCS and CBS (Hong Kong Special Administrative Region

Government, 2025). These interventions aim to level the playing field without filtering access through socio-economic credentials. However, persistent outcome gaps—especially in Chinese language attainment—suggest that rights alone do not eliminate inequality (Karim & Hue, 2023).

Despite the richness of city-specific studies, few comparative analyses directly assess how these two governance approaches perform across the full range of equity dimensions. Existing research often focuses on single aspects—access, language support, or admissions—but does not offer an integrated evaluation grounded in shared theory. No study, to our knowledge, has applied Edgar's five-dimensional framework in tandem with Rawlsian ethics to compare the two systems. This absence limits both the theoretical generalisability and policy transferability of current findings—particularly as Shenzhen and Hong Kong move toward deeper integration under the GBA development framework. Moreover, while a growing body of literature affirms the multidimensionality of educational equity and the disproportionate barriers faced by immigrant and migrant children, few studies have examined how different governance logics mediate these challenges in operational terms. Comparative evaluations across distinct legal-institutional regimes—especially between cities like Shenzhen and Hong Kong—remain rare.

By bridging normative theory with empirical policy analysis, this study addressed that gap. It asked not only what policies exist, but also for whom they work, and whether they fulfill the ethical promise of education as a right for all. This rationale provides the conceptual foundation for the theoretical framework discussed in the next section, which in turn informs the study's research questions.

2.7. Theoretical Framework

To interpret these contrasting governance logics, this study drew on two complementary theoretical lenses. First, Edgar's five-dimensional model of educational equity provides a structured, policy-relevant lens to assess fairness in terms of access, input, process, output, and outcomes. This model enables the breakdown of policy mechanisms across Shenzhen and Hong Kong into analytically comparable components. Second, Rawls' theory of justice offers a normative framework to evaluate whether education systems prioritize the needs of the least advantaged. The principles of equal liberty and of difference allow for a philosophical interrogation of whether policies in each city meet the threshold of ethical fairness, especially for marginalized populations such as migrant children and ethnic or linguistic minorities. By combining these two frameworks, the study balanced empirical policy comparison with ethical evaluation. This approach enhanced the explanatory depth of the analysis, ensuring that the cross-regional comparisons were not only descriptive but also normatively meaningful.

2.8. Comparative Value and Research Questions

Comparing Shenzhen and Hong Kong provides both theoretical and practical value. It highlights how contrasting governance logics—contribution-based in Shenzhen versus rights-based in Hong Kong—interpret and institutionalize fairness, and how both systems respond to common challenges such as migrant integration, special educational needs, and socio-economic inequality. This comparative perspective is particularly relevant to the GBA, where cross-border educational mobility underscores the need for policy coordination and mutual understanding of governance logics. Building on this rationale, the study addressed the following research questions:

RQ1: In what ways do Shenzhen and Hong Kong differ in ensuring equitable access to compulsory education?

RQ2: How do the two systems respond to the specific needs of disadvantaged groups, particularly migrant and immigrant children?

RQ3: How do these divergent policy approaches reflect different dimensions of educational equity, and what does this reveal about the influence of contrasting governance systems within the GBA?

3. Methodology

A structured policy document analysis was employed in this study to examine how Shenzhen and Hong Kong interpret and implement educational equity. The research design followed four sequential components: (a) document corpus construction, (b) retrieval and screening procedures, (c) analytical framework and coding scheme, and (d) validation and reliability checks.

3.1. Document Corpus Construction (2018–2025)

Documents were selected according to three criteria: (a) they regulate compulsory education, (b) they explicitly or implicitly reference equity-related concepts (e.g., fairness, inclusion, non-discrimination), and (c) they are officially issued by a governmental or statutory authority.

3.2. Retrieval and Screening Procedure

Policy documents were retrieved through systematic searches and manual download from official portals: Hong Kong's EDB, the Legislative Council archives, the Shenzhen Government Gazette, and district-level education websites. Metadata (title, year, issuer, URL, revision status) were logged into a registry. Duplicates and expired versions were excluded. A time filter (2018–2025) was applied to focus on the most recent phase of enrolment reforms and digitization. Two researchers independently screened summaries and tables of contents, resolving disputes through consensus. The final corpus is listed in Table 1.

3.3. Analytical Framework and Coding Scheme

The analysis integrated three layers of theoretical insight to guide the coding and interpretation process. First, the context–text–consequence model proposed by Cardno (2018) was employed to situate each policy document within its broader macro-environment, examine its discursive framing, and assess its anticipated or actual policy impacts. Second, Rawlsian principles of justice were applied to evaluate whether the policies in question upheld equal liberty and prioritized the needs of the least advantaged. Third, Edgar's five-dimensional model of educational equity was used to operationalize fairness across five interconnected domains: access, input, process, output, and outcome.

To implement this analytical framework, an initial set of 12 coding nodes was developed, corresponding to the two Rawlsian principles, five Edgar dimensions, three components of the Cardno framework, as well as two additional nodes representing policy tool types and target populations. The coding structure allowed for

Table 1. Policy documents list.

Jurisdiction	Policy Document	Issuing Authority	Year
Shenzhen	Measures for the Administration of Compulsory Education for Non-*Hukou* Children	Shenzhen Municipal Government	2018, revised 2024
	Notice on Carrying Out the Admission Work for General Primary and Secondary Schools	Shenzhen Municipal Education Bureau	2018–2025
	District-Level Points-Based Admission Guidelines (e.g., Nanshan, Guangming, Longhua)	District Education Bureaus, Shenzhen	2018–2025
Hong Kong	Primary One Admission Guides	EDB	2018–2025
	Education Ordinance (Cap. 279)	Hong Kong Legislative Council	1971
	Hong Kong Bill of Rights Ordinance (Cap. 383)	Hong Kong Legislative Council	1991
	Support Measures for NCS Students (2024 Circular)	EDB	2024

the emergence of new categories where appropriate. Coding consistency was checked through independent double coding and consensus discussions. Comparative analyses across cities and target groups were conducted through cross-tabulations and matrix queries to identify patterns and divergences in policy orientation and emphasis.

3.4. Validity and Reliability

To ensure analytic robustness, a multi-pronged strategy was adopted. First, triangulation was employed to enhance the credibility of findings: Policy interpretations were cross-validated against statistical yearbooks, school enrolment datasets, and public government reports. Second, a comprehensive audit trail was maintained throughout the research process. All source documents, coding logs, and analytical scripts were archived internally to ensure traceability. This multi-step approach helped ensure that the selected policy documents directly addressed the research questions, that the analytical frameworks meaningfully integrated both normative and operational dimensions, and that the resulting interpretations were both traceable and verifiable.

4. Findings

4.1. The Improved Equitable Access to Compulsory-School Places

4.1.1. Shenzhen: Expand First, Fine-Tune Later

At the beginning of the study period (2018), Shenzhen faced the GBA's most pronounced seat shortage, reflecting sustained pressure from migrant inflows. Between 2019 and 2020, Shenzhen's non-*hukou* population grew by more than 340,000, reaching over 1.24 million (Shenzhen Statistics Bureau, 2024,

Section 3–1). In response, the city expanded public-school quotas, banned selective entrance exams, and implemented a unified registration portal (Shenzhen Municipal Education Bureau, 2020). Local districts were required to prepare multi-year enrolment forecasts (Shenzhen Municipal Education Bureau, 2018), and a district-supervised lottery system was introduced for oversubscribed schools to absorb residual applicants (Shenzhen Municipal Education Bureau, 2020). By the end of 2024, Shenzhen had added a cumulative 825,000 basic education seats, and in that year alone added 180,000 new places (Shenzhen Municipal Education Bureau, 2025b). More than one-third of the public-school seats at the compulsory level were allocated to children of migrant families, indicating progress in equitable provision despite persistent competition for limited spots. Despite these expansions, the most precarious migrant children—whose parents lack access to stable housing or to formal employment that provides social-insurance coverage, typically requiring higher educational or professional credentials—remain categorically excluded from public provision under the Measures for the Administration of Compulsory Education for Non-*Hukou* Children (Shenzhen Municipal Government, 2018, revised 2024).

4.1.2. Hong Kong: Redistribute What Exists, Keep the Process Clean

Hong Kong faces a different constraint: land, not immigration. Total pupil numbers have been stable, but seats are spread unevenly between dense urban areas and the fast-growing Northern New Territories. Because large-scale school construction is slow, the EDB has relied on procedural tools to dilute place-based advantage.

Hong Kong, constrained by limited land, has followed a process-dominant path. Half of the Primary One places are allocated through computer-generated random central allocation, reducing discretionary influence in admissions (EDB, 2025). The introduction of the iAM Smart+ portal since 2020 has shifted nearly all applications online, streamlining access while preserving paper-submission options to accommodate digitally excluded families (Digital Policy Office, 2024). Without significantly expanding physical capacity, this process-dominant model has narrowed socio-economic disparities in elite-school entry and reduced travel times for pupils in underserved border districts. For students living further from school—typically beyond 10 minutes' walking distance—the Student Travel Subsidy Scheme provides means-tested transport support to ensure affordable access to education across school nets (Working Family and Student Financial Assistance Agency, 2025).

4.1.3. Comparative Insight

Shenzhen's strength lies in volume—a rapid build-out of public supply—and in the steady relaxation of contribution-based hurdles. Its weakness is that eligibility remains tied to parental insurance and housing credentials, leaving the poorest migrants vulnerable. Hong Kong excels at procedure—transparent, data-driven allocation rules that curb middle-class advantage even when bricks-and-mortar capacity is hard to add. Its shortcoming is an absolute seat gap in land-constrained districts, a problem algorithms cannot fix. Taken together, the two cities illustrate complementary pathways to the same equity goal: one prioritizes more seats first, the other fairer rules first. A future GBA strategy that pairs Shenzhen-style capacity expansion with Hong Kong-style procedural safeguards would come closer to universal, proximity-based access for every child.

4.2. Differentiated Support for Migrant and Immigrant Students

4.2.1. Shenzhen: Conditional Entry Through Governance-Linked Differentiation

Over half of compulsory-age pupils were migrant children in Shenzhen (Shenzhen Statistics Bureau, 2024, Section 3–1). To manage this pressure, the city embedded differentiation within a single points-based system that governed both ordinary and migrant admissions. From 2018 to 2020, families living in low-rent public housing (e.g., public rental housing, low-rent housing, transitional housing) received extra points (Nanshan District Education Bureau, 2020), indirectly reflecting economic need, while uninterrupted social-insurance records were rewarded as markers of parental contribution and long-term stability in Shenzhen.

Beginning in 2020, district-level rules recalibrated the formula in ways that explicitly tied education access to broader governance goals. Rather than lowering the weight of home ownership, several districts (e.g., Guangming) elevated its relative status by differentiating homeowners from renters in baseline scoring, reinforcing housing as a pathway to educational advantage. At the same time, child-related criteria were reshaped: Once-generous bonuses for only children were sharply reduced or eliminated by 2022 (Guangming District Education Bureau, 2019, 2020, 2022), reflecting China's demographic shift from birth control to fertility encouragement. These adjustments demonstrate how differentiated admission rules functioned less as targeted educational support and more as extensions of macro-regulation in housing, employment, and population policy.

4.2.2. Hong Kong: Universal Entry With Rights-Based Adjustments

Because lawful residence, not parental contribution, decides eligibility, Hong Kong must fine-tune support after pupils are inside the system. The EDB therefore layers categorical grants on top of its uniform funding formula. Since 2019, the Chinese as a Second Language grant has allocated approximately HK$160,000 to HK$1.6 million per school per year, based on NCS student enrolment, to support additional teachers, bilingual materials, and interpretation services (EDB, 2020; Hong Kong Special Administrative Region Government, 2025). Preliminary reviews suggest that schools receiving the highest tier of Chinese as a Second Language grant support have demonstrated notable progress in NCS students' Chinese language outcomes, even though gaps remain (Gao et al., 2019; Tse et al., 2021).

Economic targeting is subtler. Instead of differential admission points, Hong Kong uses the Student Finance Office to route textbook, lunch-fee, and transport subsidies (Working Family and Student Financial Assistance Agency, 2025) to the lowest two income deciles. From April 2024, the Working Family Allowance Scheme increased household and child allowances by 15%, raising the maximum monthly benefit for a four-person (two-child) family from HK$4,200 to HK$4,830. In 2022–2023, over 66,000 households (approximately 220,000 individuals, including more than 86,000 children) received support, and total child allowance payments exceeded HK$1.10 billion (Hong Kong Special Administrative Region Government, 2023, 2024; Working Family and Student Financial Assistance Agency, 2024). One gap remains in digital equity: At the scheme's launch in 2018, only about 8% of households used online applications (Hong Kong Special Administrative Region Government, 2023). Although this figure rose to 50% by 2023 (Hong Kong Special Administrative Region Government, 2023), the remaining half continue to rely on paper submissions, suggesting that while uptake has improved, equitable digital access is still uneven.

4.2.3. Comparative insight

Shenzhen's differentiation logic is embedded in its admission algorithm and capital spending: Once a pupil gains admission, services are largely standardized. Hong Kong's logic is superimposed: The gate is open to all lawful residents, and tailored resources are layered afterwards through earmarked grants and statutory entitlements. Shenzhen scores high on progressively lowering economic entry barriers, but it offers little systematic support for linguistic or cultural minorities. Hong Kong shines in language-of-instruction accommodation, yet still relies on household means-testing schemes that parents say are administratively heavy and have not fully solved the digital gap.

Taken together, the two systems represent contrasting equity sequences: Shenzhen places conditions upon entry but standardizes services thereafter, while Hong Kong guarantees entry upfront and differentiates support post-admission. A hybrid GBA model—combining Shenzhen's structural investment with Hong Kong's multilingual and income-responsive subsidies—would meet the needs of migrant and immigrant students more comprehensively (see Figure 1).

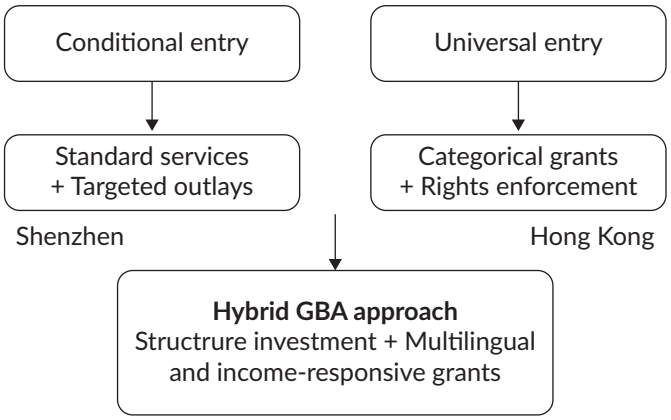

Figure 1. Governance sequences for educational equity in Shenzhen and Hong Kong.

4.3. Strengths and Persistent Challenges

Shenzhen and Hong Kong present two contrasting—but potentially complementary—models of fairness. Shenzhen's approach is resource-led: Between 2019 and 2024, the number of public schools more than doubled from 637 to 1,746, while the total number of students enrolled in ordinary primary and secondary schools rose by over 420,000 to 1.97 million (Shenzhen Municipal Education Bureau, 2025a). This rapid infrastructure expansion reflects the city's strong fiscal commitment and central coordination, aimed at accommodating a large non-*hukou* student population. Although official data on class size remain limited, the increase in capacity indicates a policy effort to alleviate school crowding in high-demand districts.

The same growth strategy, however, carries three liabilities. First, conditionality: Even after some adjustments, entrance points still reward stable housing and long social-insurance records, showing how access to education has become an instrument for broader governance goals and disadvantaging the most precarious migrants. Second, intra-urban disparity: Wealthier districts convert fiscal transfers into "smart campuses" (Shenzhen Municipal Education Bureau, 2019) and trilingual staff more quickly than do outer

industrial zones, inviting allegations that the city is reproducing, not erasing, spatial privilege. Third, thin cultural accommodation: Shenzhen provides limited and largely unsystematic language or cultural support for non-Mandarin-speaking migrant families, despite its increasingly diverse population.

Hong Kong epitomizes a process-led pathway. With little room to build, the EDB focuses on neutralizing positional advantage once places exist. Re-engineering of the Primary One allocation algorithm—in which a random number now decides almost half of all places—the policy aims to reduce the historic correlation between parental income and elite primary entry. Categorical grants for NCS, pegged to audited headcounts, authorize schools to hire specialist teachers and require the publication of outcome metrics, creating a feedback loop that civil-society groups can monitor. In short, Hong Kong's chief strength is procedural transparency backed by rights-based entitlements, a design that cushions immigrant families from both linguistic and geographic disadvantage without asking them to prove economic worth.

Yet the territory's rights-based model is bounded by absolute capacity: Land scarcity and falling birth cohorts have led to school closures in urban districts even as border towns experience rising demand. Where classrooms cannot be conjured, students face longer commutes despite transport subsidies. A second weakness is digital stratification. Online portals such as iAM Smart+ accelerate application processing for the median family, but 8–10% of the lowest-income households still rely on manual counters (EDB, 2025), widening an information gap that the EDB acknowledges but has yet to close. Finally, Hong Kong's anti-poverty instruments remain heavily means-tested and paperwork-intensive, deterring some eligible families from claiming textbook or lunch allowances (Working Family and Student Financial Assistance Agency, 2024).

Juxtaposing the two trajectories shows a complementary ledger of capabilities. Shenzhen demonstrates that rapid expansion and algorithmic admissions can raise the floor of provision, but contribution-based filters persist when embedded in local regulations. Hong Kong shows that legal entitlements, randomized allocation, and earmarked grants can compress socio-economic gradients without new construction, though gains plateau when seats or broadband access are lacking.

Seen through Rawls's difference principle, both systems intend to deliver tangible benefits to many least-advantaged children—one through quantity, the other through procedure—yet both leave identifiable minorities underserved. A future GBA agenda that pairs Shenzhen's build-out capacity with Hong Kong's rights-centered safeguards could move the region closer to equity in both opportunity and process, translating each city's comparative advantage into a more integrated, inclusive educational landscape.

5. Discussion

5.1. Advancing Equity Along Two Distinct Pathways

Taken together, the Shenzhen and Hong Kong cases show that educational equity can be pursued either by scaling physical capacity or by refining procedural allocation, yet neither pathway by itself reaches the least-advantaged learners without complementary supports. Framing the findings through Edgar's (2022) policy-oriented dimensions of equity and Rawls's (1999) normative principles clarifies where each city excels, where blind spots persist, and how a hybrid strategy could better satisfy both equal-liberty- and difference-principle requirements in the GBA.

5.2. Access, Equal Liberty, and Process Quality

Shenzhen's supply-dominant approach—more than double the number of schools, unified public–private lotteries, and a progressively relaxed point formula—has expanded access for migrant students. As of 2024, approximately 48% of all compulsory education places and 31% of public-school seats were allocated to children of non-*hukou* families—the highest share among China's major cities (Education Bureau of Guangdong Province, 2024). Formally, this approach aspires to reflect Rawls's equal-liberty principle by giving every resident child a legal route into compulsory schooling. Yet the continuing need to upload housing deeds and year-long social-insurance records imposes a procedural burden that collides with Edgar's process dimension: The poorest and most mobile families still enter at the back of the queue.

Hong Kong, constrained by limited land, has followed a process-dominant path. Approximately half of Primary One places are now assigned through computer-generated random allocation, reducing the discretionary grip in admissions (EDB, 2025). In parallel, this digital turn (i.e., iAM Smart+ portal) streamlines applications and benefits the majority of families. Yet some low-income households still rely on manual paper submissions, exposing an information gap acknowledged—but not yet resolved—by the EDB (2025). This digital stratification is difficult to justify within a Rawlsian framework, which only benefits the least advantaged after allowing for inequalities.

5.3. Differentiated Provision and the Difference Principle

Shenzhen embeds selective incentives in its admissions algorithm and capital budget, rewarding long-term residence and formal employment rather than migrant status itself. These provisions ensure basic access but fall short of Edgar's needs-based dimension, as they prioritize contribution over disadvantage. The absence of systematic language or cultural support for ethnic-minority pupils further reveals a blind spot in responsiveness.

Hong Kong layers ex-post grants on top of universal entry. The Chinese as a Second Language subsidy and cross-boundary transport allowances channel resources to the linguistically and geographically marginalized, exemplifying the Rawlsian difference principle. However, the Student Finance Office's means-tested textbook and lunch schemes remain paperwork-heavy, deterring some eligible low-income families.

5.4. Comparative Strengths and Policy Learning

To further illuminate how Shenzhen and Hong Kong operationalize different aspects of educational equity, Table 2 compares the relative strengths of each system across three dimensions outlined in Edgar's framework: minimum access, procedural fairness, and differentiated support for student needs. Rather than providing a comprehensive audit, the table highlights selected institutional features that reflect each city's strategic priorities and normative assumptions. Together, these contrasts illustrate how different governance logics can produce complementary responses to similar equity challenges.

A GBA strategy that couples Shenzhen's large-scale seat expansion and procedural transparency with Hong Kong's targeted language and income-responsive grants could reconcile quantity with fairness, more closely aligning practice with Rawls's twin principles and Edgar's full equity spectrum.

Table 2. Comparative strengths between Shenzhen and Hong Kong.

Equity dimension (Edgar)	Shenzhen strength	Hong Kong strength
Access & Minimum	Massive seat expansion; class-size caps; conditional entry via point system	Randomized allocation; low-cost cross-district transport; universal entry guarantee
Process	"Three-open" transparency in point ranking (open policy, open criteria, open results)	One-stop digital portal; procedural safeguards against discretion
Need/Gap	Limited direct needs-based support; entry rules prioritize housing, employment, and social insurance rather than compensating vulnerable groups	Targeted grants for CBS and NCS students; means-tested textbook, lunch-fee, and transport subsidies

6. Conclusion

This comparative study set out to explain how two cities operating under markedly different legal regimes and governance logics—Shenzhen under China's civil law system and Hong Kong under the British common law tradition—pursue the shared policy goal of educational equity. Drawing on Edgar's five-dimensional model and Rawls' twin principles of justice, we analyzed more than 40 core policy documents issued between 2018 and 2025 and addressed three research questions concerning access, differentiated provision, and overall system strengths.

Specifically, this study compared how Shenzhen and Hong Kong address the challenge of providing equitable compulsory education for migrant and immigrant children. Despite shared pressures under the GBA framework, the two cities embody contrasting governance logics: Shenzhen relies on a contribution-based admission system with access conditional upon parental employment, housing, and social insurance, whereas Hong Kong operates under a rights-based legal framework that guarantees education to all lawful residents. Each approach carries distinct strengths and weaknesses. Shenzhen's rapid expansion of public-school capacity has broadened access but continues to filter entry through socio-economic criteria. Hong Kong ensures broad legal access and procedural transparency, yet faces persistent outcome disparities and capacity constraints. From a policy perspective, these findings suggest that future GBA coordination could benefit from combining the strengths of both approaches: Shenzhen's capacity-expansion model with Hong Kong's procedural safeguards and categorical grants. Such a hybrid strategy would provide a more comprehensive response to the educational needs of migrant-background students in the region.

Beyond these policy implications, the comparative analysis also contributes to academic debates. Theoretically, it demonstrates how contrasting governance systems—contribution-based versus rights-based—shape the operationalization of Rawls' principles of justice and Edgar's multidimensional framework of equity. This underscores that "equity" is not a fixed universal norm but is interpreted and enacted differently across institutional contexts. Empirically, it offers rare cross-jurisdictional evidence within the GBA, showing how similar challenges—such as migrant integration and support for linguistic minorities—are mediated through divergent institutional logic, admission rules, and resource-allocation mechanisms. Taken together, these contributions clarify that the significance of the comparison lies not only

in practical policy design but also in advancing broader scholarly understanding of how governance systems condition the meaning and practice of educational equity.

7. Limitations and Implications

This study had several limitations. First, it relied primarily on official policy and government documents, which limited the ability to capture how faithfully schools implement written rules or how families experience them in practice. Second, the analysis was based on document comparison and did not establish causal mechanisms or measure the effectiveness of specific interventions. Third, the scope was confined to Shenzhen and Hong Kong, without incorporating other GBA cities such as Guangzhou or Macau, which narrowed the breadth of regional comparison.

These limitations also point to future directions. Interview-based and ethnographic research could illuminate the lived experiences of migrant and immigrant students and their families. Mixed-methods and longitudinal approaches would allow for better assessment of how policy reforms affect educational outcomes over time. Expanding the comparative scope to include additional GBA cities would also enhance the generalisability of the findings and clarify how different governance logics interact within the region. Finally, while this article is primarily explanatory, the comparison suggests a broader implication for policy and practice: Shenzhen's capacity-driven model and Hong Kong's process-driven model represent complementary approaches to educational equity, and a balanced combination may provide useful reference for ongoing debates on regional integration.

Funding

This work was supported by two grants from the Research Council of Norway: one awarded to the Centre for Research on Special Needs Education and Inclusive Practice (grant number 327377) and another to the Centres of Excellence CREATE scheme (grant number 331640). Publication of this article in open access was made possible through the institutional membership agreement between the University of Oslo and Cogitatio Press.

Conflict of Interests

The authors declare no conflict of interests.

Data Availability

All data used in this study were obtained from publicly accessible sources, including the websites of the Shenzhen Municipal Education Bureau, Hong Kong Education Bureau, Shenzhen Statistics Bureau, Census and Statistics Department of Hong Kong, and the Legislative Council of Hong Kong.

LLMs Disclosure

The authors used ChatGPT to assist with checking the clarity and fluency of the manuscript's language.

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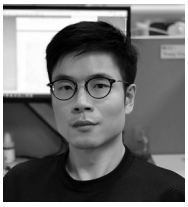

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Social Inclusion
2026 • Volume 14 • Article 10831
https://doi.org/10.17645/si.10831

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ARTICLE

Open Access Journal

Cultivating Inclusive Classrooms: Strategies for Educational Equity for Non-Chinese-Speaking Students in Hong Kong's Kindergartens

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Submitted: 22 June 2025 **Accepted:** 20 August 2025 **Published:** 13 January 2026

Issue: This article is part of the issue "Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China" edited by Huinan Liu (The Education University of Hong Kong) and Meng Zhang (South China Normal University), fully open access at https://doi.org/10.17645/si.i543

Abstract

This article explores how Hong Kong kindergartens promote inclusive early childhood education for non-Chinese-speaking children within the dynamic context of China's Greater Bay Area (GBA). It builds upon the findings of a foundational survey of 161 kindergartens from the same research project, which revealed that while new government subsidies encouraged greater inclusion, significant challenges persisted. Specifically, our survey identified systemic barriers, including human resource shortages, a heavy reliance on kindergartens' own efforts to overcome difficulties, and insufficient parental engagement, resulting in disparities in implementation. Building on these findings, this article moves from identifying problems to highlighting solutions. It analyzes qualitative data from 16 case reports, submitted for an award scheme on multicultural inclusion, and 10 follow-up interviews to uncover exemplary practices. Using the CARE model (capability, aspirations, resources, engagement) as an analytical framework, this study identifies key strategies that proactive kindergartens employ, such as building multicultural learning environments, forging strong home-school partnerships, and developing targeted outreach programs. The findings reveal that successful inclusion is not accidental but the result of a deliberate, holistic, and interconnected effort. These insights contribute to a deeper understanding of how inclusive education policies can be effectively implemented in diverse urban contexts, offering valuable lessons for advancing educational equity and sustainable development (SDGs 4 and 10) in Hong Kong and, with local adaptation, in comparable urban contexts within the GBA and beyond.

Keywords

early childhood education; educational equity; inclusive education; multiculturalism; non-Chinese-speaking children

1. Introduction

The United Nations' 2030 Agenda for Sustainable Development upholds a global commitment to inclusive and equitable quality education for all, including linguistic minorities (United Nations, 2015). In the complex and high-stakes context of Hong Kong, a key city in the Greater Bay Area (GBA), fulfilling this goal for non-Chinese-speaking (NCS) students presents a significant challenge (UNESCO, 2017; Xie et al., 2023). Recent government policy, culminating in the Kindergarten Education Scheme (KES), has aimed to improve inclusion, yet major systemic barriers persist.

A foundational survey for this research project, involving 161 kindergartens, revealed a critical disjuncture. While new government funding successfully increased the willingness of mainstream kindergartens to admit NCS students, it was insufficient to ensure a high-quality, equitable experience. The survey identified the key remaining problems: acute human resource deficits, inadequate frameworks for home-school communication, and a sense of institutional isolation (Wong et al., 2022).

This quantitative work successfully mapped the problems, creating a clear and urgent need to understand how they can be solved. The present qualitative study addresses that exact gap. Moving beyond problem identification to an analysis of solutions, it examines the exemplary practices of proactive kindergartens that have successfully navigated these systemic challenges. It also seeks to identify the deliberate, holistic, and replicable strategies that foster genuine inclusion. To situate the study within the broader fields of educational equity and inclusive education, equity is understood not only as access but as the fair distribution of opportunities, supports, and outcomes (Keddie, 2012), while inclusion is treated as a systemic, whole-school endeavor that maximizes presence, participation, and achievement for all learners (Ainscow, 2005; Booth & Ainscow, 2011; Slee, 2011). In early childhood education (ECE), inclusive pedagogy argues for high expectations for all, accompanied by responsive support—instead of separating "additional needs" (Florian & Black-Hawkins, 2011; Wong et al., 2025)—and universal design-for-learning (UDL), which provides design principles to reduce barriers at the outset (Meyer et al., 2014). Research on family–school partnerships emphasizes relational trust and culturally responsive engagement as drivers of equity (Epstein & Sheldon, 2022). Positioned within this scholarship, the present article contributes practice-based evidence for operationalizing equity and inclusion in a multilingual, high-stakes context where the language of schooling acts as an institutional gatekeeper.

2. The Educational Context for NCS Kindergarteners in Hong Kong

Even though this analysis focuses on Hong Kong, its challenges are familiar to other rapidly diversifying urban centers in the GBA, although they have very different contexts. For example, cities like Guangzhou and Shenzhen are also experiencing inward migration, but their non-local populations are primarily internal migrants from other parts of mainland China, creating different linguistic and cultural integration dynamics (Haugen, 2019). Meanwhile, Macau's education system operates with a distinct Portuguese-Cantonese bilingual heritage. Despite these differences under the "one country, two systems" framework, common underlying tensions, such as home-school language gaps, the need for specialized teacher training, and the pressure to integrate diverse student bodies, are emerging across the region (Xie et al., 2023). This section, therefore, frames Hong Kong as the focal case while noting convergences and divergences to inform cautious policy learning rather than claims of direct transfer.

2.1. The Evolving Policy Landscape for NCS Students

The policy landscape for ECE in Hong Kong has undergone a significant evolution, moving from decades of a laissez-faire approach to a more interventionist stance. For most of its history, the ECE sector was a market-driven system where parental demand for academic rigor often overshadowed holistic development (Wong, 2022). The government's first major attempt to steer the sector, the Pre-Primary Education Voucher Scheme (PEVS), introduced in 2007, was ultimately criticized for its insufficient funding and failure to address systemic quality issues (Wong & Rao, 2022).

This well-intentioned but flawed first step directly led to the landmark implementation of the KES in the 2017–2018 school year. The new scheme was designed to be a more comprehensive solution, with its direction explicitly guided by the mission stated at the forefront of the *Report of the Committee on Free Kindergarten Education*:

> To provide for a sustainable policy that respects the uniqueness of [kindergarten] education in Hong Kong as well as the diverse needs of children, and to provide for equitable access to quality holistic [kindergarten] education that promotes lifelong development of a person. (Committee on Free Kindergarten Education, 2015, p. ii)

While a central component of this mission was the principle of "catering for student diversity," the initial implementation of the KES created significant practical barriers for kindergartens seeking to support NCS students. The first was a pedagogical challenge: to receive subsidies, kindergartens were required to adopt the local "mother tongue" (i.e., Chinese) as the primary medium of instruction, a policy that placed immediate pressure on institutions needing to develop Chinese language support from a low base (Tse et al., 2020). This was compounded by a financial barrier. The government introduced a funding mechanism that provided substantial subsidies only to kindergartens admitting eight or more NCS students. This "all-or-nothing" threshold drew immediate criticism from advocacy groups like the Equal Opportunities Commission, Hong Kong Unison, and Oxfam Hong Kong, who argued it failed to support kindergartens with smaller numbers of NCS children and was a disincentive to wider inclusion (Wong et al., 2022).

The government revised the policy in the 2019–2020 school year in response to persistent advocacy regarding the funding model. It replaced the problematic threshold with a more granular five-tiered subsidy system. This new model provides a graduated scale of funding, with schools receiving different levels of financial support based on which tier their number of NCS students falls into (e.g., Tier 1 for 1–5 students, Tier 2 for 6–10 students, and so on; see Education Bureau, 2024). The critical change was that kindergartens with even a single NCS student could now receive some support, thereby removing the disincentive for mainstream schools to begin their inclusion journey. It is this revised policy context that frames the present study.

2.2. Converging Pressures: Language, Segregation, and the Critical Kindergarten Stage

The policy landscape operates within a high-stakes linguistic environment. Hong Kong's official language policy promotes "biliteracy and trilingualism," aiming for proficiency in written Chinese and English, and spoken Cantonese, Putonghua, and English (Evans, 2013; Wong, 2023). While English is an official language and holds prestige in the business and tertiary education sectors, the sociolinguistic reality of the local

community is overwhelmingly Cantonese-speaking. Cantonese is the usual language for over 90% of the population (Census and Statistics Department, 2024), and this is reflected in the local school system, where the vast majority of primary and secondary schools use Chinese as the medium of instruction. Consequently, proficiency in Chinese functions as a powerful gatekeeper to educational and career advancement (Hong Kong Unison, 2016, 2020; Ke & Tucker, 2015; Tse et al., 2020).

This reality is compounded by a legacy of "de facto segregation," which was intensified by the government's former "designated schools" policy (Gao, 2023; Hong Kong Unison, 2015; Siriboe & Harfitt, 2017). Although this policy, which channeled NCS students into a limited number of schools, was officially abolished in 2013 to promote integration, research shows its effects linger. A high concentration of NCS students persists in certain kindergartens, many of which continue to adopt English as the medium of instruction (Tse et al., 2020). This systemic inertia directly impedes language learning by depriving students of an immersive Chinese environment. It hinders their social integration and development of a dual identity as both members of an ethnic minority and fully integrated Hong Kong citizens (Cunanan, 2011; Gu & Tong, 2021). The KES policy, particularly its revised funding model, directly attempts to counteract this legacy by incentivizing mainstream kindergartens to become the new frontline for inclusion.

The kindergarten years (ages three to six) represent the crucible where these systemic challenges converge. This period is the most critical juncture for NCS students, where developmental, systemic, and practical pressures intersect. Developmentally, it is the most important window for language acquisition. The scale of this challenge is immense: research shows that native Cantonese-speaking children have mastered a full range of complex interrogative forms by age three (H. Li et al., 2013). This means an initial gap in Chinese proficiency for an NCS child tends to widen over time, creating a cumulative deficit that becomes increasingly difficult to overcome (B. Li et al., 2020). Systemically, it is the first official entry point into Hong Kong's high-stakes educational pipeline. Practically, kindergartens must now navigate these demands while facing the operational barriers of staff shortages and resource gaps identified in our foundational survey (Wong et al., 2022). Therefore, the central challenge is understanding how proactive kindergartens successfully manage this confluence of pressures to provide the foundational support essential for educational equity.

3. The Present Study

3.1. From Problem Identification to a Strength-Based Inquiry

The literature reveals a clear policy shift towards greater inclusion and points to significant systemic and linguistic barriers. A foundational survey was conducted for this research project to investigate the impact of the revised KES funding policy, collecting data from 161 kindergartens across Hong Kong (Wong et al., 2022). The results painted a complex picture. On the one hand, the policy was successful in its primary aim: the financial incentives significantly increased the willingness of mainstream kindergartens to admit NCS students, a crucial first step toward integration. On the other hand, the survey also uncovered significant and persistent systemic barriers that funding alone could not solve. The report identified three critical areas of challenge:

- Human resource deficits: Kindergartens reported acute difficulties recruiting and retaining staff with the necessary language skills and cultural competence to support NCS children and their families.

Many frontline teachers felt ill-equipped, lacking specific training in second-language pedagogy for young learners.

- Insufficient home-school communication: Establishing effective partnerships with NCS parents was a major hurdle. Barriers included language differences, a lack of translated school materials, and a perceived cultural gap in understanding parental engagement expectations.
- Institutional isolation: A pervasive theme was that kindergartens felt they were "on their own." They reported a lack of centralized support, practical guidance, and shared resources from government bodies, forcing each kindergarten to "reinvent the wheel" in developing its own strategies and materials.

The quantitative data demonstrated that while the government's policy succeeded in opening the door to access, it did not provide the systemic support needed for a high-quality experience once students were inside. The survey mapped the problems; this qualitative study was designed to discover how they are solved by examining the practices of proactive and successful kindergartens.

3.2. Conceptual Framework and Research Questions

Rejecting a traditional deficit-oriented perspective that concentrates on the shortcomings of students and institutions (Valencia, 2010), this study instead adopts a strength-based approach. The intellectual roots of this perspective can be traced to pioneers like Bertha Capen Reynolds, who challenged the prevailing pathology-focused models of her time (Reynolds, 1951). This philosophy was later formally articulated as a specific practice model (Weick et al., 1989) and synthesized for broader application (Saleebey, 2012). The approach's central tenet is that an organization should identify and build upon the existing assets of the people it serves. This principle is directly relevant to the school context. It prompts an institution to view students' and their families' cultural and linguistic assets, often termed "funds of knowledge" (Moll et al., 1992), not as barriers to overcome but as valuable resources. This perspective uniquely suits this study's goal of moving beyond problem identification to uncover replicable, successful practices.

This strength-based philosophy is operationalized through the CARE model, an analytical framework developed specifically for this research project (Wong et al., 2022). The model was developed as a synthesis, informed by theories like appreciative inquiry (Hammond, 2013), ecological systems theory (Bronfenbrenner, 1979), the findings from our prior quantitative research, and local policy analysis. The unique linguistic and policy context of Hong Kong necessitated a framework that could capture the dynamic interplay between internal institutional drivers and external supports. While established frameworks like Bronfenbrenner's (1979) ecological systems theory provide a broad map of environmental influences, the CARE model offers a more focused lens on institutional agency. Unlike frameworks such as Booth and Ainscow's (2011) Index for Inclusion, which is comprehensive in scope, the CARE model specifically emphasizes institutional aspirations to investigate the role of institutional mission and values in driving inclusive practices. The model deconstructs institutional efforts into four interrelated domains. Capability refers to the kindergarten's internal assets and existing abilities, such as staff expertise and established school-based curricula. Aspirations concern the institutional values, vision, and active commitment to supporting NCS students. Resources examine the strategic use of external support, from government subsidies to community and parental partnerships. Finally, engagement focuses on the strategies and actions the kindergarten undertakes, representing the tangible manifestation of the other three components in areas like pedagogy and home-school communication.

Our foundational quantitative study confirmed a strong perception of interconnectivity among these four domains (Wong et al., 2022). However, while that study established that a relationship existed, it could not explain the operational dynamics of *how* these components influence one another in practice. Therefore, understanding the precise nature of these relationships within a real-world context forms a central goal of the present inquiry. This framework guides the inquiry through the following research questions:

1. How do these kindergartens intentionally build their internal *capacity*, including staff expertise and school-based curricula, to effectively support a diverse student body?
2. What are the *aspirations*, core values, philosophies, and motivations that drive successful kindergartens to champion the inclusion of NCS students?
3. How do they strategically mobilize and creatively deploy *resources*, including government funding, community partnerships, and parental capital, to achieve their inclusive goals?
4. What specific, tangible strategies in pedagogy, curriculum design, and home-school communication do these kindergartens implement to put their inclusive vision into practice? How do they *engage*?

4. Methodology

This study employed a qualitative case study approach to gain an in-depth understanding of the successful strategies used by Hong Kong kindergartens to support NCS students. The selection of cases was guided by a "positive deviance" or exemplar logic, intentionally focusing on high-performing outliers from an award scheme to identify feasible solution pathways that emerge under common constraints (Bradley et al., 2009; Flyvbjerg, 2006). The primary objective of this research design is not statistical generalizability but analytic transferability. This is achieved by capturing the rich, contextualized, and multifaceted nature of real-world educational practices, thereby providing a deep understanding that can inform practice in other settings (Yin, 2017).

4.1. Data Collection

Data for this study were drawn from two primary sources: comprehensive written reports from the award scheme and follow-up interviews with school leaders.

The first consists of 16 comprehensive case reports, all written in Chinese, submitted by the participating kindergartens. These reports are rich in detail and contain narrative descriptions of institutional philosophies and strategies, supported by evidence such as lesson plans, activity photographs, and samples of parent communication materials. Altogether, this documentary corpus constitutes 59,459 Chinese characters and 366 image files.

The second source comprises 10 follow-up interviews conducted in Cantonese with principals and lead teachers. These interviews were designed to probe deeper into the motivations, challenges, and practical details of the strategies described in the reports. These interviews were conducted in two distinct formats: First, the four finalist kindergartens were invited to 30-minute judging interviews with the principal and, in some cases, a lead teacher, allowing for a more detailed exploration of their work. Second, supplementary phone interviews were conducted with key personnel from six other participating kindergartens to gather additional clarifying information.

4.2. Data Analysis

To ensure the reliability and validity of the findings, a rigorous, multi-stage thematic analysis process was implemented, following the principles outlined by Braun and Clarke (2006). Before the main analysis, the interviews conducted in Cantonese were transcribed semi-verbatim. All subsequent analysis was performed on the original Chinese texts from the reports and the transcribed interviews to preserve the nuances of the original language.

A novel dual-coder strategy was adopted, utilizing both a human researcher and a large language model (LLM) to analyze the data independently.

Stage 1 was the initial human-led analysis: A trained human research assistant first immersed herself in the entire dataset, which included the anonymized text from the 16 case reports and the transcripts from the 10 interviews. She conducted an initial round of open coding to identify emergent patterns and concepts within the data. Following this, she organized these initial codes into potential themes, guided by the four domains of the CARE model, creating a preliminary thematic map.

Stage 2 implied an independent LLM-powered analysis: To enhance inter-coder reliability and mitigate the potential for single-coder bias, the same anonymized textual dataset was then analyzed by a second coder—Google's Gemini 2.5 Pro. This model was specifically chosen for its state-of-the-art capabilities, which are highly suited to large-scale textual analysis (Doshi, 2025). A key advantage of Gemini 2.5 Pro is its huge context window (1 million tokens), which allows it to process and reason over the entire data corpus, including all 16 reports and 10 interview transcripts, in a single, coherent pass. This technical capacity is crucial for identifying overarching themes and subtle connections across the full dataset without chunking or segmentation, which can lead to fragmented analysis. The general methodological approach of using an LLM as a second coder is supported by research showing that it can increase the efficiency and reliability of qualitative analysis by mitigating single-researcher subjectivity (Bano et al., 2024; Dai et al., 2023). The LLM was given a specific persona as a qualitative research assistant. The prompt provided the definitions for the four CARE domains and then instructed the model to analyze the entire anonymized data corpus. Its core task was to identify emergent themes from the text, provide a brief definition for each theme, and then organize them under the most appropriate CARE domain. The prompt was designed to be open-ended, explicitly instructing the model to generate themes based solely on patterns found within the provided data and not to introduce external knowledge or preconceived conclusions.

Stage 3 implied triangulation and thematic refinement: The principal investigator performed a triangulation process. For this type of emergent thematic analysis, a qualitative triangulation process was deemed more appropriate for ensuring rigor than a quantitative inter-coder reliability metric. The thematic map generated by the human research assistant was compared against that of the LLM's. Themes that showed high convergence between both coders were considered robust and were adopted into the final thematic framework. Instances of divergence, where one coder identified a theme that the other did not, or where themes were categorized differently, were flagged. These points of divergence were not treated as errors but as areas requiring deeper interpretive analysis. For example, the divergences were often instructive: The LLM excelled at identifying the frequency and explicit co-occurrence of concepts across the entire dataset (e.g., noting that nearly all kindergartens linked government funding to hiring staff), while the human

coder was more adept at capturing subtle, context-dependent nuances in tone (e.g., distinguishing between principals who spoke of funding as a bureaucratic necessity versus those who saw it as empowering). The author returned to the original data in these specific areas to critically examine the nuances of the text and make the final determination of the thematic structure. This human-in-the-loop approach is important for mitigating the inherent biases in a model's training data. This dual-coder process, combining human interpretive depth with the systematic pattern-recognition capabilities of an LLM, ensures a comprehensive and trustworthy analysis of the data.

4.3. Ethical Considerations

All data collection and analysis procedures adhered to strict ethical guidelines. Informed consent was obtained from all participating kindergartens and interviewees. All data, including case reports, interview transcripts, and photographs, were fully anonymized prior to analysis to protect the identities of the institutions, staff, and children. This anonymization was performed before any analysis, ensuring that no personally identifiable information was processed by either the human researcher or the LLM.

5. Findings

The data analysis revealed a consistent pattern. Kindergartens that successfully cultivated inclusive environments did not rely on a single initiative but instead implemented a holistic ecosystem of mutually reinforcing strategies. These practices, which aligned with the four domains of the CARE model, demonstrated that effective inclusion was a deliberate, multifaceted, and proactive endeavor.

5.1. Capability: Building an Inclusive Organizational Foundation

The journey toward inclusion began with the deliberate cultivation of internal organizational capabilities. These foundational strengths, encompassing staff expertise, collaborative structures, and school-based curricula, empowered kindergartens to move from well-intentioned ideas to effective, sustainable practice. Proactive kindergartens demonstrated remarkable agency in systematically building this internal capacity.

A primary strategy was a deep and continuous investment in teacher professional development. The data showed a clear pattern of kindergartens sending their staff, from principals to frontline teachers, to specialized training programs (Cases 02, 05, 12, 13, 15, 16). These programs, offered by local universities (Cases 01, 02, 13) and large-scale projects (Cases 01, 04), equipped educators with evidence-based pedagogical knowledge for teaching Chinese as a second language. This training was not a passive exercise; it actively built a shared professional language and collective confidence in tackling the challenges of inclusion.

Importantly, this knowledge was shared throughout the institution through robust internal mechanisms. Kindergartens strategically established a culture of professional growth where expertise was distributed rather than siloed. Leaders who completed advanced courses often served as internal "seed teachers" (Cases 01, 14), sharing their learning through peer observations, collaborative lesson planning, and regular staff sharing sessions (Cases 02, 03). As one case report described, after the principal and director completed a university course, they would "share the teaching skills and key points learned from the course with [all] teachers, to enhance their professional knowledge and skills" (Case 13). This "whole-school participation" model transformed individual training into a collective organizational capability.

Furthermore, these kindergartens built capacity by formalizing their commitment through specialized roles and teams. Many used government subsidies to create dedicated positions such as NCS support teachers or multicultural teaching assistants (Cases 02, 03, 04, 05, 06, 15). These staff members provided targeted academic support and were vital cultural liaisons with families. This human infrastructure was often supported by formal teams, such as an "NCS support group" (Case 12) or a dedicated "function group" (Case 04), which brought together specialist teachers and social workers to coordinate support efforts, ensuring that inclusion was a structural priority.

Finally, the most experienced kindergartens solidified their capability through the development of sophisticated school-based curricula and assessment tools. These kindergartens evolved from consumers of generic materials to producers of tailored solutions. For instance, one kindergarten developed a comprehensive, three-tiered system of picture books and assessment instruments for different proficiency levels (Case 14), while another systematically integrated "character component pedagogy" with custom-made learning materials (Case 02). This capacity for curriculum innovation, often built upon a decade or more of experience (Cases 01, 11, 14), signaled a mature and deeply embedded institutional capability. This growing foundation of practical skills and proven strategies appeared to energize the kindergartens' guiding philosophies, giving them the confidence to embrace an even more ambitious vision for inclusion.

5.2. Aspirations: The Driving Philosophy of Inclusion

Fueled by this growing sense of competence, a robust set of institutional aspirations provided the "why" that gave meaning and direction to the kindergartens' actions. This guiding philosophy was the engine for their inclusive efforts, giving them the confidence to pursue a higher mission.

First, a core aspiration was an unwavering belief in equal educational rights. Kindergarten leaders consistently articulated a mission of "education for all," viewing NCS children as integral members of Hong Kong society who deserved every opportunity to succeed (Cases 01, 09, 15). This was strongly conveyed in one case report:

> We believe that all children, regardless of their race, religion, or social class, should enjoy the basic right to equal education. Ethnic minority children are also a part of Hong Kong and will participate in building Hong Kong's future. (Case 01)

Others clarified that commitment persisted regardless of funding fluctuations: "Even if government subsidies were removed, our commitment to admit and teach NCS learners would remain" (Interview 08). This conviction served as a non-negotiable principle that drove decision-making, framing inclusion not as a choice but as a moral imperative.

Second, successful kindergartens intentionally reframed the narrative around diversity, shifting from a mindset of tolerance to one of celebration. Instead of viewing NCS students as a "challenge," these kindergartens perceived cultural diversity as an invaluable asset for the entire kindergarten community (Cases 03, 13, 16). They aspired to foster mutual respect and enhance the cross-cultural sensitivity of local children (Cases 03, 08). This reframed the "problem" of supporting NCS students into an "opportunity" to enrich the educational experience for all.

Third, these aspirations were grounded in a strategic vision of early intervention. School leaders recognized that the kindergarten years represented a critical window for language acquisition. They believed that providing effective Chinese language support from the outset was essential for adapting to the local curriculum and ensuring a smooth transition to primary schools (Cases 04, 15). This foresight resulted in a clear institutional goal: creating a rich Chinese language environment to build a solid linguistic foundation for long-term academic success.

5.3. Resources: Strategic Mobilization Beyond the School Gate

Proactive kindergartens understood that their internal capabilities and clear vision were amplified exponentially when they acted as strategic brokers, actively drawing in and integrating external resources. They demonstrated significant agency in weaving together support from the government, academia, community organizations, and parents into a multi-layered support network.

The strategic use of government funding served as foundational seed capital. Kindergartens utilized the NCS subsidy provided under the KES to build their core human infrastructure. Reports consistently indicated that this funding was primarily used for hiring additional staff, such as NCS support teachers (Cases 01, 03, 04, 05, 11), purchasing specialized teaching materials like reading pens (Cases 05, 11, 14), and financing cultural inclusion activities (Cases 05, 13). One principal described the difference funding made to the breadth of action: "Without government subsidies, the school would be less proactive with translation, outreach, and searching for external resources" (Interview 11).

With funding, kindergartens actively pursued deep collaborations with universities and professional organizations (Cases 01, 02, 04, 05, 12). They participated in large-scale support programs such as C-for-Chinese@JC (https://cforchinese-jc.hk) and Start From the Beginning (https://kgcsl.edu.hku.hk). The value of these partnerships extended far beyond free materials; a significant benefit highlighted in the reports was the on-site professional support from university-affiliated experts who engaged in co-planning and lesson observation, directly elevating the quality of instruction (Cases 01, 03, 04).

A third pillar of support was the establishment of a tight-knit community network. Most kindergartens partnered with NGOs to provide on-site social work services (Cases 04, 09, 10, 12, 16). These social workers were invaluable, offering professional counseling, organizing parent workshops, and connecting families with wider community resources and financial aid (Cases 04, 11). This expanded the kindergartens' function from purely educational to holistic family support.

Finally, these kindergartens transformed parents from passive recipients into active partners and resources. They systematically created opportunities for parents to contribute their unique knowledge. Many had established robust parent volunteer teams, inviting NCS parents to share their culture, prepare traditional foods, or assist in school activities (Cases 03, 06, 12, 13). This approach enriched the kindergartens' cultural lives, validated parents' expertise, and empowered them as key contributors.

5.4. Engagement: Putting an Inclusive Vision into Action

The tangible success of these kindergartens lies in their proactive engagement strategies. These concrete actions were the logical culmination of their guiding aspirations, enabled by their internal capabilities and

fueled by the resources they had skillfully mobilized. This was where vision became a reality for every child and family.

5.4.1. Inclusive Pedagogy and Curriculum

Kindergartens strategically engineered a rich and effective Chinese learning environment. They employed differentiated instruction, such as pull-out small groups (Cases 05, 13) and ability-based learning (Case 14), to provide focused support. A key mechanism was peer-mediated learning, where NCS students were paired with Chinese-speaking peers to create authentic, low-stakes communicative situations that formal instruction could not replicate (Cases 07, 09, 14). Learning was made engaging through game-based and drama-based approaches, including role-playing (Case 16) and classroom theater (Case 02), which were supported by innovative teaching aids like reading pens (Cases 09, 14, 16) and teacher-made materials (Cases 02, 10, 16).

5.4.2. Holistic Home-School Partnership

Recognizing language as a barrier, kindergartens implemented a multi-pronged communication strategy. This included direct linguistic support through bilingual staff (Cases 06, 09) and translated school materials (Cases 09, 11, 16). More profoundly, they focused on building trusting relationships through proactive outreach. One kindergarten described its strategy of making "sunshine calls," where "teachers will periodically call parents every month…to understand the child's situation at home and let parents know about the child's learning performance at school" (Case 09). The goal was to establish a positive connection before any problems arose. This was supplemented by home visits (Case 03). Most importantly, they worked to empower parents as educational partners. They achieved this by organizing workshops for NCS parents on supporting Chinese learning at home (Cases 02, 03, 05, 13) and actively involving them in school governance and activities through parent-teacher associations and volunteer teams (Case 03).

5.4.3. Dual-Cultural Validation and Celebration

The engagement strategies revealed a sophisticated process of dual-cultural validation. Kindergartens first validated a child's home culture through events like International Day, where families shared traditions and food (Cases 09, 12, 16). This built self-esteem and signaled institutional respect. Having established this foundation of security, they then guided students to explore and participate in local traditions, such as celebrating the Chinese New Year (Case 07), visiting a dim sum restaurant (Case 01), or exploring community facilities (Case 13). This dual approach fostered a hybrid identity, allowing children to see themselves as both members of their ethnic group and full members of the Hong Kong community.

5.4.4. Nurturing Emotional Well-being and Confidence

Finally, kindergartens demonstrated that academic learning was intrinsically linked to emotional security. They paid special attention to the initial adaptation period for new students, using strategies like allowing a comfort object from home and decorating the classroom with family photos to create a sense of safety (Case 11). They systematically worked to build student self-confidence throughout their time at the kindergarten. As one report detailed:

> The school provides more performance opportunities for NCS children in class and gives them more opportunities to share…so they become more confident in expressing their needs and feelings. (Case 09)

They provided NCS students with frequent opportunities to take on leadership roles and perform in front of their peers (Cases 02, 03, 09, 16), celebrating their successes and empowering them to become confident learners.

5.5. Cross-Domain Dynamics: The CARE Ecosystem in Action

The interplay between the CARE domains is best illustrated through the trajectory of a single kindergarten (Case 04). A clear institutional commitment to "laying a solid Chinese language foundation while ensuring students' joyful, whole-person development" (aspirations) was matched and further enabled through direct investment in capability, such as hiring specialist teachers and ensuring staff were well-qualified. This strong foundation of intertwined vision and expertise empowered the leadership to broker external resources effectively, securing government funding and NGO partnerships for teacher training and on-site social work. These assets were then converted into concrete Engagement practices, including targeted instruction and robust home-school communication. The positive outcomes created a reinforcing feedback loop: Word-of-mouth reputation led to increased NCS enrollment, and successful new practices like teacher exchanges were institutionalized to support student transitions. This vignette exemplifies the central dynamic observed across the findings: an internal engine, powered by the reciprocal relationship between aspirations and capability, allows a kindergarten to leverage resources for effective engagement. At the same time, this entire process is shaped by boundary conditions, as principals in other contexts noted that factors beyond their control, such as local demographics and a community's religious profile, can limit student intake despite a kindergarten's inclusive vision and enthusiasm (Interviews 01 & 08).

6. Discussion

The findings illustrate a clear ecosystem of inclusive practices within proactive kindergartens. This discussion synthesizes these results through the CARE model to interpret their meaning, explores their broader implications for policy and practice in the GBA and beyond, and proposes avenues for future research.

6.1. The CARE Ecosystem: A Dynamic Model of Inclusive Practice

As illustrated in Figure 1, the central argument emerging from this study is that successful inclusion is not achieved through piecemeal initiatives but through a synergistic "ecosystem" where capability, aspirations, resources, and engagement are deeply interconnected and reinforce each other. This model provides a direct, practice-based answer to the systemic barriers of human resource deficits, poor home-school communication, and institutional isolation that our foundational survey identified (Wong et al., 2022). The CARE ecosystem, in effect, serves as an operational blueprint for the "dynamic whole-school supportive structure that embraced heterogeneity," which Wong (2023) identified as essential for success in multicultural educational settings. It is also a powerful manifestation of the strength-based approach (Saleebey, 2012) that this study adopted, consciously moving away from the deficit thinking that often characterizes discussions around minority education (Valencia, 2010).

In this ecosystem, capability and aspirations reinforce each other in a virtuous loop. Small wins in practice (for example, more parents taking part or children using Cantonese during play) boost staff confidence and strengthen the kindergarten's shared purpose. That stronger purpose then justifies and motivates further investment in staff skills and tools. This internal momentum, in turn, makes it easier to mobilize external Resources and to engage parents as active partners who contribute their "funds of knowledge" (Moll et al., 1992). These pieces come together in concrete engagement. Engagement is not the endpoint; it feeds back into the system by building new skills, reaffirming values, and widening resource networks. This reinforcing effect was also strongly affirmed in our foundational survey, where respondents commonly agreed that supporting NCS students and parents helped increase their capability (90.8%), aspirations (97.7%), and resources (88.4%; see Wong et al., 2022). Over time, these feedback loops make the whole system more resilient and adaptive.

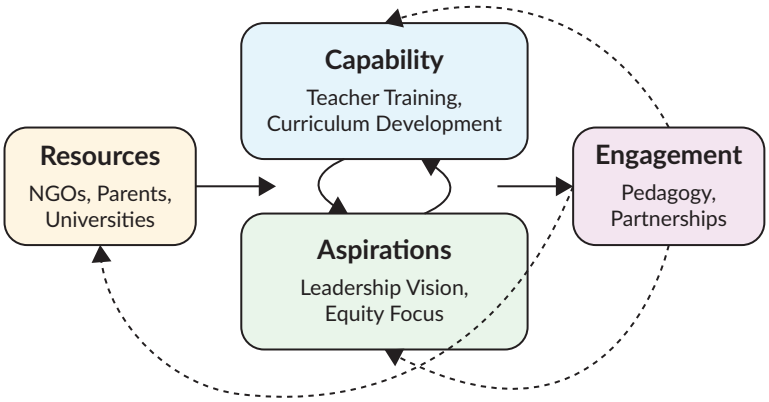

Figure 1. The CARE ecosystem of inclusion as a dynamic system.

6.2. Theoretical Contributions and Framing of the CARE Model

To ground this framework in established theory, the CARE model can be understood as an application of ecological systems theory (Bronfenbrenner, 1979) to the specific context of school-level inclusion. The internal capability and aspirations represent the core of the school's microsystem. The mobilization of resources and the practice of engagement reflect the critical processes in the mesosystem, where the school actively connects with families, community organizations, and other institutions. Government policy, such as the KES, acts as a key feature of the exosystem influencing the school's operations. Furthermore, the virtuous cycle between capability and aspirations can be seen as a form of organizational learning, where early successes foster a collective efficacy that encourages the institution to move from single-loop learning (improving existing strategies) to double-loop learning (questioning and reshaping the core mission and values of the school itself).

This theoretical view maps directly onto what the cases show in practice. Inclusive pedagogy appears in teachers' high expectations coupled with concrete supports, instead of separating children into "additional needs" groups (Florian & Black-Hawkins, 2011). UDL is visible in routines that give children multiple ways to join in, understand, and express themselves (Meyer et al., 2014). Day-to-day peer-buddy work and brief translanguaging moments create frequent, low-pressure chances to use Cantonese while building a sense of belonging and hybrid identity (García & Wei, 2014; Gu & Tong, 2021). At the mesosystem level, leaders act as brokers: They turn policy subsidies, university partnerships, and NGO support into stable capacity, not

one-off activities. In short, the microsystem (capability and aspirations) and mesosystem (resources and engagement) operate together, exactly as ecological theory would predict, and the observed feedback between small wins and renewed commitment aligns with organizational learning.

The primary theoretical contribution of the CARE model lies less in the novelty of its parts and more in how it integrates them and explains their reciprocal effects. CARE highlights how capability and aspirations fuel each other, how resources are brokered to support engagement, and how engagement feeds back to strengthen the whole. This dynamic view shifts attention from "what schools have" to "how schools grow" over time.

6.3. Lessons for the GBA and Beyond

The findings from these Hong Kong kindergartens offer a useful model of social integration for other rapidly diversifying urban contexts, particularly within China's GBA. While cities like Shenzhen and Guangzhou face similar challenges of cultural diversity and de facto segregation (Haugen, 2019; Hu, 2025; Xie et al., 2023), the "one country, two systems" framework requires a nuanced approach to policy learning. The key lesson is not to copy specific activities but to adapt the underlying principles of the CARE model. For instance, this could involve practical actions such as piloting mentor-school networks that connect experienced institutions with those newer to the challenge, focusing on shared issues like home-school language gaps and the risk of segregation. Another possible action would be to create recognized micro-credentials in early years Chinese as a Second Language to build teacher capability systematically. Both initiatives, however, would need to be co-designed with local communities to ensure cultural and linguistic fit, embodying the adaptive spirit of the CARE model itself.

This focus on adapting core principles, instead of replicating specific activities, is precisely what gives the model its global relevance. The challenge of overcoming "de facto segregation" (Gao, 2023; Siriboe & Harfitt, 2017) and its detrimental impact on language acquisition and social integration remains a persistent issue in multicultural cities worldwide. The principles embedded in the CARE model are easily transferable. The strategy of "dual-cultural validation," for instance, offers a sophisticated pedagogical approach to fostering the hybrid identities that characterize successful integration in multicultural societies (Gu & Tong, 2021; Ward et al., 2018; Wong & Wong, 2024). It illustrates how schools can simultaneously affirm a child's heritage while cultivating a sense of belonging within the host community. While specific activities must be adapted to local contexts, the core process of building internal capacity, aligning it with institutional values, and utilizing community assets provides a robust and universally applicable framework for advancing the United Nations' goal of equitable and inclusive education for all (UNESCO, 2017).

6.4. Implications for Policy and Practice

The findings generate several actionable implications for policymakers and practitioners serious about moving from rhetoric to reality in educational equity.

For policy, the primary lesson is the need to evolve beyond financial subsidies as the sole instrument of change. While funding is a critical enabler, it is insufficient on its own, a conclusion that reinforces critiques of earlier, less holistic voucher schemes (Wong & Rao, 2022). A more sophisticated policy approach would focus on building systemic capacity. For instance, creating government-funded "mentor kindergarten"

programs would institutionalize the transfer of best practices from exemplary institutions to those beginning their inclusion journey. However, for such an initiative to be effective and fair, it needs to be designed considering practical realities. It would require a dedicated funding stream integrated into existing ECE budgets. There should also be clear incentives for participating mentor staff, such as professional development credits, salary recognition, or workload adjustments. Moreover, it is important to have a targeted allocation mechanism to ensure that marginalized and under-resourced schools have priority access. Similarly, to address the persistent human resource deficit, policy could move to professionalize the role of multicultural support staff. This means creating dedicated career pathways and recognized salary scales, transforming what is often a temporary position into a sustainable and valued profession within the education ecosystem.

Although such a top-down policy is necessary to create an enabling environment, the findings reaffirm that its success depends on bottom-up practice and visionary leadership. For school leaders, the CARE model can serve as a diagnostic and strategic planning tool. They can use its four domains to self-assess their institution's strengths and weaknesses, identifying, for example, whether a lack of engagement stems from a deficit in capability or a weakness in external resources. The entire CARE ecosystem is predicated on the aspirations set by principals and their management teams, who must possess what Wong (2023) terms a "global vision and an open mind" (p. 15) to champion an unwavering institutional commitment to equity. This framework encourages leaders to see parents not as a communication challenge but as essential partners and to foster a whole-school culture where inclusivity is the foundation of all practice, not a peripheral program.

6.5. Limitations and Future Research

This study's insights should be considered in light of its limitations, which in turn illuminate critical directions for future inquiry. The sample consisted of self-selected kindergartens participating in an award scheme, which likely represents a "best-case scenario" of proactive and well-resourced institutions. While studying these exemplars is critical for establishing an empirical benchmark of what is possible within the current policy environment, it risks portraying inclusion as a matter of simply replicating "best practices" without addressing the systemic barriers, such as funding disparities and high staff turnover, that may render such strategies impractical for the average kindergarten. The findings, therefore, should be seen as a "proof of concept" rather than a representation of the typical experience. The findings also rely on the kindergartens' self-reported data; even though interviews provided a layer of validation, the perspectives were primarily those of the educators. The absence of the direct voices of NCS parents and children also means that claims about the success of "holistic home-school partnerships" and "dual-cultural validation" are viewed through the lens of the institution providing the service, not the family receiving it.

These limitations point to several important avenues for future research. First, longitudinal studies are urgently needed to track the long-term academic and social-emotional outcomes of NCS children who experience these holistic inclusion models. Does this strong foundation translate into sustained success in primary school and beyond? Second, research that explicitly centers the voices and experiences of NCS parents and children is crucial for a more complete and detailed understanding of the home-school partnership and the lived reality of inclusion. Third, comparative studies of inclusive practices in other GBA cities, such as Shenzhen or Macau, would provide invaluable insights into how different policy and social contexts shape school-level strategies. Building on the nature of our sample, future research could also

explore the differential transferability of the CARE components, distinguishing between high-investment elements (e.g., hiring specialist staff) and low-cost, high-impact elements (e.g., cultivating inclusive aspirations) that may be more readily adopted by institutions facing greater financial constraints. Finally, future work should explore the professional identities, challenges, and career trajectories of the multicultural teaching staff who form the human infrastructure of these inclusive ecosystems, yet whose own experiences remain largely unexamined.

7. Conclusion

This study moved beyond a diagnosis of systemic barriers to illuminate a pathway toward genuine educational equity. The research revealed that successful inclusion is not the product of isolated programs but of a dynamic institutional ecosystem. The proactive cultivation of internal capability, driven by clear aspirations, amplified by external resources, and realized through meaningful engagement, creates a virtuous cycle of continuous improvement. The CARE model offers more than a set of best practices; it provides a replicable framework for any institution committed to transforming inclusive policy from a noble intention into a lived reality. The work taking place in these kindergartens goes far beyond their classroom walls. They nurture the next generation of global citizens and lay the essential groundwork for socially sustainable and harmonious societies, a core objective for the GBA and the world.

Acknowledgments

The author wishes to thank the participating kindergartens for their invaluable insights. Gratitude is also extended to the panel of award judges, Prof. Hazel Lam, Dr Raees Baig, and Dr Cindy Lam, and to the anonymous reviewers for their constructive feedback.

Funding

The work described in this article was fully supported by a grant from the Equal Opportunities Commission of Hong Kong (R-2020/21–116).

Conflict of Interests

The author declares no conflict of interest.

Data Availability

Due to the nature of the research, data sharing does not apply to this article.

LLMs Disclosure

The LLM Google Gemini 2.5 Pro was used in this study. Its role was to act as the second coder in a dual-coder thematic analysis framework. The LLM independently analyzed the entire anonymized textual corpus (16 case reports and 10 interview transcripts) to generate a thematic map based on the study's analytical framework. This LLM-generated map was then triangulated with the map created by the human coder to enhance the reliability and validity of the final thematic analysis.

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Social Inclusion
2026 • Volume 14 • Article 10868
https://doi.org/10.17645/si.10868

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Open Access Journal

Perceived Social Support and Craftsmanship Spirit in Vocational Students: Mediating Roles of Professional Identity and Identity Recognition

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Submitted: 30 June 2025 **Accepted:** 2 September 2025 **Published:** 13 January 2026

Issue: This article is part of the issue "Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China" edited by Huinan Liu (The Education University of Hong Kong) and Meng Zhang (South China Normal University), fully open access at https://doi.org/10.17645/si.i543

Abstract

In the context of a transforming manufacturing industry globally, skilled talents with a "craftsmanship spirit" are crucial for enhancing industrial competitiveness. While existing research primarily focuses on the development of "craftsmanship spirit" among frontline workers, it often overlooks the cultivation of this spirit in "skill-oriented reserve talents" within higher vocational education. This study, grounded in social support theory, investigates how "perceived social support" among higher vocational students positively influences the development of their "craftsmanship spirit," with "professional identity" and "identity recognition" acting as mediators. To mitigate potential "common method bias," we employed a multi-wave survey design, collecting data from 348 students across three higher vocational institutions at three different time points. The findings reveal that "perceived social support" significantly and positively impacts the development of "craftsmanship spirit" in higher vocational students. Furthermore, both "professional identity" and "identity recognition" are essential mediators in this relationship. This research advances the theoretical understanding of "craftsmanship spirit's" antecedents while offering practical guidance for fostering professional ethics and identity cognition among skill-oriented talents in vocational education.

Keywords

craftsmanship spirit; higher vocational education; identity recognition; perceived social support; professional identity

1. Introduction

In the face of escalating global economic competition, markets are increasingly demanding higher standards of product quality and innovation. Consequently, the manufacturing industry is under immense pressure to transform and upgrade. Central to this transformation is the need for highly skilled personnel who not only exhibit technical prowess but also embody a spirit of innovation and professional dedication. The craftsmanship spirit encapsulates a set of values and attitudes toward work, reflecting the goals individuals consider worthy of pursuit. These internalized goals shape their work preferences and guide their behavior, typically manifesting in qualities such as deep dedication, persistent focus, a drive for skill mastery, and the relentless pursuit of perfection (Gao et al., 2020). Skilled workers embodying the craftsmanship spirit are crucial for enterprise transformation, as they enhance product quality, boost corporate competitiveness, and drive technological innovation.

Existing research on the craftsmanship spirit has predominantly focused on frontline workers in workplaces, examining how individual personality traits and specific motivational strategies foster this spirit (Y. Zhu et al., 2021). However, a significant gap in current literature is the neglect of cultivating this spirit among students in higher vocational education. This research gap is particularly salient given that higher vocational colleges serve as critical institutions for cultivating high-quality skilled talent and play a central role in the national talent development system (Xiong et al., 2024). A systematic investigation into the factors influencing the cultivation of the craftsmanship spirit within this context would not only contribute to the supply of competent professionals for the manufacturing industry but also provide theoretical and practical implications for the reform and development of vocational education. Accordingly, this study shifts the research focus from in-service skilled workers in the workplace to prospective skilled talents being trained in vocational education, aiming to explore the antecedents and underlying mechanisms that foster the craftsmanship spirit among higher vocational students.

Existing literature concerning the antecedents of craftsmanship spirit among students in higher vocational education has primarily centered on three dimensions: individual characteristics of students, the quality of mentor-apprentice relationships, and the structure and content of practical training. In studies concerning personality factors, previous research has mainly investigated the relationship between the Big Five personality traits and the craftsmanship spirit, seeking to identify which personality traits are more conducive to its development. For instance, Z. Li et al. (2024) found that individuals with high conscientiousness and openness are more likely to develop the craftsmanship spirit. Regarding the quality of master-apprentice relationships, Ye et al. (2020) revealed that the interpersonal quality of mentorship within apprenticeship settings significantly contributes to the development of professional attitudes, enhancing skill levels, and fostering the craftsmanship spirit. Furthermore, some scholars argue that mentorship experiences within this relationship are also crucial. The study by Guo et al. (2024), for example, indicated that negative mentorship experiences from masters can inhibit the formation of the craftsmanship spirit by diminishing students' professional identity.

While these studies provide valuable insights into the formation of the craftsmanship spirit, they have largely neglected the important role of perceived social support. This issue is particularly salient within the context of China's vocational education system, where students are often stereotyped as academically underperforming, face pervasive social prejudice, and suffer from inadequate social support (P. Xu, 2024).

Notably, the cultivation of a craftsmanship spirit necessitates not only institutional efforts but also broad-based societal support (Mu et al., 2023). Recognition and support from various sources—including family, school, enterprises, and society—not only bolster students' self-confidence but also create more opportunities for hands-on practice and professional development, thereby contributing positively to the formation of their craftsmanship spirit (Chen, 2018). Accordingly, this study proposes that perceived social support plays a crucial role in promoting the development of the craftsmanship spirit among higher vocational students, who represent a vital reserve of skilled talent.

Social support theory posits that when individuals perceive support from a variety of sources, they tend to experience enhanced psychological well-being (Acoba, 2024). According to social support theory, we propose that perceived social support contributes to the development of positive psychological outcomes among vocational college students, specifically their professional identity and identity recognition. We argue that these identities act as a crucial mediating mechanism through which perceived social support influences the cultivation of the craftsmanship spirit. On the one hand, higher vocational students, who often find themselves in marginalized or discriminated environments, can develop positive psychological attitudes upon receiving substantial social support. For instance, when they perceive understanding and encouragement from their families or receive help and support from teachers and peers, they are more likely to remain committed to their current field of study and prefer future careers aligned with their majors (H. Li, 2024). This fosters a stronger professional identity, motivating them to invest more energy, focus on enhancing their professional skills, actively innovate, and pursue technical excellence (M. Xu, 2024). On the other hand, this study also posits that identity recognition plays a critical role in the development of craftsmanship spirit among vocational college students. Especially in the context of their specific social roles, such as being a skilled talent or vocational student (M. Zhang & Yang, 2022). Identity recognition is the acceptance of one's professional role and identity. It differs from self-efficacy (belief in one's ability) by emphasizing a clear vocational path and long-term commitment (Liao et al., 2023). This makes it a key concept for our study, which examines how social support fosters students' deep acceptance of professional roles and group affiliations. This identity recognition can, in turn, effectively stimulate their passion for mastering professional skills and drive them toward excellence (Q. Li & Tang, 2023). Thus, we argue that social support triggers a dual psychological transformation: It solidifies students' commitment to their chosen field (professional identity) while reinforcing their acceptance of a broader social role as skilled artisans (identity recognition), both of which are crucial for cultivating the craftsmanship spirit.

In summary, grounded in social support theory, this study aims to investigate the relationship between perceived social support and the craftsmanship spirit among higher vocational students, as well as the mediating roles of professional identity and identity recognition in this process. The theoretical and practical contributions of this study are as follows. First, by exploring the relationship between perceived social support and the craftsmanship spirit, our research contributes to the existing literature on the antecedents of the craftsmanship spirit by addressing a previously underexplored factor—external social support. While prior studies have primarily focused on skilled workers in the workplace, emphasizing interpersonal dynamics or personality traits, they have largely overlooked the influence of perceived social support. This omission is particularly important in the context of higher vocational students, who often experience a lack of social support and societal inclusion (X. Lin et al., 2023). Second, by examining the parallel mediating roles of professional identity and identity recognition, this study advances beyond prior research that typically explored the effects of social support through singular cognitive or emotional pathways. It offers a more

integrative perspective by elucidating how perceived social support fosters the internalization of professional values (professional identity) and reinforces a sense of group belonging (identity recognition), thereby promoting the development of the craftsmanship spirit. While earlier studies have tended to frame these mechanisms through isolated lenses—such as emotional regulation, social exchange, or skill acquisition—this research incorporates both identity constructs into a unified theoretical model (see Figure 1). In doing so, it not only deepens the theoretical understanding of how the craftsmanship spirit is cultivated in vocational education but also yields practical implications for educational strategies aimed at nurturing it.

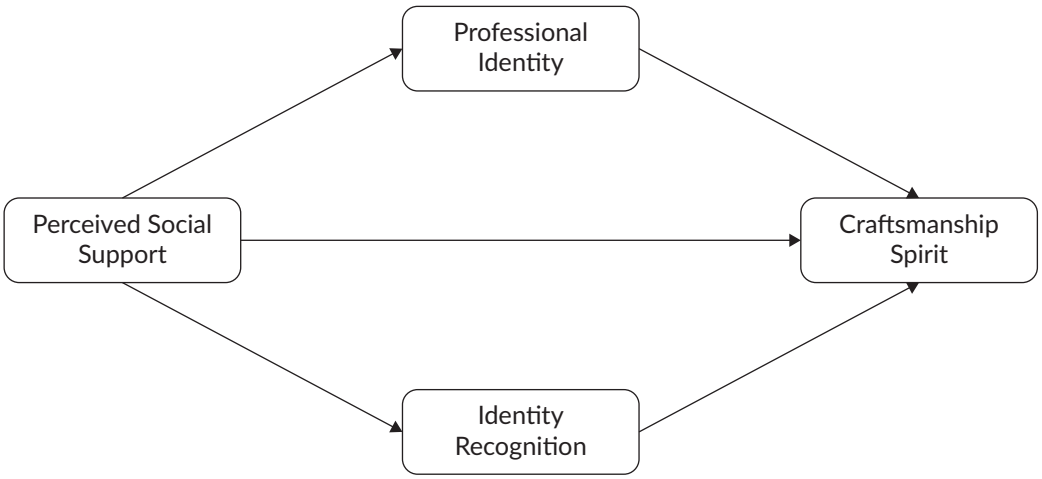

Figure 1. Theoretical model.

2. Theoretical Background and Hypotheses

2.1. Perceived Social Support and Craftsmanship Spirit

According to social support theory, support originating from family, educational institutions, workplaces, and broader societal structures is pivotal for an individual's psychological development and behavioral patterns (Cobb, 1976; Ding et al., 2024). Perceived social support refers to higher vocational students' subjective feelings and evaluations of the extent to which they are supported by others, including emotional experiences of being supported, understood, and respected (Zimet et al., 1988). When vocational college students perceive support and recognition from their social environment, they develop greater confidence in their professional roles, which in turn enhances their intrinsic motivation for learning and work. Moreover, Rautanen et al. (2021) suggest that higher levels of perceived social support are associated with increased individual proactivity. The craftsmanship spirit reflects the value orientation and behavioral tendencies that higher vocational students are expected to embody in their future professional lives (J. Zhou, 2022). It is typically manifested through positive traits such as dedication, pursuit of excellence, concentration, perseverance, and innovation (D. Zhu & Cao, 2025). More than a set of behaviors conducive to career advancement, it represents an intrinsic sense of mission driven by a high level of internal motivation (Liu et al., 2022). Empirical evidence also indicates that social support significantly influences individual work performance (AbuAlRub, 2004; Koh et al., 2018; Zeng et al., 2022) and innovative behavior (Doğru, 2018; G. Li et al., 2018; Xia et al., 2020). Concurrently, increased social support has been shown to enhance the

professional nursing standards of nurses (Kim & Ahn, 2022). The pursuit of work performance and professional excellence, along with proactive and innovative behaviors, represents the core tenets of the craftsmanship spirit. Therefore, we propose the following hypothesis:

> Hypothesis 1: Perceived social support is positively associated with the craftsmanship spirit.

2.2. The Mediating Role of Professional Identity

Professional identity refers to the internal acceptance and endorsement by higher vocational students of the profession they are preparing to enter, which is then translated into external behavioral motivation (D. Xie, Li, & Yin, 2025). Interpersonal interaction and social support are critical influences on students' professional socialization (Yousofvand et al., 2024). On the one hand, emotional support from parents, teachers, classmates, and peers can enhance students' sense of security and self-confidence, thereby fostering more positive attitudes toward learning and development (D. Xie, Li, & Yin, 2025). Perceived support has also been shown to activate students' internal positive cognition and translate into constructive behavioral outcomes (Chong et al., 2018). On the other hand, school-enterprise cooperation—an increasingly adopted model in vocational education—integrates industry into student training, enabling them to acquire professional knowledge, practical skills, and access to internships or on-the-job training (Kong et al., 2023). Such engagement provides support from key social agents, helping students recognize the social value and career prospects of their profession, align personal values with professional demands, and strengthen their identification with and aspiration for future career roles (S. D. Brown & Lent, 2019). Furthermore, empirical research has demonstrated a positive relationship between perceived social support and professional identity, suggesting that a supportive environment plays a pivotal role in shaping students' career self-concept and long-term professional commitment (Huang et al., 2022). Generally, students with a strong professional identity tend to experience a greater sense of belonging to their chosen field, which motivates them to actively adapt and engage in learning to pursue their career goals. This not only helps them overcome psychological challenges such as academic burnout but also fosters intrinsic motivation for sustained participation in professional studies (L. Xu et al., 2023). Such motivation enhances their perseverance in the face of technical difficulties and stimulates innovation, thereby contributing positively to the cultivation of the craftsmanship spirit. Evidence from workplace studies further supports this link: employees with a strong professional identity are more likely to exhibit dedication to their work and invest time and effort in skill development (X. M. Zhang & Chang, 2025). Moreover, professional identity has been shown to positively influence learning engagement (D. Xie, Li, & Yin, 2025) and is significantly associated with the development of the craftsmanship spirit (X. Wang & Xu, 2021). Therefore, we propose the following hypothesis:

> Hypothesis 2: Professional identity mediates the relationship between perceived social support and the craftsmanship spirit.

2.3. The Mediating Role of Identity Recognition

Identity recognition refers to individuals' understanding and articulation of their background, social status, educational experience, major occupation, and the various roles they assume in society (Tan & Nie, 2024). Social support theory posits that the support an individual receives from their social network serves as a

critical resource for managing stress and fostering a positive sense of identity (Jankowska-Tvedten & Wiium, 2023). Accordingly, an individual's identity recognition is significantly influenced by their level of perceived social support, which in turn enables them to maintain and enhance their self-evaluation when facing external challenges. On one hand, when students perceive recognition and support from their social networks, they tend to maintain confidence in their abilities and self-worth, facilitating the internalization and affirmation of a positive self-image. Empirical studies have demonstrated positive correlations between perceived social support and higher vocational students' self-efficacy (Liu et al., 2015) as well as self-affirmation (X. Lin & Cui, 2020). On the other hand, higher vocational students may be influenced by societal stereotypes and disparities in educational resources, career pathways, and institutional status, which can foster feelings of inferiority and a 'second-class' self-perception, potentially leading to identity crises (Tan & Nie, 2024). In this vulnerable context, social support becomes crucial. It helps students build a positive identity as 'skilled talents' by countering negative stereotypes. This enables them to internalize their value as high-quality professionals, thereby solidifying their identity recognition. Consistently, prior research has confirmed the constructive role of perceived social support in shaping positive self-concept among marginalized populations (Chen, 2024; Pratiwi & Mangunsong, 2020). Higher vocational students possess a dual identity as both students and apprentices of skilled talent, and their perception of this dual role significantly influences their engagement and performance in academic and skills training (Xiao et al., 2022). According to social support theory, social support not only directly influences individual mental health but can also enhance learning and work motivation by fostering "identity recognition" (Luo et al., 2024). As an important source of technical and skilled talents, vocational students are more likely to sustain active participation in learning and skill development during their studies if they perceive strong support from schools, families, and society, particularly through adequate affirmation and encouragement in skill growth and career orientation (K. Lin & Xue, 2024). This commitment is essential for achieving technical mastery and preserving a legacy of quality craftsmanship, intimately connected with the cultivation of the craftsmanship spirit. Although direct empirical evidence linking this specific form of identity recognition to the craftsmanship spirit is currently lacking, related research highlights its critical role in professional development—such as among teachers (Gu & Zheng, 2020)—and its capacity to stimulate proactive and exploratory behaviors in workplace settings (Ma et al., 2023). Therefore, we propose the following hypothesis:

> Hypothesis 3:Identity recognition mediates the relationship between perceived social support and the craftsmanship spirit.

3. Research Methods

3.1. Participants and Procedures

Participants were recruited from three vocational colleges in Shenzhen, Guangdong Province, utilizing a random sampling method to minimize selection bias and potential confounding effects. The students were drawn from majors such as mechatronics technology, automobile inspection and repair, and software technology. These majors emphasize the cultivation of professional ethics and practical skills, which are closely aligned with the core values of a "craftsmanship spirit." Prior to the survey, approval was obtained from the administrators of the respective schools. Data collection involved three sets of questionnaires administered at different intervals, each four weeks apart. At the initial time-point (T1), a web link was distributed to 400 students who volunteered to participate. This link directed participants to a webpage

detailing the study's purpose and data collection procedures, ensuring anonymity and confidentiality. The survey included measures of perceived social support and demographic variables. After excluding incomplete responses and outliers, 382 valid questionnaires were retained, yielding a response rate of 95.5%. Four weeks later, at the second time-point (T2), the same 382 participants were invited to assess their professional identity and identity recognition, resulting in 360 valid responses and a response rate of 94.2%. At the third time-point (T3), participants were asked to evaluate their craftsmanship spirit, with 348 complete and matched responses collected, achieving a final response rate of 96.6%. The final sample comprised 155 males (44.5%) and 193 females (55.5%), with 156 first-year students (44.8%), 105 second-year students (30.2%), and 87 third-year students (25.0%).

3.2. Measures

3.2.1. Perceived Social Support Scale (PSSS)

We employed the Chinese version of the PSSS to assess perceived social support, which was originally developed by Zimet et al. (1988) and revised by Jiang (2001). The scale consists of 12 items and is scored on a 7-point Likert scale (from 1 = *very strongly disagree* to 7 = *very strongly agree*). An example item is: "My family can offer me tangible and concrete help." Higher scores indicate a higher level of perceived social support. In this study, the Cronbach's α coefficient for this scale was 0.81.

3.2.2. Professional Identity Scale

We employed the Chinese version of the Professional Identity Scale to assess professional identity, which was originally developed by R. Brown et al. (1986) and later translated by Lu et al. (2007). The scale consists of 10 items and is scored on a 5-point Likert scale (from 1 = *never* to 5 = *always*). An example item is: "This major allows you to utilize your strengths." Items 2, 3, 6, 7, and 10 are reverse-scored. Higher scores indicate a stronger professional identity. In this study, the Cronbach's α coefficient for this scale was 0.82.

3.2.3. Adolescent Identity Recognition Scale

We employed the Chinese version of the Adolescent Identity Recognition Scale to assess identity recognition, which was originally developed by Ochse and Plug (1986) and later translated by Y. Li and Lou (2009). The scale consists of 19 items and is scored on a 4-point Likert scale (from 1 = *very strongly disagree* to 4 = *very strongly agree*). An example item is: "I feel that my lifestyle suits me." Items 1, 2, 4, 8, 9, and 12 through 18 are reverse-scored. Higher scores indicate a stronger identity recognition. In this study, the Cronbach's α coefficient for this scale was 0.89.

3.2.4. Craftsmanship Spirit Scale

We used a scale to measure craftsmanship spirit that was adapted for higher vocational students based on the manufacturing employees' craftsmanship spirit scale developed by Y. Zhu et al. (2021). We adapted the craftsmanship spirit scale to better reflect the context of higher vocational students. For example, items referencing "work" were reframed to address "professional skills learning" or "career planning," aligning with students' current stage of development. While their direct work experience may be limited,

China's vocational education system emphasizes school-enterprise cooperation, providing extensive workplace-based learning through internships and on-the-job training. These opportunities allow students to develop a practical understanding of required skills and attitudes for their future careers, thus grounding their understanding of craftsmanship spirit in the workplace (Colley et al., 2003; Guo et al., 2024). The scale consists of 23 items and is scored on a 5-point Likert scale (from 1 = *never* to 5 = *always*). An example item is: "In my professional skills learning, I pay great attention to detail and strive for perfection." Higher scores indicate a higher level of craftsmanship spirit. In this study, the Cronbach's α coefficient for this scale was 0.91.

3.3. Data Analysis

Data were processed and analyzed using SPSS version 26.0, employing the PROCESS macro (Model 4) to test mediation effects. Hypotheses derived from the theoretical framework were tested to draw conclusions.

3.3.1. Discriminant Validity Test

To examine the discriminant validity among the study variables, a series of confirmatory factor analyses (CFAs) were conducted by Mplus 8.3. Before conducting the CFAs, we noted the large number of measurement items, which could potentially lead to poor model fit if all items were included directly. Furthermore, the primary focus of this study was on the discriminant validity between constructs rather than the inter-item correlations within each construct. Therefore, following the recommendation of Little et al. (2002), an item parceling strategy was employed. Specifically, for constructs measured with five or more items, we created parcels using a random assignment approach. The results of the CFAs are presented in Table 1. As shown, the proposed four-factor model demonstrated an excellent fit to the data, with all fit indices meeting or exceeding recommended academic standards (χ^2/df = 1.200, CFI = 0.995, TLI = 0.994, RMSEA = 0.024, SRMR = 0.021). Moreover, this model provided a significantly better fit than all alternative models. These findings collectively indicate that the main constructs of this study possess strong discriminant validity.

Table 1. Results of CFAs (N = 348).

Measurement model	χ^2	df	χ^2/df	RMSEA	CFI	TLI	SRMR
1. Four-factor model (PSS, PI, IR, CS)	57.597	48	1.200	0.024	0.995	0.994	0.021
2. Three-factor model(PSS,PI+ IR,CS)	3518.843	1949	1.805	0.048	0.786	0.778	0.051
3. Two-factor model(PSS+PI+ IR,CS)	3546.128	1951	1.818	0.049	0.782	0.775	0.051
4. One-factor model(PSS+PI+ IR+CS)	3581.442	1952	1.835	0.049	0.777	0.770	0.051

Notes: PSS stands for "perceived social support"; PI for "professional identity," IR for "identity recognition," and CS for "craftsmanship spirit."

4. Results

4.1. Common Method Bias Test

Due to the reliance on self-reported data from participants, potential common method bias may affect the study results. We conducted a Harman's single-factor test using an unrotated principal component factor analysis of all variables to assess possible common method bias (Podsakoff et al., 2003). The results indicated

that there were 14 factors with eigenvalues greater than 1, and the first factor explained 9.30% of the total variance, which is less than 50%. Therefore, common method bias does not appear to be a significant issue in this study (H. Zhou & Long, 2004).

4.2. Descriptive Statistics and Correlation Analysis

Table 2 presents the correlations among the variables. Perceived social support, professional identity, identity recognition, and craftsmanship spirit were all found to be significantly correlated. Specifically, craftsmanship spirit was significantly and positively correlated with perceived social support ($r = 0.427$, $p < 0.01$), professional identity ($r = 0.549$, $p < 0.01$), and identity recognition ($r = 0.502$, $p < 0.01$), providing a preliminary basis for the subsequent mediation analysis.

Table 2. Means, standard deviations, and correlations among study variables ($N = 348$).

	M	*SD*	1	2	3	4	5	6	7	8
1. Gender	1.55	0.498	1							
2. Grade	1.80	0.813	0.016	1						
3. Registered residence	1.40	0.490	−0.042	0.010	1					
4. Only Child or Not	1.35	0.478	−0.020	−0.021	0.045	1				
5. Perceived Social Support	3.30	0.77	0.048	0.008	−0.055	−0.091	1			
6. Professional Identity	3.29	0.82	0.087	0.047	−0.033	−0.097	0.513**	1		
7. Identity Recognition	3.41	0.62	0.033	0.055	−0.078	−0.076	0.456**	0.591**	1	
8. Craftsmanship Spirit	3.26	0.75	0.040	0.023	−0.030	−0.071	0.427**	0.549**	0.502**	1

Note: * $p < 0.05$,** $p < 0.01$,*** $p < 0.001$.

4.3. Testing the Hypotheses

Hypothesis 1 proposed that perceived social support is positively related to craftsmanship spirit. As shown in Table 3, the relationship between perceived social support and craftsmanship spirit was significant and positive ($\beta = 0.43$, $t = 7.45$, $p < 0.001$). Thus, hypothesis 1 was supported.

Hypothesis 2 proposed that professional identity mediates the relationship between perceived social support and craftsmanship spirit. The results in Table 3 indicate that perceived social support was positively related to professional identity ($\beta = 0.41$, $t = 5.63$, $p < 0.001$), and professional identity, in turn, was significantly and positively related to craftsmanship spirit ($\beta = 0.46$, $t = 9.91$, $p < 0.001$). After including the mediator, the direct effect of perceived social support on craftsmanship spirit remained significant ($\beta = 0.36$, $t = 8.12$, $p < 0.001$). This indicates that professional identity partially mediates the relationship between perceived social support and craftsmanship spirit. The indirect effect (0.19, 95% CI[0.15, 0.45]; see Table 4) accounted for 30.65% of the total effect. Therefore, hypothesis 2 was supported.

Hypothesis 3 proposed that identity recognition mediates the relationship between perceived social support and craftsmanship spirit. As shown in Table 3, perceived social support is positively related to identity recognition ($\beta = 0.56$, $t = 6.25$, $p < 0.001$), and identity recognition is significantly and positively associated with craftsmanship spirit ($\beta = 0.16$, $t = 4.40$, $p < 0.001$). This suggests that identity recognition partially mediates the relationship between perceived social support and craftsmanship spirit. The Bootstrap 95% confidence intervals for the indirect effect (0.08, 95% CI [0.05, 0.16]; see Table 4) and the total effect (0.62, 95% CI [0.52, 0.86]; see Table 4) did not contain zero. Therefore, hypothesis 3 was supported. The indirect effect accounted for 12.90% of the total effect. Overall, the two mediating pathways (professional identity and identity recognition) collectively accounted for approximately 43.55% of the total effect of perceived social support on craftsmanship spirit.

Table 3. Regression analysis results ($N = 348$).

	Craftsmanship spirit		Professional identity		Identity recognition		Craftsmanship spirit	
Predictor variable	β	t	β	t	β	t	β	t
Gender	0.01	−0.11	0.05	1.52	0.00	0.02	−0.02	−0.87
Grade	0.02	0.56	0.04	1.28	0.05	1.23	−0.01	−0.36
Perceived Social Support	0.43	7.45***	0.41	5.63***	0.56	6.25**	0.36	8.12***
Professional Identity							0.46	9.91***
Identity Recognition							0.16	4.40***
R	0.83		0.82		0.66		0.89	
R^2	0.68		0.67		0.43		0.79	
F	47.92		57.53		87.59		58.54	

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4. Bootstrap analysis for the significance of mediation effects.

	Effect	BootSE	BootLLCI	BootULCI
Total effect	0.62	0.03	0.52	0.86
Direct effect	0.35	0.04	0.26	0.43
PSS-PI-CS	0.19	0.04	0.15	0.45
PSS-IR-CS	0.08	0.03	0.05	0.16

Notes: PSS stands for "perceived social support"; PI for "professional identity," IR for "identity recognition," and CS for "craftsmanship spirit."

5. Discussion

Grounded in social support theory, this study examined how perceived social support influences the craftsmanship spirit of prospective skilled talents in vocational education, with professional identity and identity recognition serving as mediators. Our findings demonstrate that when students perceive support from family, schools, enterprises, and society, they become more committed to their chosen career path. This commitment enhances their confidence in future career development and significantly strengthens their professional identity. In turn, this heightened professional identity motivates students to invest greater effort in acquiring professional skills and engaging in innovative practices, thereby fostering the development of a craftsmanship spirit. Furthermore, perceived social support reinforces students'

recognition of their social role as skilled professionals, enhancing their identity recognition. This sense of acceptance and affirmation fuels their passion and sense of mission for mastering skills, driving them to pursue excellence and further promote a craftsmanship spirit. Thus, professional identity and identity recognition play key mediating roles by channeling the positive impact of perceived social support into the cultivation of craftsmanship spirit. Theoretical and practical implications of these findings are discussed in detail.

5.1. Theoretical Implications

First, this study contributes to the literature by examining vocational students and investigating the relationship between perceived social support and craftsmanship spirit. This offers a new perspective on the antecedents of craftsmanship spirit and extends its research context from the workplace to vocational education. Previous research has primarily focused on the individual characteristics and management factors of frontline skilled workers (Y. Zhu et al., 2021) or the impact of individual traits, skills training, and mentorship on craftsmanship spirit among vocational students, with less attention paid to the critical role of professional identity (Y. Li et al., 2024). By focusing on prospective skilled talents who have not yet entered the workforce, this study broadens the applicability of craftsmanship spirit research. Furthermore, while many prior studies, often based on self-efficacy or psychological capital theories, have highlighted the effects of emotional support and skills training on vocational students (Sauli et al., 2022), this study, grounded in social support theory, specifically emphasizes the positive influence of the external supportive environment, thereby enriching the understanding of external factors that shape craftsmanship spirit.

Second, this study further explores the mediating role of professional identity in the relationship between perceived social support and craftsmanship spirit. This not only provides a new theoretical lens for understanding how social support is converted into students' intrinsic motivation but also enriches the understanding of the mechanisms underlying a craftsmanship spirit. While existing literature widely acknowledges the positive effects of social support on professional development, such as improving job satisfaction, reducing burnout, and indirectly influencing career choices and commitment (A. Zhou et al., 2024), little is known about how social support internally drives individuals' commitment to excellence, such as the development of craftsmanship spirit. This study fills this gap by demonstrating that when vocational students perceive support from diverse sources (family, school, and enterprises), their identification with their profession and future career is significantly enhanced. This, in turn, stimulates their intrinsic motivation to master professional skills, ultimately promoting the formation of a craftsmanship spirit. This finding is consistent with research showing a positive link between social support and professional identity, such as D. Xie, Li, and Yin (2025), who found that social support indirectly enhances professional identity through psychological adjustment and school belonging. By leveraging social support theory, our study uncovers the identity-based mechanisms (including professional and identity recognition) in the formation of craftsmanship spirit, offering a new perspective on how social support is translated into this valued trait. The selection of professional identity and identity recognition as mediating variables is rooted in a deep insight into the unique characteristics of higher vocational students: they need not only to identify with their specific chosen profession (professional identity) but also to affirm their social identity as skilled talents (identity recognition) to counteract societal prejudices. This approach differs from self-efficacy, which primarily focuses on belief in one's capabilities, or mere vocational commitment, which is often a preference for a career choice. Although professional identity and identity recognition are conceptually related, this

study's empirical data (e.g., an acceptable correlation coefficient between them in Table 2, well below the discriminant validity threshold) preliminarily support their empirical distinctiveness as independent mediating pathways.

Finally, this study confirms that group identity acts as a mediator in the cultivation of the craftsmanship spirit. This finding advances our understanding by highlighting a key group-related psychological mechanism, identity recognition, that has been largely overlooked in prior research. Vocational students are often perceived as a marginalized group, facing identity crises related to academic performance and employment prospects. Some scholars have argued that, in the absence of a strong sense of group-based identity recognition, efforts to cultivate craftsmanship spirit in vocational education may remain superficial and lack lasting impact (Sugimura et al., 2025). Empirical evidence also suggests that a clear sense of professional-based group identity encourages students to actively engage in professional learning and innovation (Suyitno et al., 2023). Building on social support theory, this study systematically examines how multi-source social support enhances the group identity of vocational students, thereby stimulating their drive for skill mastery and excellence. This not only responds to the assertion by Sugimura et al. (2025, p. 455) that "the sense of feeling that one knows where one is headed and could thus facilitate students' future career plans," but also provides a new paradigm from a social support perspective for addressing the issue of low group identity among vocational students.

5.2. Practical Implications

First, our findings underscore the significant impact of perceived social support on the development of craftsmanship spirit among vocational students. It is therefore crucial to enhance students' perception of support, particularly from family, school, enterprises, and the broader society. Specifically, schools can establish a collaborative family-school-enterprise educational mechanism to provide students with rich support resources. For instance, inviting parents to career experience days or mock job fairs can improve students' overall perception of social support and sense of identity. Regularly inviting national skill competition winners, master craftsmen, and alumni to share their journeys can allow students to feel social respect and career anticipation through authentic stories. These initiatives can make students tangibly feel external care and support, strengthening their confidence and fostering the professional identity and group belonging that are foundational to craftsmanship spirit.

Second, professional identity serves as a critical bridge between perceived social support and craftsmanship spirit. Therefore, schools and families should implement measures to bolster students' professional identity. Schools can strengthen career planning education to help students clarify their career goals and development paths. Systematic psychological counseling and career advising can address students' uncertainties and build their professional confidence. Furthermore, creating more practical career experience opportunities, such as regular internships and apprenticeships in manufacturing enterprises and workshops, is essential. Requiring students to engage in frontline operations and reflect through interviews and mentorship allows them to gain a realistic understanding of the workplace, thereby enhancing their identification with their professional roles. When students develop a clear and genuine passion for their profession, their intrinsic motivation to learn and achieve will be significantly enhanced, setting them on a path where professional identity fuels the cultivation of a craftsmanship spirit.

Finally, the group identity of vocational students is another vital factor in internalizing a craftsmanship spirit. From a group belonging perspective, schools and society should cultivate an environment that respects skilled labor and esteems craftsmanship, thereby enhancing students' sense of honor and belonging as members of the skilled talent community. Schools can form professional clubs or interest groups to encourage peer learning and support networks. Regular campus events and award ceremonies themed around "craftsmanship spirit" can establish role models of skill-based success, reinforcing group pride. To effectively counteract societal prejudices and prevent students from feeling isolated, the following strategies are crucial: Firstly, schools should actively organize and encourage students to participate in various national and provincial skill competitions, vigorously promoting their achievements in such contests. This leverages authoritative social recognition to enhance both students' and society's perception of skilled talents. Secondly, establishing extensive school-enterprise cooperation platforms will enable students to engage in projects within real work environments, producing valuable outcomes. Through corporate feedback and compensation incentives, students can genuinely experience the social value of their skills and their contributions as skilled professionals. Thirdly, schools can regularly host "vocational skills open days" or "craftsmanship spirit into community" events, inviting the public and primary/secondary school students to experience the appeal of vocational skills and showcase the professional demeanor of higher vocational students. This promotes societal understanding and respect for vocational education, gradually transforming negative stereotypes. Through these internally strengthening and externally integrating strategies, the aim is for students to not only internalize a sense of honor but also to confidently integrate into the broader society, becoming socially recognized skilled contributors, rather than merely confining their identity recognition within small, isolated groups. Social practice and community service can also help students experience the societal respect afforded to skilled professionals. When vocational students develop a deep sense of pride in their professional group, they become more engaged and motivated to pursue excellence, fostering a collective drive towards craftsmanship.

5.3. Limitations and Future Research

Although this study explored the impact of perceived social support on the craftsmanship spirit of vocational students and analyzed the mediating roles of professional and identity recognition, several limitations warrant further investigation.

First, this study focused primarily on vocational students. Future research could extend to other educational levels or professional groups, particularly through comparative studies between vocational and undergraduate students. This would allow for a more systematic examination of the proposed mediation model and its generalizability versus specificity across different educational contexts. While our sample included students from various skill-oriented and practical majors within higher vocational education, which inherently emphasize professional ethics and hands-on competence aligned with craftsmanship, future studies could explore the applicability of these mechanisms in broader or non-skill-specific vocational programs. Additionally, cross-cultural research could provide a more comprehensive perspective, as the influence of social support on craftsmanship spirit may vary across different regions and cultures. Moreover, although this study has adapted the craftsmanship spirit scale, it is important to acknowledge that because our participants are students who have not yet fully entered the workforce, their understanding of craftsmanship spirit may, to some extent, be influenced by their educational background and idealistic perceptions, potentially differing from how it manifests in actual work performance. Future research could

consider combining behavioral observations or longer-term longitudinal tracking to more comprehensively assess the practical development of craftsmanship spirit.

Second, while this study employed a multi-wave survey design to establish temporal precedence and mitigate common method bias (H. Xu, 2024), it is important to note that this design, without advanced causal modeling (e.g., cross-lagged panel analysis or experimental manipulation), does not definitively establish causality. Future research could employ longitudinal or experimental designs to explore the long-term effects of social support on the development of craftsmanship spirit and to further validate the mediating roles of professional and identity recognition. Furthermore, to address potential omitted variable bias and gain a more comprehensive understanding, future studies could incorporate and control for other relevant variables not examined here, such as participants' prior work experience, family socioeconomic status, or specific characteristics of vocational programs (e.g., depth of industry-education integration, intensity of apprenticeship training; see R. Wang, 2023; W. Xie, Wu, & Xiang, 2025; C. Q. Xu & Li, 2025). These factors might influence both social support perception and craftsmanship spirit development.

Finally, while this study examined the overall effect of social support, it did not differentiate between various types of support (e.g., emotional, informational, tangible). Future research could build on this foundation by distinguishing between different forms of support to explore their specific mechanisms of influence on students' craftsmanship spirit in various contexts.

In summary, while this study provides theoretical analysis and empirical support for cultivating "craftsmanship spirit" in vocational students, many questions remain. Future research can address these gaps from multiple perspectives and levels to provide a more comprehensive theoretical basis and practical guidance for fostering a craftsmanship spirit.

6. Conclusion

This study, grounded in social support theory, explores the intricate relationship between perceived social support and the development of craftsmanship spirit among vocational students, emphasizing the mediating roles of professional identity and identity recognition. Our findings underscore that when students perceive robust support from diverse sources—such as family, educational institutions, peers, and the broader society—this multifaceted support significantly enhances their professional identity and identity recognition. These enhancements, in turn, foster the cultivation of a craftsmanship spirit. This research illuminates the pivotal role of external social support in nurturing craftsmanship spirit and elucidates the mediating mechanisms of professional identity and identity recognition within this process. The insights gained provide a comprehensive theoretical framework for fostering craftsmanship spirit within vocational education. Furthermore, they offer practical recommendations for enhancing social support systems to effectively promote craftsmanship spirit, thereby contributing to the broader discourse on vocational education and social inclusion.

Acknowledgments

This study complies with the Declaration of Helsinki. Ethical approval was obtained from the research ethics committee of Guangdong University of Finance (JKYLLSM20200607) before data collection. We extend our heartfelt gratitude to participants from Shenzhen City, whose active cooperation greatly contributed to the successful execution of this study. Additionally, we express our appreciation to Guangdong Polytechnic

Normal University, Guangdong University of Finance and Economics, and other institutions for their invaluable support in facilitating the ethical review process, research efforts, and coordination activities.

Funding

This research was supported by the Guangdong Province Philosophy and Social Sciences Planning 2023 Discipline Co-Construction Project (GD23XJY17), the Guangdong Province Philosophy and Social Sciences Planning 2024 Discipline Co-Construction Project (GD24XJY11), the Guangzhou Philosophy and Social Science Planning Project (2023GZGJ164), and the Special Research Project of Philosophy and Social Sciences in Universities of Guangdong Province (2022GXJK245).

Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

LLMs Disclosure

During the preparation of this work, the authors used ChatGPT 4.0 to improve the language and readability of the manuscript. The tool was used for grammar correction, spelling checks, and rephrasing sentences to enhance clarity. It is important to state that the core academic content, including the research ideas, data analysis, and conclusions, was generated solely by the human authors. The authors reviewed and edited all AI-generated text to ensure its accuracy and take full responsibility for the final content of the manuscript.

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Social Inclusion
2026 • Volume 14 • Article 10784
https://doi.org/10.17645/si.10784

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Open Access Journal

Engaging With Mathematics: Exploring Different Learning Environments at the Elementary School Level

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Submitted: 3 June 2025 **Accepted:** 21 October 2025 **Published:** 13 January 2026

Issue: This article is part of the issue "Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China" edited by Huinan Liu (The Education University of Hong Kong) and Meng Zhang (South China Normal University), fully open access at https://doi.org/10.17645/si.i543

Abstract

This article examines the "effectiveness" of school-level mathematics and explores how teachers' instruction, within classrooms, contributes to an effective learning. By using multiple data sources, including classroom observations and teacher interviews, we found that students from "effective schools" receive more intellectual support than students in "typical schools" and benefit from better learning environments overall. We also found that the overall intellectual quality differs as per students' ability level, favoring students of "lower ability" when they are enrolled in effective schools. Teacher interviews suggest that teachers from effective schools tend to hold higher expectations for low-ability students than in typical schools and know how to adapt to them by adopting individualized instruction to meet their learning needs.

Keywords

classroom learning environment; effective schools; elementary schools; mathematics; typical schools

1. Introduction

School effectiveness research (SER) has grown rapidly over the past four decades, partly because it seeks to answer fundamental questions about education—answers that lie at the core of why students in some schools perform better than in others—and promote the development of so-called "effective schools." Effective schools are commonly understood as ones in which students perform better than in other schools on most academic subjects, generally as measured via standardized tests (Clewell et al., 2007); typical schools are those where students score average or below-average on standardized tests. From its inception, SER focused on identifying non-instructional factors that could influence the "effectiveness" of a school,

factors that relate, among other things, to the environment, organization, resources, and culture of a school. This continues to be a feature of SER more broadly. Purkey and Smith's (1983) early review helped define the concept of effective school by providing a list of characteristics that add extra value to students' learning experiences: school organization and structure (see also Bedard & Do, 2005), external support, leadership and staff stability, safety, and cultural elements. Features like school management (Cheng, 2022) and parent involvement (Pelemo, 2022) have also been investigated for their association with students' learning outcomes and are some of the non-instructional factors that have been shown to contribute to school-level effectiveness.

More recently, research on classroom teaching has explored the importance of classroom-level, instructional factors on effectiveness and there is a growing acceptance that the best way to improve ineffective schools is by providing them with better teachers and high-quality classroom instruction (Waxman et al., 2007). Research on teaching practices has also advanced our understanding of the factors that are more effective for students' learning of mathematics. Numerous studies have documented that teaching practices are positively associated with student mathematical achievement and play a critical role in academic success (Osborne, 2021; Tan & Dimmock, 2022; Yu & Singh, 2018). Using a generic observational framework, Zhu and Kaiser (2022) found that teachers' social support and teaching quality positively impacted students' mathematical performance, whereas classroom management did not have a significant direct impact. Likewise, using an observational framework focused on teaching practices that are specific to teaching mathematics, Merritt et al. (2017) found that teachers' use of multiple representations, vocabulary-building techniques, and attention to individuals' understanding were prevalent practices in high-gain classrooms.

These findings suggest the need for considering both cross-classroom and within-classroom features when examining school effectiveness. Yet, as previously mentioned, most studies on teaching quality have not been situated within the broader context of school effectiveness. Reynolds (2010) believed that the separation of SER and teaching quality research might be ignoring school-level conditions and arrangements that can contribute to an effective instruction within classrooms. In the case of mathematics specifically, researchers have found that classroom-level factors, such as students' perception of "in-classroom" learning environments (Waxman et al., 2021) and structural teaching, time on mathematical tasks, and curriculum quality (Scheerens, 2016), significantly contribute to school effectiveness. Within-classroom features such as students' gender and ability levels have also been found to influence teachers' instructional practices. For instance, Nurmi's (2012) meta-analysis found that teachers tend to give more attention to students they expect to perform well compared to those they expect to perform poorly. Desimone and Long (2010) reported that teachers in schools located in disadvantaged socioeconomic areas spent less teaching time on low-achieving students. These two studies suggest it might be necessary to consider within-classroom factors when examining the relationship between classroom instruction and school effectiveness.

Most research on mathematics instructional quality (Merritt et al., 2017; Osborne, 2021; Zhu & Kaiser, 2022) has not been within the context of school effectiveness. Limited attention has been paid simultaneously to school-level, classroom-level, and student characteristics. Most SER research has focused on one or, at the most, two out of three instructional-level factors that are known to impact student mathematics achievement: students, classrooms, and schools. Extant classroom-level studies have focused on general teacher behaviors or classroom instruction (Charalambous & Praetorius, 2018; Zhu & Kaiser, 2022). In this article, we examine all three factors simultaneously and use systematic, mathematics-specific observation scales.

We aligned students' learning behaviors with teachers' instructional practices in what we refer to as "classroom learning environment." A strict focus on teacher practices misses the impact that students' behavior has on their own learning. Teaching practices can only be effective if students engage with them. Thus, classroom learning environment refers to a coordination of within-classroom instruction that includes teacher behavior (Fisher et al., 2005) as well as teacher–student and/or student–student interactions (Zedan, 2010).

This article also looks at the "intellectual quality" of environments specific to the learning of mathematics. By "intellectual quality" we mean the depth to which mathematics is treated in a given classroom, the understanding thereof that is evident in the classroom, and the range of students' engagement with mathematics (see Newmann et al., 1996; Secada & Lee, 2000). The following four research questions guide this study:

1. Are there any significant differences in the learning environment and student engagement with mathematics between "highly effective" and "typical" urban schools?
2. Are students' experiences of mathematical learning environments and engagement different based on students' ability levels, and whether students' ability levels interact with school-level effectiveness?
3. Are students' experiences of mathematical learning environments and engagement different based on students' sex, and do students' sex interact with school-level effectiveness and student ability?
4. (exploratory) What underlying teacher perceptions about mathematics, their students, and/or teaching might shed light on these findings?

1.1. Quality of Mathematics Instruction Within Effective Schools

Some studies have provided evidence that teachers in effective schools consistently display "effective teaching" behaviors. Using high-inference classroom observations of 65 reading teachers from effective schools versus 51 teachers from ineffective schools, Teddlie et al. (1989) found that reading teachers in effective schools exhibit more "student time on task," frequent presentation of new materials, high expectations for students, positive reinforcement, and a friendly learning environment. Teddlie and Reynolds (2000) distinguished effective schools from less effective schools in the following ways: Math teachers in the more effective schools were more likely to adopt student-centered activities and small-group instruction, their students were encouraged to use mathematical manipulations and problem-solving techniques, and the teachers were more likely to extend the curriculum by adding relevant information from varied sources beyond textbooks. Teacher-directed and whole-class instruction were primarily used in less effective schools.

Based on the survey and interviews of 523 teachers from two school districts (10 effective schools and six typical schools), Clewell et al. (2007) found that highly effective school teachers reported holding higher expectations of their students, spending more time working on the mathematical content, and developing their own materials for mathematical instruction. Aside from differences in teacher practices, highly effective schools had a higher proportion of qualified and experienced teachers, and provided more professional development opportunities for their teachers than their counterpart schools. The same study relied on direct observation of teachers' classrooms, embedded students within those classrooms, and, in an exploratory manner, related instructional practices to teacher beliefs and perceptions.

Studies have investigated the differences in students' learning behaviors and their perceptions of classroom learning environments between effective and ineffective schools. Waxman et al.'s (2021) observations of 947 fourth- and fifth-grade students' behaviors during reading and mathematics found that students in effective schools were much more engaged in tasks, perceived learning environments as more positive, and had more time to interact with their teachers. Students enrolled in average and ineffective schools were less engaged in tasks, more distracted, and had much lower perceptions of their learning environments.

1.2. Effective Urban Schools

Research on the effective school goes back to Edmonds (1979), who sought to provide direction for improving the education of students enrolled in urban schools in the United States by focusing on school-level characteristics of effective schools. Subsequent work in urban settings consistently reported similar findings. Muijs et al.'s (2004) review lists the following factors as those that most impact schools in socioeconomically disadvantaged areas: leadership capacity, a positive school culture, continuous professional development of teachers and administrators, teaching and learning, and external support. A set of Canadian case studies that examined 12 secondary schools in low-income settings drew the conclusion that high expectations for all students, a clear focus on academic achievement, and supportive structure and services contributed to the success of their students (Raham, 2004). In a case study of three English schools with high proportions of students from minority ethnic groups qualifying for free school meals, Engel et al. (2010) identified the ethos of inclusion as central to the success of schools catering to students from challenging environments. They argued that inclusion went beyond classroom strategies and practices; rather, it permeated the entire school and affected schools in every aspect of how they functioned.

1.3. Student Factors Within an Effective School Setting

Students' socio-demographic characteristics can be linked to their cultural backgrounds in relation to classroom instruction, either positively as resources for instruction or negatively by providing fewer learning opportunities during instruction. The importance of differentiating classroom instruction arises from the fact that students differ from one another in terms of prior knowledge, interests, motivation, learning needs, and learning styles (Dowson & McInerney, 2003). By adapting instruction to individual students' needs, teachers increase students' chances of success and help to reduce the learning gaps among students. Creemers and Kyriakides (2007) studied the extent to which teachers give more instructional opportunities and instruction to students who need them. J. B. Smith et al. (2001) found that low-achieving, economically disadvantaged students benefited from the interactive instruction that emphasized teachers' guidance and encouraged students' explanation and discussion of mathematical concepts. Ketterlin-Geller et al. (2008) found that additional exposure to the core mathematical concepts and practices increased the achievement gains of state-standardized tests for low-achieving students. Unfortunately, numerous studies have found that low-achieving students from disadvantaged socioeconomic areas tend to get teachers who spend less time on instruction and provide less conceptual and more procedural instruction compared with their counterparts in high SES settings (Desimone & Long, 2010; J. B. Smith et al., 2001; T. M. Smith et al., 2005).

Early gender-based teaching research found that teachers favored male over female students in the quantity and quality of their interactions (Garrahy, 2001; Wimer et al., 2001), a trend that more recent research continues to confirm regarding teachers' perception and expectations of students' abilities and performance.

Riegle-Crumb and Humphries (2012), for instance, found that high school math teachers perceived boys (especially white boys) as more capable than girls, just as Tiedemann (2002), a decade earlier, found that middle-school teachers considered boys to possess higher mathematical abilities and profit more from additional efforts than girls. Teachers may also respond differently to boys and girls based on students' abilities: Dukmak (2009) found that teachers initiated more interactions with high-achieving boys than with high-achieving girls; yet, they initiated more interactions with low-achieving girls than with low-achieving boys.

2. Conceptual Framework for Classroom Environments

2.1. Simultaneous Focus on Teachers and Students

Teaching and learning are social practices that are dependent on context; student learning does not happen in isolation (Lemke, 2001). Both teachers and students co-create and support classroom learning environments. A teacher may engage in practices that focus on in-depth treatment of a mathematical topic. But without broad student uptake based on those practices, students are unlikely to learn the content in much depth. Similarly, teacher practices may focus on developing students' understanding of mathematical topics and/or on mathematical analysis (higher-order thinking). Without students' co-participation in those practices, students' understanding and application of analysis are unlikely. Our focus on learning environments as co-constructed by teachers and students highlights that teachers and their students simultaneously shape and contribute to the intellectual quality of the classroom's learning environment.

Socio-constructivist learning theory provides a foundation for this view of learning since it portrays learning as an active process, where learners actively construct their mathematical ways of knowing as they participate in the classroom community (Cobb & Yackel, 1996). Students are not passively receiving knowledge from teachers' transmissions (e.g., pretending to listen to lectures), but they are actively involved in the learning processes. By building on one another's contributions, teachers and students create a rich learning environment. Based on this theoretical perspective, we assessed the quality of learning environments not by focusing on a single aspect of the classroom, such as teacher quality (Jong et al., 2004), instructional tasks, and task implementation (Stigler & Hiebert, 2004), or classroom artifacts (Clare & Aschbacher, 2001). We adopted an interactional lens that focused on the relationship among individual students, teachers, and the context within which that student learning took place.

2.2. Things Matter for Mathematical Learning

We focused on three aspects in mathematical learning: (a) depth in the treatment of mathematical content, (b) level of focus in developing conceptual understanding, and (c) support for engaging students in mathematical analysis (high-order thinking). These three aspects are consistent with the *Principles to Actions: Ensuring Mathematical Success for All*, a document by the National Council of Teachers of Mathematics (NCTM) that provides research-based descriptions of instructional/teaching practices in support of students' learning of mathematics (NCTM, 2014). In addition to developing a conceptual understanding of key mathematical ideas, the NCTM also recommends a flexible use of procedures and strategies to engage students in mathematical practices, including reasoning, problem-solving, and communicating. Our standards were derived from what Newmann (1996) called "authentic learning," which argued that teaching and

learning should lead students to a deep understanding of concepts and relationships in contexts that involve real-world problems. Newmann and Weglage (1993) provided five authentic instructional practices that align with these learning goals, of which we adopted the following three: higher-order thinking, depth of knowledge, and social support for student achievement.

Mathematical tasks provide the basis for classroom teaching and learning. Students should spend a substantial portion of instructional time focused on challenging tasks and that will keep them deeply engaged in mathematics content, so that they can achieve rigorous mathematical learning goals (Cobb & Wilhelm, 2022; Sullivan et al., 2015). Sullivan et al. (2015) and Sullivan and Mornane (2014) have worked with groups of primary and secondary teachers to support their efforts to convert challenging mathematical tasks into classroom lessons. Challenging tasks allow students opportunities to engage with important mathematical ideas, to choose their strategies, goals, and levels of accessing the task, and to extend their knowledge and thinking in new ways. Sullivan and Mornane (2014) stressed that challenging tasks are those that help students build networks and connections between ideas with which students are familiar. Stein et al. (2008) stated that challenging tasks are cognitively demanding and promote conceptual understanding and the development of thinking, reasoning, and problem-solving skills.

Students learning mathematics with understanding is a critical feature of the principles and standards for school mathematics (NCTM, 2014). Learning mathematics with understanding involves students in understanding mathematical ideas and procedures and making connections among ideas (Stylianides & Stylianides, 2007). These connections facilitate the transfer of prior knowledge to novel situations. Memorizing facts or procedures without understanding results in fragile and non-transferable learning. In this case, students' knowledge may be shallow, thin, or superficial and cannot be transferred to other contexts since the mere mastery of facts and procedures does not necessarily imply mathematical proficiency (NCTM, 2014). The NCTM clarifies that effective teaching of mathematics builds fluency with procedures on the foundation of conceptual understanding; thus, conceptual understanding and procedural fluency are essential and integrated components of mathematical proficiency.

Higher-order thinking skills refer to the ability to analyze, evaluate, and create, based on Bloom's (1956) taxonomy. Unfortunately, people have used the term when discussing mathematics in the classroom with no attachment to actual math content. To highlight that mathematics is the content of higher-order thinking, we used the term "mathematical analysis." Mathematical analysis involves searching for mathematical patterns, making mathematical conjectures, and justifying them (Secada & Lee, 2000). Mathematical analysis also includes organizing, synthesizing, evaluating, arguing, hypothesizing, describing patterns, and making models or simulations. In all these cases, the "content of the thinking" is mathematics.

3. Method

In our research, we followed an overall SER logic, i.e., we identified schools that were considered highly effective in mathematics based on multi-year results from their state mathematics assessments and compared them to schools whose performance was typical for their respective districts. We observed multiple sessions of classroom instruction spread over the Fall and Spring of a given academic year: Fall observations focused on whole-classroom instruction, while Spring observations followed individual students of the same classroom. Observers did not know which schools had been identified as highly effective, nor which observed students

had been identified in terms of their mathematical ability. We assumed that classroom instruction is relatively stable across a given school year, as Newmann et al. (1996) found in their unpublished data analysis.

3.1. Criteria for the Selection of Schools

Data for this study were extracted from a larger study that aimed at identifying the different characteristics, practices, and policies between effective schools and typical schools around disadvantaged communities (see Clewell et al., 2007; Secada & Lee, 2000). Two districts, President City Area and Arbor City, were selected for serving a large population of low-income and minority students. The majority of students (85%) in the President City Area were Hispanic, 11% were white, and 3% were African American. In the Arbor City district, most district students (65%) were African American, 16% were white, and 13% were Hispanic/Latino (Secada & Lee, 2000).

The criteria for identifying highly effective schools in each district were based on state-wide standardized mathematics tests at the fourth-grade level across a minimum of three years prior to the study. Highly effective schools were those where a higher percentage of fourth graders demonstrated at least a basic level of expertise in mathematics, with a significant number of students exhibiting high levels of proficiency. Ninety percent or more of fourth graders passing their mathematics tests, and 50% or more of fourth graders scoring proficient or higher were used as the criteria in the President City area. As national science tests were also available in Arbor City, both mathematics and science tests were used as the criteria for selecting effective schools; that is, schools with 66% or more of fourth graders scoring basic or above-basic levels, and 30% or more of fourth graders scoring proficient or above-proficient levels were considered as the potential highly effective schools. Based on the criteria, five elementary schools were selected as the highly effective schools in each district. Three elementary schools were selected as the counterpart typical schools; they scored less well on the same tests but were closely matched in terms of student demographics in the same district (Clewell & Campbell, 2007).

3.2. Instruments and Data Collection

A high-inference classroom observational instrument was developed and used in the present study, derived from the observation scales developed by the Center for Organization and Restructuring of Schools (https://www.centerforcsri.org) to measure instructional quality (Newmann et al., 1996). These scales provide a systematic observation schedule to measure overall classroom instruction beyond dyadic interactions. This instrument is grounded in the idea that authentic assessment should emphasize certain practices (or instructions) to help students achieve an in-depth understanding of academic subjects (Newmann, 1996). The individual observation scales (from 1 to 5) and their brief descriptions are provided below:

1. Measuring intellectual support: To what extent is the classroom learning environment characterized by an atmosphere of high academic expectations for all students, coupled with mutual respect and support among students?
2. Measuring depth of knowledge and student understanding: To what extent is mathematical knowledge treated deeply in the class? To what extent is knowledge treated in a shallow and superficial manner?
3. Measuring mathematical analysis: To what extent do students use mathematical analysis?

4. Student engagement was measured by students' on-task behaviors that signal a serious psychological investment in class work.

Each trained on-site team consisted of two mathematics education specialists. During the Fall observation, they observed the teachers' mathematics classroom teaching twice. Observers did not know which schools were highly effective versus typical.

The original whole-class observational instrument was modified to follow individual students during the Spring observation. This shift in emphasis recognizes the relationship between individual students and the context in which students' learning is taking place. This change allowed the unit of analysis to be individual students. During each of the two classroom visits, the same three students were observed: One had been listed by the teachers as being of high ability, another was considered of medium ability, and a final one of low ability. Each student was observed twice for between five to 10 minutes per lesson. Student sex was counter-balanced at the school level. Two observations per student, per visit, and two visits resulted in four observations per student in total. Spring observers did not know which schools were "effective," nor did they know any student's ability level. Table A in the Supplementary File presents the number of observations in both Fall and Spring.

3.3. Teacher Interviews

Semi-structured interviews were conducted to understand teachers' conceptions, knowledge, and teaching beliefs involving student diversity. The following topics were considered: (a) general reactions to their lessons, (b) conceptions of the nature of mathematics, (c) conceptions of student diversity, and (d) conceptions of teaching mathematics to students of different ability levels. Fall and Spring interviews followed similar protocols. Spring interviews added some questions related to teachers' expectations, evaluations, and teaching to the three observed students. Each interview lasted about 45 minutes to one hour. In the Spring, 15 mathematics teachers from the highly effective schools and 11 mathematics teachers from the typical schools were interviewed. For this study, we analyzed those interviews wherein teachers talked about the three individually observed students.

3.4. Data Analysis

The mixed-methods sequential explanatory approach began with quantitative, followed by qualitative analyses (Creswell et al., 2003). The quantitative phase used advanced multi-level modeling (Reynolds, 2010) to examine the differences in classroom learning environments between typical and highly effective schools. The qualitative phase focused on the interview data to help explain and elaborate on the quantitative results obtained in the first phase. The quantitative results guide the case selection for the qualitative analyses.

This reanalysis of an extant database taken from Secada and Lee (2000) used more advanced methodology and statistical tools than were available at that time, which allowed us to pursue the research questions listed at the start of this manuscript. The quantitative analysis used a three-level model to analyze the classroom learning environment: Students were embedded within their fourth-grade classrooms; classrooms were embedded within their schools; and schools were categorized as either effective or typical. Student-level factors are students' demographic information, including sex (female vs. male) and ability (high ability, medium ability, and low ability). In our study, low-ability students were defined as those perceived by their teachers as performing

below average in mathematical learning. Gender is a social construction that, at present, is highly contested. Hence, we are relying on the biological term of sex and use that terminology.

To establish that a three-level model is suitable and relevant for this analysis—it is significantly better than the two- or single-level model (traditional regression analysis)—we used a likelihood ratio test (LRT). The three-level model is better than the two-level model without the school level for the dimensions of intellectual support and intellectual quality, and better than the one-level model for all the dimensions, except for student engagement. The three-level model fits the data better than models with fewer levels.

The Fall classroom observations provide the classroom-level factors to examine whether the classroom learning environment from the same teachers was consistent across terms. The Spring observations of intellectual support, student understanding, mathematical analysis, the intellectual quality of the learning environment (averaged from the three prior subscales), and student engagement were used as the dependent variables.

All the models were estimated using restricted maximum likelihood (REML), which is commonly considered a viable option for obtaining accurate parameter estimates with small sample sizes (Kenward & RogeR, 1997) in the R environment using the lme4 package (Bates & Sarkar, 2007). Data analysis proceeded in the two steps: First, unconditional models without any predictors were run to check the variance explained at the classroom and schools; then, full models including student-level (ability and sex), classroom-level (Fall observations), and school-level (school types) variables, interaction between school types with students' sex, ability, and Fall observation, were run. We ran full models instead of adding factors level by level because our research questions involve all three levels simultaneously.

In the qualitative phase, we selected representative teachers based on their quantitative instructional quality scores to examine how their perceptions and self-reported practices aligned with observed classroom practices. We employed open-ended coding for teachers' expectations, teachers' evaluation of students' abilities to learn mathematics, specific teaching strategies for low-ability students, and the challenges of teaching those students. Particular attention was given to aspects that corresponded with the observed classroom outcomes.

4. Results

4.1. Descriptive Statistical Analysis

Table 1 reports the number of students and teachers, student-level means, and standard deviation (SD) for Spring classroom observations based on the school types. Students from effective schools demonstrated slightly higher mean scores for depth of knowledge, mathematical analysis, and student engagement than students from typical schools. The mean differences in intellectual support and instructional quality between typical and effective schools were relatively larger, suggesting that school types may contribute to the differences in those two dimensions. Table 2 presents the three-level analyses results on Spring classroom learning environments. The discussion of results by research questions is based on Table 2.

Table 1. Student-level means (SD) for Spring classroom observations by school types.

Type of school	No. of students	No. of teachers	Intellectual support	Depth of knowledge	Mathematical analysis	Instructional quality	Student engagement
Typical	33	11	2.49(0.64)	1.28(0.37)	1.14(0.23)	4.93(0.79)	3.37(0.67)
Effective	49	26	2.84(0.44)	1.51(0.52)	1.32(0.37)	5.68(1.09)	3.40(0.85)

Note: Instructional quality is the sum of the three sub-scales.

Table 2. Beta values (and standard error) from multi-level model analyses on classroom learning environments.

Variables	Intellectual supports		Depth and understanding		Math analysis		Intellectual quality		Student engagement	
	β	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*
School-level										
Effective	3.85**	1.16	1.50	1.01	−0.04	0.99	4.16**	1.29	−0.32	1.12
Teacher-level										
Fall Intellectual	0.96**	0.34								
Fall Understanding			0.25	0.63						
Fall Analysis					−0.71	0.06				
Fall Instruction							1.17*	0.51		
Fall Engagement									0.23	0.17
Student-level										
High ability	0.34	0.34	−0.11	0.35	0.89	0.45	0.38	0.30	0.18	0.49
Male	−0.83*	0.34	−0.80*	0.36	−0.22	0.42	−0.84*	0.35	−0.24	0.45
Interaction										
Effective × High ability	−0.72	0.36	−0.63	0.37	−0.42	0.49	−0.79*	0.38	−0.04	0.52
Effective × Male	0.17	0.31	0.42	0.33	0.24	0.42	0.30	0.33	−0.09	0.44
High ability × Male	0.71	0.39	0.84*	0.41	−0.42	0.49	0.67	0.40	−0.01	0.55

Notes: ** $p < 0.01$, * $p < 0.05$; typical schools are the reference group for school type, low-ability students for ability, and female for student sex.

4.2. Differences Across School Types

Table 2 shows that the differences in overall intellectual quality were significant ($\beta = 4.16$, $SE = 1.29$, $p < 0.01$) across school types, favoring effective schools. However, no significant differences in student engagement were found. Although students in both effective and typical schools are engaged to a similar extent in mathematical learning, students in effective schools experience and contribute towards a higher intellectual quality of mathematical learning environments than their peers in typical schools.

The differences in intellectual support were significant across school types, favoring the effective schools ($\beta = 3.85$, $SE = 1.16$, $p < 0.01$), suggesting that an important reason that students in effective schools could have experienced and contributed towards a higher intellectual quality was that students experienced and contributed to a learning environment that was characterized by an atmosphere of high academic standards for all students coupled with mutual respect and support among teachers and students.

4.3. Differences Across Ability Levels and School Types

We found no significant differences in student engagement across students' ability levels or across school types (Table 2). Across both effective and typical schools, low-ability students engage comparably to high-ability students, and students from effective schools engage comparably to their peers at the same ability level as those in typical schools. Hence, students' engagement in their mathematics classrooms seems unaffected by their ability level or by the effectiveness of their school.

Figure 1, based on the interaction for intellectual quality (Table 2), shows that high-ability students in both typical and effective schools get similar mathematical learning experiences in classrooms. So, what makes some schools effective? The differences in the overall intellectual quality were significant in effective schools ($\beta = -0.79$, $SE = 0.38$, $p < 0.05$) between students' ability levels, favoring low-ability students. This indicates that low-ability students in highly effective schools experienced instruction of higher intellectual quality than did their high-ability peers, suggesting that teachers in effective schools allocate their instructional resources (which shape the learning environment) based on students' needs.

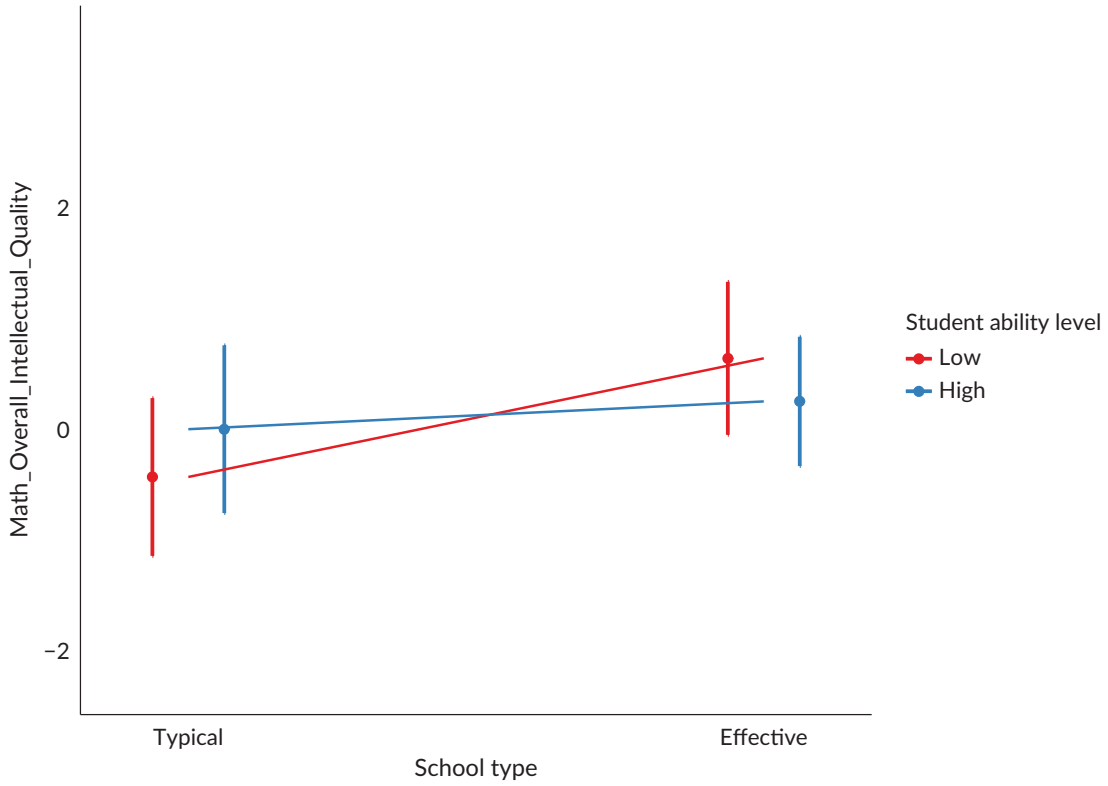

Figure 1. The interaction between students' ability and school types for the overall intellectual quality.

4.4. Differences Across Students' Sex, Ability Levels, and School Types

Previous research has found that mathematics instruction favors and benefits male students over female students (Garrahy, 2001; Wimer et al., 2001). However, our results indicate the contrary. Differences in the intellectual quality of the classroom learning environment between male and female students were significant ($\beta = -0.84$, $SE = 0.35$, $p < 0.05$), favoring female students with no interaction (Table 2, $\beta = 0.30$,

SE = 0.33, $p < 0.05$). Female students in both effective and typical schools experience and contribute towards a higher intellectual quality learning environment than their male peers.

Furthermore, significant differences in intellectual support and depth and understanding ($\beta = -0.83$, $SE = 0.34$, $p < 0.05$; $\beta = -0.80$, $SE = 0.36$, $p < 0.05$) were found between female and male students across both types of schools, favoring female students. These findings suggest that some specific ways in which female students experience a higher quality mathematics learning environment in their classrooms are because teachers and their female students work together towards (a) conveying and accepting high academic standards and mutual respect and support and (b) focusing on deeper engagement in mathematical knowledge, to a greater extent than do male students.

Figure 2 shows the contrast between students' ability level and sex for students' depth of knowledge and understanding, to further understand the nuances of our results in the context of students' ability levels. Previous literature states that high-ability male students are the most benefited group, as far as instructional quality is concerned, in mathematics classrooms because teachers perceive them to have greater mathematical abilities than their female peers (Riegle-Crumb & Humphries, 2012). However, we found that low-ability and high-ability female students experienced deeper engagement in mathematical knowledge to a similar extent as high-ability male students. This is an important finding because it shows that teacher bias towards high-ability males during mathematical instruction may have been attenuated by the female students responding more deeply to their teachers' efforts.

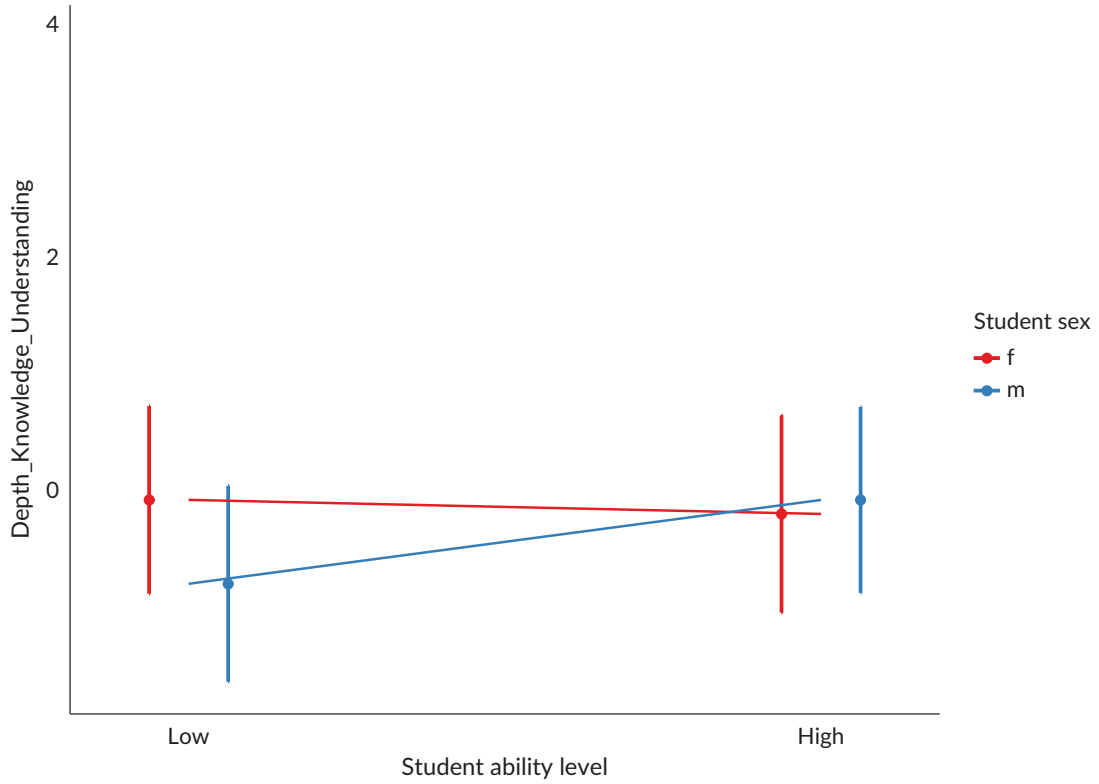

Figure 2. The interaction between student ability levels and sex for students' depth of knowledge and understanding.

Additionally, we found that male students with lower ability levels experienced the least depth of knowledge and understanding compared to all other peer groups. This finding is consistent with previous literature that low-ability male students were perceived to have discipline issues and lower mathematical abilities by their teachers and, as a result, received instruction aligned with lower academic expectations (Straehler-Pohl et al., 2014).

No significant differences in student engagement were found between male and female students in both typical and effective schools. This suggests that student engagement in schools is not affected by students' sex, suggesting that the engagement of all students in mathematics classrooms is comparable.

4.5. Teachers' Underlying Perceptions and Beliefs

On average, teachers in effective schools provided a higher intellectual quality in their learning environments to low-ability students compared to high-ability students. Whereas, in typical schools, teachers provided greater intellectual quality to high-ability students as compared to low-ability students. In our qualitative analyses, we selected teachers whose classrooms provided a similar pattern of intellectual quality to low-and high-ability students based on the type of schools in which they taught. In the effective schools, three teachers satisfied the two criteria. After examining whether teachers discussed low-ability students, two teachers, Mrs. B (2 points to the low-ability student and 1.58 points to the high-ability student) and Mrs. R (1.7 points to the low-ability student and 1.67 points to the high-ability student), were selected as the representative teachers. In typical schools, two teachers, Mrs. A (1.58 points to the low-ability student and 1.75 points to the high-ability student) and Mrs. T (1.42 points to the low-ability student and 1.58 points to the high-ability student), met the two criteria and were selected as representative teachers. Below, we report those teachers' underlying perceptions and self-reported practices and examine how their perceptions and beliefs were aligned with the observed classroom results.

4.5.1. Mrs. B

Mrs. B's low-ability students experienced higher intellectual quality than did her high-ability students. Her expectations and perceptions of the low-ability students and her self-reported teaching practices follow this pattern. Lily, a low-ability student, may not be promoted to the fifth grade; Mrs. B did not lower the standards and continued to hold high and positive expectations for her student:

> I don't like to lower my standards, but I like the children to have some type of success also. So if I grade her on the level that I grade some of the other children, then she would never have any success. It is just that when she gives me an assignment, I make a judgment based on what I know she can do grades-wise.

Mrs. B also identified and recognized Lily's progress across semesters. At the beginning of the year, Lily "would give up immediately and say she can't do it….So I think she is starting to catch on a little faster." Mrs. B's accommodations, based on her understanding of this student, allowed Lily to have some success in mathematics. According to Mrs. B, Lily did not know the basic mathematical facts and abstract concepts very well, while "concrete things work better for her." Lily's strength was that she knew how to ask for help and was persistent. Thus, Mrs. B knew that Lily should not be assigned independent work and the best strategies

for teaching her were to "pull her to the back of the room and work with her one on one" and to use explicit instruction (i.e., "show her an example of what we are doing and take her through them step by step").

Importantly, Mrs. B did not attribute Lily's non-successful grade promotion to the student despite her having some special needs. Instead, Mrs. B attributed Lily's academic struggles to the apparent lack of parental support. Lily lives in a single-parent family, with her mother and grandmother, neither of whom has checked her school performance: "She [Lily] doesn't have the parental support. I haven't met the parents yet. It is May, no one has picked up any of her report cards."

4.5.2. Mrs. R

Mrs. R is a teacher from an effective school whose low-ability student experienced greater intellectual quality than did a high-ability student. Amelia is a very shy, anxious, and less confident student. Mrs. R did not have low expectations of her; instead, she stated that "she has done well—she really has" and "she also tends to do on tests pretty much the way I expect her to."But Amelia is shy and "doesn't have that confidence yet in math." Her teacher gave her the chance to present a calendar, during which "she is coming out a little bit, and I think that is going to give her the confidence she needs when she is doing her exams and when she is doing her paper." Mrs. R also attempted to build Amelia's confidence through verbally encouraging and creating a safe learning environment: "I tell her to calm down and breathe. You'll do well, and if you don't do well, then we know which ones we have to target next week." Mrs. R also tried to use handy resources to better support Amelia's learning of multiplication facts, which are a weakness. Mrs. R made multiplication rap songs, little math puzzles, flashcards, multiplication computer games, and Saturday tutoring to help her. Amelia gradually grasped the basic mathematical facts that she had completely lost previously.

4.5.3. Mrs. A

Mrs. A taught in a typical school where her low-ability student experienced lower intellectual quality than did her high-ability student. When asked about the reason for Mia, a low-ability female student's failure to meet her expectations in math, Mrs. A responded:

> Some children are just not good at math, and it runs in the family. I talked to her mother about it [and] she said: "You know [Mrs. A], I was never good at math." So they project that down through the generations, you know.

Mrs. A's perceptions reflected that she treated students' low performance as passed between generations and rooted in parents' poor mathematics performance. When asked about Mia's strengths in math, Mrs. A responded: "Those kinds of questions, I can't answer right off the bat. You know, she's [an] average student and she just does the best that she can." Different from her effective schools colleagues, who identified their students' strengths and weaknesses in math, Mrs. A does not seem to have a good understanding of her students. Her perceptions suggest that she thinks there is nothing that she can do. Asked whether there were any ways of teaching that she adopted for her low-ability student, Mrs. A responded: "No. Not other than what I give to the whole class." She provided the same responses and asked if there were any ways of teaching that she just would not use with Mia ("No. I'm a generalizing person"). Mrs. A's perceptions of Mia's poor performance in math would seem to make it less likely that she would adopt individualized instruction and/or any other adaptation based on Mia's weaknesses and strengths in mathematics.

Surprisingly, Mrs. A also mentioned that her students did not have supportive home learning environments, noting that Mia came from a single-parent family with four to five children and that her mother also had drug abuse problems at some points.

4.5.4. Mrs. T

When Mrs. T talked about Kevin, her low-ability student, she seemed to face pressure to help this student pass the fourth-grade tests. Mrs. T knew, from Kevin's mother, that she had drug abuse problems when he was born, so Kevin may have learning disabilities and problems staying focused. However, his mother was first in denial and refused to test Kevin, which did not help him get the support that he needed:

> Um…but, she does realize that he has some learning difficulties. And he's so immature. You know, he was okay for these two days. But, I mean, he can really just…uh! Like…he's on the level of a kindergartner or a first-grader. You know, just everything is funny, and he's laughing and giggling.

In the two days of classroom observations, Kevin behaved well, but Mrs. T was not surprised, reporting: "I think he's a little scared of me." Giving Kevin the opportunities to work with his peer sometimes works, but not always: "Sometimes they do kind of tease each other, and I kind of squelch that as soon as they start. But, um…I don't know…he's uh! It's frustrating. It's really frustrating. But then again, I understand why he is the way he is." Based on Mrs. T's responses, she seemed very frustrated and overwhelmed by this low-ability student.

When asked about the kinds of assistance and resources that are available to help him, Mrs. T believed that a small setting might help, but she had a big class: "A much smaller setting. Not in a regular classroom, no. Not with 27, and see, we can go up to 33. Never with 33 people in a classroom. He would be lost." Also, Kevin was signed up for one-to-one tutoring and reinforcement with a retired teacher to keep him focused, but this mainly focused on literacy, not math.

Teachers in both the effective and the typical schools attributed students' low performance to family-related issues such as parent drug issues and family size. Unsupportive home learning environments were a common constraint and challenge for these teachers when teaching low-ability students who might need additional attention and instruction. However, there are some nuanced differences in teachers' perceptions, beliefs, and self-reported teaching practices. Teachers from effective schools held high and positive expectations of low-ability students and adopted individualized instructions that particularly met their learning needs; on the contrary, the teachers from typical schools held static perceptions about students' failure in math, such as that it passed from generation to generation.

5. Discussion

The present study found that students in effective schools experienced more intellectual support and greater overall intellectual quality of mathematics instruction than their peers in typical schools. Our observational evidence documents classroom environments with a strong academic focus and teachers with high expectations for their low-ability students (Clewell et al., 2007; Jesse et al., 2004; Price & Waxman, 2005; Teddlie & Reynolds, 2000). Classroom environments from effective schools provided greater intellectual support to students. Low-ability students in effective schools experienced better intellectual

quality of their learning environment, characterized by high academic expectations, mutual respect and support for all students, and deeper engagement in mathematical knowledge than their high-ability peers. The analysis of four mathematics teachers' interviews confirmed and expanded on these results; that is, the two teachers from effective schools hold high and positive expectations for the low-ability students, and they could identify low-ability students' strengths and weaknesses in mathematics, use the knowledge to make accommodations to teach them, and make use of resources to better support their mathematical learning. The typical school's teachers seemed very pessimistic about teaching low-ability students. Mrs. A holds that a student's poor performance passes between generations and is more likely to adopt general, non-individualized instruction to teach the low-ability students. Mrs. T is more negative and overwhelmed when facing low-ability students who have learning difficulties, blaming uncooperative parents.

This study also found some commonalities in the self-reported challenges and constraints of teaching low-ability students between effective and typical schools. Teachers from both schools mentioned that students, especially low-ability students, had unsupportive family environments, parental drug issues, and large families. As a result, those students presented behavior problems, could not concentrate on classroom learning and schoolwork, and showed no interest in mathematical learning. Generally, these challenges are not fundamentally different from other studies conducted in Urban areas (Du Plessis & Mestry, 2019; Muijs, 2003). What is similar across effective and typical schools relates to aspects of specific contextual circumstances, such as home learning environments, while what is different is how teachers perceive, expect, and teach students in mathematical classrooms. This finding opens a potential direction for future research; that is, rather than merely focusing on what makes effective schools different from ineffective ones, we might also need to study how effective schools overcome the challenges and pressures caused by distressing outside environments to provide a better school learning environment for students.

This study makes substantial contributions to current research. In examining how classroom learning environments contributed to school effectiveness, we went beyond focusing solely on the teacher side, such as teacher behaviors (Muijs & Reynolds, 2000) or instructional quality (Jong et al., 2004). We focused on teachers and students and their mutual contribution to the construction of high-quality learning environments.

Second, we examined classroom learning environments within contexts of school effectiveness and student ability. Results show that low-ability students from effective schools experienced better overall intellectual quality from their teachers than their peers (low- and high-ability) from typical schools. Sinclair et al. (2010) found that students from urban neighborhoods are less likely to progress toward positive outcomes after leaving school. It is not yet clear whether effective schools are able to add significant value to students' mathematical achievement since this study does not examine students' academic achievement. Surprisingly, teachers in our effective schools seem to compensate for low-ability students' disadvantaged academic status by providing better classroom learning environments and engagement opportunities.

The current study has limitations. We relied on a relatively small amount of observation data for multiple-level analysis, limiting the generalizability of the findings. Although schools in urban areas (Du Plessis & Mestry, 2019) faced similar challenges, such as paying less attention to low-achieving students and a lack of parental participation in children's education, an updated understanding of effective schools in urban contexts using larger-scale data collection approaches is needed. Second, our qualitative results are

limited to four representative teachers, illustrating how they perceived and taught students of varying ability levels. Future research should conduct more in-depth analyses to reveal diverse patterns in teachers' perceptions, expectations, and self-reported teaching practices across typical and effective schools.

The result of this study also has implications for educators, school leaders, and policymakers. This study revealed that teachers in highly effective schools supported low-ability students' mathematical learning by maintaining high expectations and adopting more individualized instructional strategies, even in the face of external challenges. The experiences of effective schools in addressing the needs of low-ability students from urban areas may provide valuable guidance for teachers in typical schools, as they face similar and often challenging circumstances. Therefore, fostering communication and collaboration among teachers across different schools is essential. Furthermore, Maden (2001) argued that in order to achieve and sustain improvement, schools in urban areas must go beyond what might be termed as "normal efforts." Teachers from both school types faced extremely serious challenges that extend beyond the capacity of individual teachers. Consequently, improving schools in the urban areas requires collaboration between schools, parents, and the broader community.

Acknowledgments

This study, and the larger study of which it was a part (see Clewell et al., 2007), were supported by a grant from the National Science Foundation to the Urban Institute in Washington, DC. Data were gathered while Walter Secada was on faculty at the University of Wisconsin–Madison. Secada received additional support during his sabbatical year from the UW–Madison Graduate School and School of Education, by the National Center for Improving Student Learning and Achievement in Mathematics and Science (funded by the US Department of Education Office of Educational Research and Improvement), and by Diversity in Mathematics Education/Center on Learning and Teaching (funded by NSF). All findings and opinions are the authors'. No endorsement by any of the above organizations or funding agencies should be inferred. We would also like to thank Lisa Byrd Adajian and Sherian Foster, who helped with gathering the classroom observation data and interviewing the teachers. Lisa Adajian organized and ably managed the two-day training institute on how to use the observational scales. Dominic Peressini modified the Classroom Observation Scales so that they could be used to follow individual students during the second wave of data gathering. Tona Williams coded the corpus of interview data and very ably trained the rest of the research team on the use of the software program.

Funding

This study was supported by fundamental research funds for the Central University and two Jiangsu Research Projects: Research on the Assessment and Practice of Interdisciplinary Thematic Learning Performance for Primary and Secondary School Students (2024SJYB0645) and Research on the International Comparison and Local Adaptation of STEM Curriculum for Cultivating Primary School Students' Higher-Order Thinking (B-b/2024/01/196).

Conflict of Interests

The authors declare no conflict of interest.

Data Availability

Data from this study are available upon reasonable request from the first author.

LLMs Disclosure

LLM tools were not used in the production of this article.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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II.

The System & Teachers' Stories

Social Inclusion
2026 • Volume 14 • Article 10950
https://doi.org/10.17645/si.10950

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Understanding Teacher Learning Through "Boundary Crossing" in the Greater Bay Area: Voices From Hong Kong and Guangzhou

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Submitted: 13 July 2025 **Accepted:** 2 October 2025 **Published:** 13 January 2026

Issue: This article is part of the issue "Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China" edited by Huinan Liu (The Education University of Hong Kong) and Meng Zhang (South China Normal University), fully open access at https://doi.org/10.17645/si.i543

Abstract

Alongside the growing demand for educational reform, calls for commitment to teacher learning have increased exponentially in the last decade. Yet, little is known about the effects teacher learning across different educational systems (what we will also call "cross-system teacher learning practices") have on the work itself, or how the learning these teachers experience across schools is reflected in their engagement in practices and activities when they return to their original schools and classrooms. Through the lens of activity theory, this study aims to ascertain the experiences of groups of teachers in mainland China and Hong Kong who participate in cross-system teacher learning activities. A qualitative multi-case study was adopted where three schools were sampled in both Guangzhou and Hong Kong. Six principals and 12 teachers participated in the study. Interviews were collected and qualitatively analysed to categorise the major processes and effects of cross-system teacher learning and capture the nature of cross-system teacher learning in China. The study showed that: (a) education departments "set the tone" for teacher education across different educational systems; (b) teaching methods and "the other side" of educational development serve as boundary objects; (c) principals function as boundary brokers; and (d) different types of learning activities regulate teacher learning. Four recurrent themes emerged related to the impact of cross-system teacher education: (a) awareness and understanding; (b) increased collective efficacy; (c) decision-making and problem-solving; and (d) teaching knowledge and skills. It is argued that equity and sustainability were central issues that teachers faced during the study. Relational trust contributed to teachers' collaboration across different educational systems and community-building. In the end of this article, suggestions to support cross-system teacher learning are made and implications for future research are proposed.

Keywords

activity theory; boundary crossing; educational systems; Hong Kong; mainland China; teacher learning

1. Introduction

Education systems worldwide are undergoing reform and change (Day & Gu, 2018; Lieberman & Grolnick, 1998), and it is widely acknowledged that teachers play a key role in implementing educational change (Fullan, 2014; Lieberman & Pointer Mace, 2008). Alongside calls for reform, calls for commitment to teacher learning have increased exponentially in the last few decades (see, e.g., Darling-Hammond & Richardson, 2009; Hayes et al., 2024; Wilson & Berne, 1999). However, teacher learning is a complex process influenced by multiple contexts, as teachers often participate in school-based learning communities as well as in cross-school learning communities in order to develop professionally. "School-based teacher learning" refers to teachers who acquire new practices ("learn") through the observation of their teaching peers, proactive action research, and "lesson study," a teaching improvement process that includes, for instance, teachers meeting to discuss learning goals, or planning a classroom lesson; "out-of-school teacher learning" includes learning in-school–university partnerships, teachers' training at the district and provincial levels, and possible school visits and exchanges (Darling-Hammond et al., 2009).

Teachers need time to go across contextual boundaries, in addition to daily professional learning within schools, to look for successful experiences (Burtch & Gordon, 2021). When teachers engage in different learning communities, crossing boundaries in multiple spheres, their learning is fostered. Indeed, the boundary crossing of teacher learning, including teachers' participation in courses and activities beyond school and beyond the system, enhances the scope of teacher learning opportunities. Although studies on boundary crossing emphasise that boundaries carry learning potential, they do not explain the specific mechanisms through which this potential is realised (Akkerman & Bakker, 2011). Little is currently known about how cross-system teacher learning drives teacher improvement, or how the learning these teachers experience in cross-system settings is reflected in their engagement in the practices and activities of schools and classrooms when they return.

China is no exception; Chinese teachers typically engage in subject-based teacher learning within schools. Additionally, these teachers are involved in professional activities beyond schools and the education system, such as school visits and exchanges in the Greater Bay Area (GBA).

At the policy level, attempts have been made to build cooperative relationships and shared understanding between teachers in different contexts. In 2019, the Chinese government promulgated the *Outline of the Development Plan of the Guangdong, Hong Kong and Macao Greater Bay Area*, a document that fosters sustainable collaboration and communication in the GBA. Teachers' participation in learning activities in the GBA allows them to engage at the intersection of their collective professional boundaries and enhance their professional connections. Indeed, Guangdong, Hong Kong, and Macao have historical collaborations in the field of teacher learning. By examining the development trajectory of Guangdong's interaction with Hong Kong and Macao, it is evident that the cooperation in teacher learning among these regions has undergone a process of experimentation and exploration, comprehensive development, as well as deepening and expansion, since the country's reform and opening up (Ma, 2014; Shi, 2021).

However, there is limited research on how cross-system teacher learning contributes to teacher improvement, and the process remains underexplored. Therefore, this study aims to ascertain specific practices of groups of in-service mainland Chinese teachers and groups of Hong Kong teachers who engage

in professional development activities in the GBA, a multilateral planning and ongoing development space, with a particular focus on Hong Kong and Guangzhou.

2. Hong Kong: Mainland Connection in the Context of the GBA Under the "One Country, Two Systems" Ideal

Hong Kong remained a British colony for over 150 years until June 1997, when it returned to mainland China as the Hong Kong Special Administrative Region. Under the "One Country, Two Systems" policy stipulated by the Basic Law, this former British colony retained a high degree of autonomy in all matters except foreign affairs and defence. Despite this, the influence of the British colonial period continues to shape Hong Kong, as evidenced by the retention of the education system established by the colonial government and the high priority placed on English. While Chinese education is rooted in the influence of Confucius (Bush & Qian, 2000), Hong Kong has been influenced by a hybrid of Western and Confucian cultures (Walker & Qian, 2017). Schools in mainland China are primarily classified as public schools operated directly by the government, self-financed private schools, or international schools. In Hong Kong, the school system comprises public schools directly operated by the government, or schools fully funded by the government and managed through incorporated management committees or school management committees. Additionally, there are direct subsidy schools that can charge tuition fees and receive government funding based on student enrollment, as well as self-financed private schools and international schools.

Since Hong Kong's return to China, educational exchanges and cooperation between the mainland and Hong Kong have continuously increased. In early 2019, the State Council issued the *Outline Development Plan for the Guangdong–Hong Kong–Macao Greater Bay Area* to encourage primary and secondary schools in Guangdong and Hong Kong to establish partnerships and promote the qualification of Hong Kong primary and secondary school teachers, allowing them to teach in Guangdong (State Council of the People's Republic of China, 2019).

The Guangdong–Hong Kong–Macao GBA refers to an integrated cross-system region encompassing the two special administrative regions of Hong Kong and Macao and nine cities in Guangdong Province, including Guangzhou. The GBA spans a total area of 56,500 square kilometres and has a resident population exceeding 86.90 million (Government of Macao Special Administrative Region Statistics and Census Service, 2023).

Given its geographical location and economic significance within China's socioeconomic landscape, the central government launched the GBA development strategy—China's first bay area regional development strategy, elevated to the national level. The GBA development represents both a new endeavour to foster a new pattern of comprehensive opening-up in the new era and a fresh practice in advancing the "One Country, Two Systems" cause. The development of the GBA also facilitates the establishment of school partnerships among primary and secondary schools in Guangdong, Hong Kong, and Macao, while accelerating cross-system teacher mobility (Qian et al., 2025).

The research to date on teacher learning provides useful theoretical angles to examine cross-system teacher learning (e.g., Lieberman, 2000), yet cross-system teacher learning presents unique features that cannot be fully understood with existing teacher learning frameworks. In other words, although job-embedded professional learning demonstrates significant potential at the school and district levels, little is known about how to scale this model more broadly. Teacher learning between Hong Kong and Guangzhou involves

crossing a hard boundary—namely, the difference between their school systems (Cheung & Hui, 2003). Historical ties (sharing the same roots) have bridged these two systems. The GBA, a nationally prioritised zone, cultivates a more integrative and collaborative educational environment, which provides an informative case for this study. The current study extends the literature on teacher mobility and cross-system collaboration, demonstrating how teachers contribute to and benefit from the GBA space.

3. Teacher Learning in the Chinese Context

Teacher learning, which is the same as teacher professional development (Avalos, 2011), encompasses work-integrated formal and informal learning. In the present study, teacher learning refers to collegial exchange of work-related subject and pedagogical knowledge and skills aimed at improving teaching and learning (de Vries et al., 2013; Kyndt et al., 2016; Meirink et al., 2007). The ongoing educational reform accentuates the importance of teacher learning. In China, such development has a long tradition embedded in the workplace practice of schools (Qian & Walker, 2021). A teaching-research group, as a teacher learning community, exists in each school. School-wide teacher development activities are routinised through teaching-research groups, under which lesson preparation groups operate as the smallest formal teaching learning community in schools (Tsui & Wong, 2009). Apart from these two teacher learning communities, teachers are also developed through the apprenticeship model, in which the old guide the young. This mentor–novice scheme supports young and inexperienced teachers at the beginning of their careers to get on the right track quickly.

In addition to school-based teacher learning opportunities, there are a number of out-of-school teacher learning opportunities available. These include master teacher studios, teacher training, and collective lesson study at the district and provincial levels, as well as school visits and exchanges. The Chinese government has made efforts to strengthen teaching quality by implementing effective systems to support teacher learning. Over the years, teacher learning has been institutionalised based on the official and unique setting of the teaching-research system. Given clear structural support, teacher learning in China becomes embedded in daily practice and very much relies on the interactions with colleagues within and across schools and with inputs from experts and professional associations, such as master teacher studios.

In recent years, China has reconstructed regional development planning in the form of city clusters, which has become an effective means of integrating and developing various fields within regions. At the same time, the governments of the two special administrative regions of Hong Kong and Macao have specifically emphasised in their policy addresses that they will continue to strengthen co-operation with the mainland provinces and actively act as facilitators of regional development. Both the central government and various local governments have innovated China's regional development model with great theoretical wisdom and great theoretical courage. Cross-border collaboration in teacher learning is an important means of enhancing the level of education development in the GBA, innovating modes of teacher learning, and building an exemplary brand of regional cooperation in China. In the past decades, some research has shown the potential influence of cross-system teacher learning on teacher development and identified a list of forms of cross-system teacher learning in the GBA, such as education forums, peer observation and exchange, research projects, and teaching competitions (Tang & Zhou, 2019). This study examines how teachers learn together when they engage in cross-system learning activities. Through the lens of activity theory, the authors explored the processes and effects of cross-system teacher learning in the GBA. Our aims were:

1. To identify the patterns of cross-system teacher learning in China.
2. To analyse different perspectives on the impact of cross-system learning in teacher development.

Two interrelated research questions have been formulated:

1. What mechanisms constitute teacher learning of boundary crossing?
2. How do school leaders and teachers perceive the impact of cross-system teacher learning in the GBA?

4. Theoretical Framework: Teacher Learning Through Boundary Crossing and "The Third Space"

Extensive evidence shows that teachers approach their long-standing practices and assumptions with a fresh perspective through boundary crossing. Boundaries often carry learning potential and can be opportunities for deep learning (Opfer & Pedder, 2011; Wenger, 1998). Akkerman and Bakker (2011) identified four mechanisms of learning that take place during boundary crossing: identification, coordination, reflection, and transformation. Two well-known theories that can be found in studying the boundary crossing behaviours and processes are activity theory (Engeström et al., 1995) and communities of practice (Wenger, 1998). Both theories emphasise the importance of boundaries and how they can facilitate learning.

Engeström's activity theory is well-suited for investigating cross-system teacher learning in the GBA because it focuses on analysing both individual systems and the intersecting or boundary spaces. This aligns closely with the concept of "the third space" (Bhabha, 1994; Gutiérrez et al., 1999), referred to as the "boundary zone" by activity theorists, which can be seen when two activity systems interact (Akkerman & Bakker, 2011). Professional partnership develops a "third space" where knowledge communities meet (Bloomfield & Nguyen, 2015; Daza et al., 2021). These concepts highlight the importance of recognising and leveraging the potential of these boundary spaces for learning and collaboration. The two interacting activity systems, as a minimal model for activity theory (see Figure 1), provide the specific dimensions of the exploration of the process and effects of the cross-system teacher learning. This allows for a comprehensive understanding of how teachers learn and interact across different educational systems in the GBA.

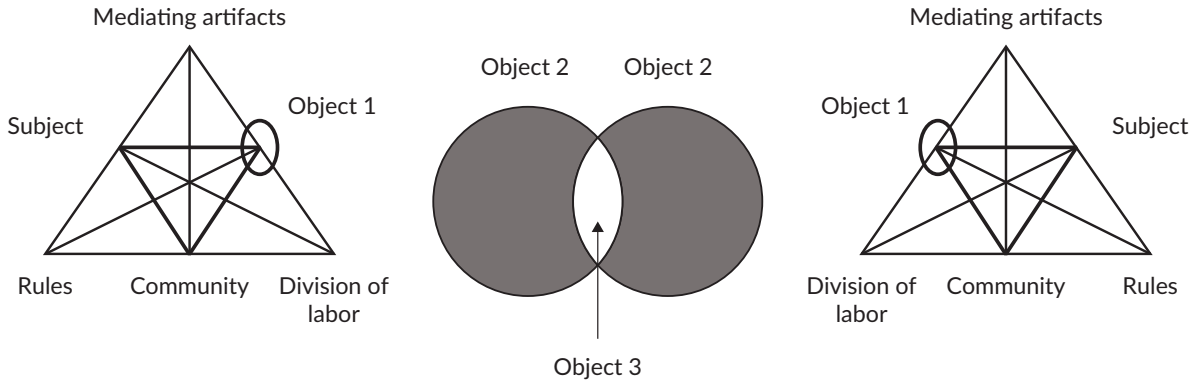

Figure 1. Two interacting activity systems as a minimal model for activity theory (Engeström, 2001).

The conceptual framework drawn upon in this study, referred to as the third generation, shows social influences and interdependence in a complex web of activity. It is comprised of six interrelated components,

including the object, division of labour, community, rules, subject, and mediating artefacts. These analytical dimensions facilitate the comprehensive understanding of the major processes and impacts of teacher learning activities when they move across different communities of practice (Wenger, 1998) or activity systems (Engeström et al., 1995).

5. Methodology

5.1. Case Study

Guided by the research questions centred on the nature of the cross-system teacher learning and detailed perspectives of how teachers learn together when they engage in cross-system learning activities, we chose a qualitative multiple-case approach as the most suitable method for this exploration.

First, case studies are a good fit for answering "how" and "why" questions (Flyvbjerg, 2006; Johnson & Christensen, 2017; Yin, 2014). Data was collected to answer these two types of questions to understand the process and effects of cross-system teacher learning. The nature of the study demonstrates depth rather than breadth, considering the "what" and "how" research questions. Case studies can facilitate an in-depth understanding of the process and effects by revealing the complexity of the situation and its meaning.

Second, case studies emphasise understanding the process over simply measuring outcomes and prioritise exploration rather than seeking to confirm predefined hypotheses (Stake, 2010). This study explores how teachers learn together when they engage in cross-system teacher learning. Case studies enable researchers to investigate the dynamics and complexity of the process. Thus, a qualitative case study is the most appropriate approach for addressing the research questions of this study.

Purposive sampling, which includes information-rich cases for exploration (Patton, 1990), was used to recruit participants. Researchers can learn most from the information-rich cases (Merriam, 1998). Cases for analysis needed to meet the following criteria:

1. The schools involved have sister schools in the GBA, ensuring that there is a connection and collaboration between schools within the region.

2. The teachers participating in the study are actively engaged in cross-system professional learning activities regularly in the GBA, ensuring that the teachers have firsthand experience and involvement in the cross-system learning process.

English, Chinese, and mathematics are the main subjects in mainland schools, while English, Chinese, mathematics, and citizenship and social development are the core subjects in Hong Kong schools. Thus, teachers and school leaders of these subjects were sampled. The research included different types of schools, different core subjects, and different years of teaching experience to maximise the variety. The aim is to sample six schools—three schools in Hong Kong and three schools in mainland China. In total, six schools, 12 teachers (two for each school), and six principals (a principal for each school) participated in the study (see Table 1).

Through the qualitative case research design, we try to untangle the dynamics and complexities of how teachers experience learning through participating in a range of cross-system learning activities in the GBA. Through the lens of activity theory, we investigate how cross-system teacher learning communities can drive teacher professionalism.

Table 1. Participants' information.

School ($n = 6$)	Principals ($n = 6$)		Teachers ($n = 12$)	
	Number and code	Years of leadership	Number and code	Years of teaching experience
School A (public school)	1 (A1)	11 years	2 (A2 & A3)	8 & 12 years
School B (private school)	1 (B1)	26 years	2 (B2 & B3)	9 & 16 years
School C (public school)	1 (C1)	12 years	2 (C2 & C3)	11 & 24 years
School D (public school)	1 (D1)	7 years	2 (D2 & D3)	10 & 30 years
School E (public school)	1 (E1)	15 years	2 (E2 & E3)	6 & 20 years
School F (public school)	1 (F1)	17 years	2 (F2 & F3)	23 & 28 years

5.2. Data Collection and Data Analysis

In the data collection, semi-structured individual interviews were used to collect data to address the research questions. Each interview lasted between 45 and 60 minutes. Hong Kong participants were interviewed in Cantonese, while mainland participants were interviewed in Mandarin. The language of the interview was determined based on the participants' preferences. The interviews were audiotaped with the participants' consent. Participants were asked about the experiences of cross-system teacher learning and how this form of learning influences teachers. We employed the deductive and inductive approaches (hybrid approach) to identify the theme of patterns (Braun & Clarke, 2006) by using NVivo 12.0. These themes were analysed in relation to Engeström's (2001) framework (i.e., the object, division of labour, community, rules, subject, and mediating artefacts). Similar to the findings from both within-case and cross-case analyses, transitioning from individual codes to broader patterns highlighted the similarities and differences that addressed the research questions.

Four recurrent themes emerged: (a) education departments "set the tone" of the cross-system teacher learning; (b) teaching methods and the other side of educational development as boundary objects; (c) principals as boundary brokers; and (d) different types of learning activities serve as a regulation of teacher cross-system learning. The outcome of cross-system teacher learning would finally be defined as the overall impact of cross-system teacher learning (Goodnough, 2016). Four recurrent domains emerged in relation to the impact of this teacher learning practice: (a) awareness and understanding; (b) increased collective efficacy; (c) decision-making and problem-solving; and (d) teaching knowledge and skills.

6. Findings

Drawing upon activity theory, this study explored the processes and effects of cross-system teacher learning in the GBA.

6.1. What Mechanisms Constitute Teacher Learning of Boundary Crossing?

6.1.1. Education Departments "Set the Tone" of Cross-System Teacher Learning

Our analysis of the data identified several organisers of cross-system teacher learning, including education departments, sister schools, universities, and school sponsoring bodies. The interviews further highlighted that local and provincial education departments across the GBA play an important role as primary organisers of this collective learning:

> The education departments in Guangzhou, Shenzhen, and Macau typically organise cross-system learning seminars and school visits. Additionally, we have other organisers, such as our school sponsoring body, the Salvation Army. (A1)

> In recent years, the education department has taken on a more proactive and central role. Initially, we took the initiative ourselves, starting with our sister schools. We collaborated with them, with support from the Nanshan district education department in Shenzhen….Universities are frequently involved as well. Researchers from local universities, connected with the Hong Kong Federation of Education Workers and local schools, actively facilitate cross-system learning. (B1)

Our analysis of the data suggests that education departments guided the work of the networked learning community by establishing funds, deploying guidelines and policies, and designing teacher training programmes that incorporate cross-system learning. Another principal gave an example of how the education department supported cross-system teacher learning:

> These cross-boundary exchange activities for our teachers are mainly organised by the Education Bureau. We are a public school with limited funding, so we still rely on the Education Bureau. The Education Bureau provides some subsidies so that teachers can go out more easily. When teachers go out to study, part of the subsidies can be used to hire substitute teachers. In addition, the Education Bureau also has some projects, such as the "Passing on the Torch" National Education Activity Series, to promote exchanges and learning among teachers in the Greater Bay Area. (D1)

In addition to education departments, multiple organisations are involved in creating a multi-tiered system of support with boundary crossing. The interviews revealed partnerships between local, provincial education departments, universities, and other entities to establish a network of support and resources. One principal stated: "Every year, the education department allocates $150,000 to the schools for the sister school exchange programme, covering transportation and accommodation costs." The data suggested government-led initiatives for teacher learning through boundary crossing.

6.1.2. Teaching Methods and Understanding Each Other's Educational Development as Boundary Objects

Participants were asked to indicate what served as a reason for cross-system teacher learning and how other teachers have been involved. The interviewees showed that many innovative teaching methods could be incorporated into the teaching repertoire to enhance classroom effectiveness, and suggested that cross-system learning might be one of the most effective strategies for acquiring these innovative methods:

> They [the mainland Chinese teachers] seem to be more successful than us in terms of teaching. What are we missing? So, I'm actually thinking that it's a motivation for us to engage in cross-system activities. (B3)

> I am eager to bring something precious back to the school, back to Po Leung Kuk, and back to Hong Kong. This is a great opportunity. Teachers from Guangdong disseminated their own excellent education experience and education stories…and in turn, through exchanges and mutual learning with their Hong Kong colleagues, they brought back to Guangdong Hong Kong's distinctive education concepts and practices, which had strongly contributed to the development of Guangdong teachers and the enhancement of the quality of education, and realised the two-way running and mutual achievements of the teachers of Guangdong and Hong Kong. (C3)

One principal further explained:

> As part of the GBA, Hong Kong is increasingly connected to the mainland, prompting us to reflect on our actions. What are they doing? Is there something we can learn from this situation? Over the past decade, the landscape has shifted dramatically. Ten years ago, many teachers from the mainland came to Hong Kong to study and learn from our education system. However, we now recognise that cities in the mainland are advancing more rapidly than Hong Kong. Consequently, we are turning back to engage in idea exchanges with them. (D1)

Teachers engaged in collaborative learning with others outside of their everyday community of practice to improve teaching methods. Additionally, the interviews indicated teachers' interest in what is transpiring in other education systems. A teacher from Guangdong shared her observations:

> The diversified modes of running basic education in Hong Kong, including government, subsidised, direct subsidy scheme, and private schools, can give full play to all kinds of resources devoted to education, and also enable parents and students with different needs to have more choices. Education in Hong Kong focuses on whole-person development. It not only pays attention to the academic performance of students but also attaches importance to the development of students' comprehensive qualities, such as moral character, social skills, and innovative thinking. This concept of holistic parenting is worthy of reference for our schools, and we should pay more attention to the development of students' personalities and the cultivation of multiple intelligences. Currently, our education is still mostly through a single classroom model, and much of the subject knowledge and character education is framed in PowerPoint. (F3)

The recurrent theme is teaching methods and recent educational development in the GBA in the interviews. Moreover, the teachers and principals in this study welcomed one another's experience and expertise and developed a tone where each member of the GBA was perceived as a resource with expertise to share. The teachers also suggested shared belief, stating: "We are *tonggen tongyuan* [meaning: sharing the same roots and the same origin]." The teachers emphasised the sense of national identity and expressed a desire to learn from one another in similar contexts: "I believe that hosting these events creates a synergy for the GBA, resulting in a positive ripple effect that allows more teachers to access quality resources." The data indicated that cross-system learning aimed to promote a space where equity and deeper learning thrive.

6.1.3. Principals as Boundary Brokers

The brokering role of the principals was highlighted in the study. The data showed that the principals fostered coherence among various activity systems, such as the education bureau and teachers in their schools. In this space, the principals sought connection and agency, as noted by one principal:

> My role is mainly to receive information [in case] there is an event, and I [mobilise] the relevant teachers to attend the topic in question. Based on the fact that it is easier for the school principal to connect when they go, sometimes I also go with the teachers. Moreover, sometimes there are some activities that require the principals to participate and do some sharing. (B1)

The data indicated that the role of a principal is not only to disseminate the information and organise the participation of colleagues, but also to be a participant. They maintained relationships with other schools and supported teachers to cross boundaries by participating in the learning activities. Additionally, the principals interpreted a series of learning activities in which teachers may assume different roles and perform different actions. One teacher responded:

> The principal would encourage us to attend….Depending on the topic, he would find relevant colleagues to attend, and he would talk to us about what he expected of us. (F1)

One principal further explained:

> I send the information to the teachers. Some of our colleagues show interest. For [their] professional development, I let a portion of the teachers develop first and lead other teachers, and then the rest of the teachers develop gradually. I hope everyone has the chance to participate in cross-system learning and extrapolate good practices. (E1)

The data indicated that brokering is one type of practice that principals might engage in as they support teacher professional learning in multiple activity systems. The principals worked with different communities, including education departments, peer schools, and colleagues, to promote teachers' boundary-crossing behaviours. For example, one principal (F1) noted: "Some of the teachers are away on study trips and I will approach their subject groups and then ask for help from the subject groups to sort out the substitutions." Another principal elaborated:

> I have first-hand knowledge of what is happening in [a] school. After receiving the information about the event, I will see which teachers are suitable to participate in the event, and how to arrange it so that the school can benefit more. I will then nominate my colleagues to participate. (C1)

The interviews highlighted the decision-making role of principals as brokers. They leveraged their decisional capital to promote teacher learning. The principals also made sense of internal and external expectations throughout the process. One principal noted:

> In the past, we did not pay so much attention to the "sister school" scheme. The Education Bureau did not care whether you applied or not. But in the past few years, we have seen that the Education

> Bureau has been very active. Some schools that haven't yet applied may reach out to ask if you need assistance in pairing with sister schools. (C1)

The data showed the importance of the role of principals as brokers. At the top level, the principal helped translate the policy and events from the education departments to the schools. At the bottom level, the principals helped teachers communicate with other schools.

6.1.4. Different Types of Learning Activities Serve as Regulation of Teacher Cross-System Learning

The interviews demonstrated multi-level teacher learning in the GBA, involving novice teachers, mid-career teachers, and experienced teachers. In the main, the data demonstrated that there are generally five types of cross-system teacher learning methods: (a) attending conferences and workshops; (b) school visits and classroom observation; (c) collaborative teaching; (d) participating in teacher training programmes; and (e) through access to regional resources.

The majority of the teachers we interviewed had the experience of attending conferences and workshops in the GBA. One principal responded:

> The Guangzhou Education Department and the Macao Education and Youth Development Bureau co-organise conferences and school visits, which we attend, as well as forums organised by the local universities in Hong Kong, which we, and those from schools in Shenzhen and Guangzhou, also attend. (F3)

These teachers spoke of their learning through "hands-on experiences," such as school visits and classroom observation. One teacher mentioned:

> Schools from Hong Kong come over to our school, and the teachers bring their students over, and our teachers teach. Their students are mixed with our students in a class above, and our teachers come and teach. It's a one-day school visit, with lessons in the morning and extra-curricular activities in the afternoon. Then the teachers get to know each other's education system and teaching practices. (D2)

Teachers also indicated that they learnt through collaborative teaching, for example, talking with students and colleagues, sharing materials, and participating in project groups. One principal responded:

> Apart from visits and tours, nowadays, we are increasingly engaging in lesson study, using the same lesson, doing it once in Hong Kong, once in the Bay Area and once in other places, so for teachers, the path of professional development is broader. (C1)

Another teacher added:

> We usually went for a day or two. We went to Hong Kong with lessons, prepared the lessons, made copies of the textbooks for our lessons, and taught their students, mainly in English and Chinese, for one or two lessons. The content of the lessons was mainly suggested by their director of the teaching affairs office and the principal, and after we negotiated with them, we went there with the lessons. It is

> not the whole subject group that goes there, and our principal decides which teachers are sent there. We go there at public expense, and the Education Bureau will support us with funding. Additionally, we have a colleague who went to a school in Hong Kong 10 years ago to teach and work on a project for about two or three years. Later, she came back and became the backbone of the school, serving as the director of the teaching affairs office and later as the principal. (E3)

Concerning the teacher training programmes, one principal shared:

> The pilot programme [*Linghang Jihua*] is another important milestone in the education exchange and co-operation between the mainland and Hong Kong, a brand-new attempt in teacher co-operation in the GBA. Initiated by South China Normal University, the programme serves as the first training and exchange base for our teachers, offering one year of continuous and in-depth training, which includes "close guidance," such as shadowing and visiting schools, as well as practical teaching and learning activities. (A1)

In addition to the teacher training programmes, teachers' boundary-crossing learning uses regional resources, such as technology-related advancements in the mainland. One principal noted:

> After recovering from the epidemic, we visited Huawei's office, which feels like a village. We needed to take a bus to get there. Our teachers also visited the Tencent Building in Shenzhen, located in the GBA. It's all about science and technology, urban planning, and learning from the teachers. That's the focus—science, technology, and city development. (D1)

The data suggested that different types of learning activities were supposed to steer teacher cross-system learning. Based on our analysis of the data, teachers learnt through cooperating and interacting with colleagues and students, extra-work contexts, and through teacher training programmes in the GBA.

6.2. What Is the Impact of Cross-System Teacher Learning on Teachers?

The data indicated the impact of teacher learning through boundary crossing in a broad array of domains, namely (a) awareness and understanding, (b) increased collective efficacy, (c) decision-making and problem-solving, and (d) teaching knowledge and skills.

The interviews indicated that teachers developed a strong awareness and understanding of each other's classrooms through their interactions. One teacher responded:

> These activities, particularly lesson observation, have facilitated our reflection and understanding when compared to classrooms in the mainland. I noticed that teaching in the mainland has become more interactive. We focus on how students learn, while the mainland emphasises how teachers teach. Additionally, I observed that they are increasingly meticulous in their lesson preparation and more precise in their teaching points. Often, our students don't learn as much through play, which is a difference. (A3)

One teacher emphasised the increased collective efficacy:

> We welcome one another's experience in an effort to develop a tone where each member of the community is perceived as a resource with expertise to share. We have opportunities to collaborate in the GBA through teaching one another's students, which can support us to enact plans and problem-solve in a different education system. (D2)

Additionally, the data showed that teachers' decisional capital improved. One principal stated:

> I think our teachers, by going out, have opened their eyes and have more options. The concept of education has become richer. They have become more flexible, more suitable for teaching in a wider environment, and have been exposed to issues that they have not been exposed to on the mainland, leading to an improvement in their decision-making abilities. The system and students are also different, which promotes thinking, and it is also helpful for teachers' career development. (E1)

A majority of principals responded that teachers' engagement in the cross-system learning has "raised the expertise of teachers within their schools." The teachers piloted the educational innovation and instructional improvement strategies, as noted by participants:

> I think the first thing is to broaden teachers' horizons. Teachers know that they can do a better job with different resources, so when they know that, they try it out in their schools, introduce these methods, and bring them to Hong Kong for localisation. (B1)

> Hong Kong's student-centred teaching is still worthy of our reference. From this, we can reflect on our own classroom, our lesson preparation, our classroom teaching sessions, and the setting up of teaching activities; that is, we have to think from the perspective of the students. In the process of implementation, we have to pay attention to what students think and make adjustments accordingly, not just follow the instructional design. (D3)

The data showed that cross-system learning provided teachers with opportunities to enact agency and access support. Participants identified the impact on teachers across various domains, including enhanced awareness and understanding of each other's classrooms, increased collective efficacy, improved decision-making and problem-solving abilities, and increased teaching knowledge and skills. The interviews also showed that participants expected a structured and systematic learning system to foster teachers' transformation and professional development.

7. Discussion

Although research on boundary crossing indicates that boundaries hold learning potential, the specific mechanisms through which this occurs are not clearly defined (Akkerman & Bakker, 2011). This qualitative study explores the process and effects of cross-system teacher learning in the GBA from the perspective of Engeström's (2001) activity theory. This theoretical focus helped capture the core dynamics of how teachers learn and interact across different educational systems.

The cross-system teacher learning in this study involves an expanded, more diverse community than a traditional inter-school professional learning community. Brokering was one type of practice that school principals engaged in as they supported teachers being presented in multiple contexts. The brokering role of the school principals highlighted the multi-level influences that are intertwined and influence each other, both within and across systems. It was a multifaceted role as it included "processes of translation, coordination, and alignment between perspectives" (Wenger, 1998, p. 109).

A reason for teachers to continuously participate in cross-system teacher learning was that many innovative teaching methods could be incorporated into their teaching repertoire to enhance classroom effectiveness. Teachers negotiated ingredients from different contexts into instructional-improvement strategies, which corresponds to Engeström et al.'s (1995) term "hybridisation." Teachers moved between schools and the GBA contexts to look for successful practices (Burtch & Gordon, 2021).

Further, another transformation process, gaining new perspectives on one another's education development, was also found in the data. Our analysis of the data indicated that teacher learning through boundary crossing had an impact across a broad array of domains and led to a process of mutual identification, reflection, and transformation. These findings echo the findings of Bloomfield and Nguyen (2015) and Daza et al. (2021), suggesting the potential of the "third space" where knowledge communities meet for professional growth in myriad ways. The transformation process was not a one-time occurrence, but was shaped over an extensive period of time, which resonates with Engeström's (2001) term "historicity."

The GBA as a "third space" makes a unique contribution, emphasising the importance of *tonggen tongyuan* (shared cultural heritage) as well as belonging and attachment in the study of professional identity and development. The finding enriches the understanding of previous studies on how individuals engaged in the joint activities (Engeström, 2001), suggesting that, beyond structural and material conditions, the relational trust and shared cultural heritage contributed to the teacher learning through system boundary crossing. Simultaneously, national interests and policy priorities dictated the nature of the learning networks. Multi-actors, such as the principals acting as boundary brokers, facilitated teachers' spatial practices and teacher learning clusters, and strengthened the partnership synergy. Our analysis of data also indicated that cross-system learning aimed to promote a space where equity and deeper learning thrive, leading to a beneficial ripple effect that enables more teachers to tap into high-quality resources. It is argued that equity and sustainability were central issues facing teachers.

8. Conclusion

This qualitative study examined how teachers learn through boundary crossing when they move between school and GBA contexts. By applying activity theory to these findings, the study showed how the interplay of different elements shaped cross-system teacher learning. The current article extends the literature on teacher mobility and cross-system collaboration, demonstrating how teachers contribute to and benefit from the GBA.

Teachers integrated ingredients from different contexts into instructional-improvement strategies, reflecting Engeström et al.'s (1995) concept of "hybridisation." Teachers navigated between schools across the GBA looking for successful practices (Burtch & Gordon, 2021). Our study identified five main ways teacher learning across different educational systems can take place: (a) conference and workshop attendance;

(b) school visits and classroom observation; (c) via collaborative teaching; (d) by participating in teacher training programmes; and (e) by using regional resources. Teacher learning across different systems showed a positive impact on teachers' enhanced awareness and understanding of each other's classrooms, on the increased collective efficacy, on decision-making, and on teachers' problem-solving abilities and increased teaching knowledge and skills. Relational trust contributed to the cross-system collaboration and networked community building. The innovative aspect of this study lies in the unique application of activity theory to explore cross-system teacher learning within professional experiences.

9. Implication of the Study

This research investigates how teachers learn across different systems and examines the effects of that learning process. The observed mechanisms may serve as a reference for similar regional initiatives worldwide, particularly those considering local differences and cross-system connections. National-level coordination remains important. The study further emphasises that, in promoting cross-system teacher learning, attention should be given to equity and sustainability, promoting cross-cultural knowledge and understanding, and building trustful relationships. The study is helpful and valuable for teachers, policymakers, school leaders, and other educational practitioners in understanding key features of cross-system teacher learning in the GBA and learn from the Chinese experience. The study advances knowledge of teachers' boundary crossing through horizontal and hierarchical forms from the perspective of activity theory. It develops regionally focused knowledge in cross-system teacher learning in a non-Western country, namely China. The study concludes by outlining practical implications for supporting teachers' ongoing development in cross-system settings.

Through the lens of activity theory, the authors explored the processes and effects of cross-system teacher learning in the GBA. The study sampled five public schools and one private school. Considering the differences in resource allocation and school autonomy, future research will include additional private schools to yield a richer and more nuanced understanding. Cross-system teacher learning does not occur in a vacuum; rather, it is highly shaped by multi-level influences. Thus, more clarity is needed to understand the key factors and how they interact with one another to shape the learning process. Additionally, future research should focus on longitudinal studies that track the long-term impacts of cross-system teacher learning on teaching practices and student outcomes. More in situ research is recommended to examine teacher learning to provide cross-societal discourse.

Acknowledgments

The authors thank the editorial team at *Social Inclusion* and the anonymous reviewers for their constructive feedback. We also thank the principals and teachers who participated in our research and shared their views and experiences with us.

Funding

The project In Search of the Third Space: Teacher Learning Through Boundary Crossing in the Greater Bay Area was funded by Hong Kong's Research Grants Council.

Conflict of Interests

The authors declare no conflict of interest.

Data Availability

Data is not publicly accessible to protect the respondents' anonymity.

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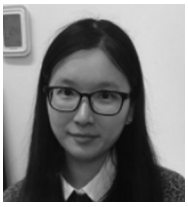

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Social Inclusion
2026 • Volume 14 • Article 10998
https://doi.org/10.17645/si.10998

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Open Access Journal

Contextualizing System Leadership in China: Evidence From Inter-School Collaboration in the Greater Bay Area

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Submitted: 24 July 2025 **Accepted:** 1 September 2025 **Published:** 13 January 2026

Issue: This article is part of the issue "Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China" edited by Huinan Liu (The Education University of Hong Kong) and Meng Zhang (South China Normal University), fully open access at https://doi.org/10.17645/si.i543

Abstract

As inter-school collaboration becomes a key strategy for educational improvement, the role of system leaders in sustaining such efforts has drawn increasing attention. Yet empirical research in the Chinese context remains limited. This study examines how system leaders facilitate sustainable inter-school collaboration in China's Greater Bay Area, focusing on a successful long-term school partnership established under the government-supported Sister School Scheme. Using a qualitative case study, we analyzed interview data from five principals—each holding multiple roles—as our primary data source. Documentary materials (e.g., policy texts and school reports) were used to triangulate and contextualize the interview findings. Thematic coding analysis shows that these leaders enacted system leadership by shifting among four interrelated roles—thought advocate, practice pioneer, boundary spanner, and resource mobilizer, each linked to specific leadership practices. The study advances international understanding of system leadership by showing how principals lead across school and system boundaries in China's policy-driven, cross-border context. It also offers practical insights for sustaining inter-school collaboration.

Keywords

Greater Bay Area; inter-school collaboration; Sister School Scheme; system leadership

1. Introduction

Over the past two decades, inter-school collaboration has attracted growing global interest as education systems move beyond traditional top-down reforms (Muijs, 2015). The increasing permeability of school

boundaries has underscored the strategic value of cross-school partnerships in fostering innovation and driving school improvement (Chapman & Muijs, 2014; Cheah, 2023; Hargreaves, 2011). Specifically, inter-school collaboration facilitates resource sharing (e.g., teachers, facilities), builds mutual support for school improvement (Chapman & Muijs, 2014; Lieberman, 2000; Muijs et al., 2010), and promotes knowledge integration and innovation, as well as the diffusion of effective practices (Atkinson et al., 2007; Katz & Earl, 2010). As such, building school networks has also become popular in discourses on school change and improvement (Díaz-Gibson et al., 2017).

Against this context, there has been growing scholarly interest in system leaders—educational leaders who demonstrate systems thinking and exert system leadership across multiple levels (Fullan, 2004). As inter-school collaboration does not inherently yield positive outcomes, its effectiveness depends on supportive conditions, particularly the presence of system leaders who act as boundary spanning agents extending stakeholder influence across organizations (Senge et al., 2015). In the educational context, system leaders drive systemic transformation and ensure lasting impact within, between, and beyond schools (Chapman & Muijs, 2014; Hopkins & Higham, 2007). As for system leadership, scholars (e.g., Beehner, 2019; Boylan, 2016; Greany, 2022; Harris, 2010) have proposed varied definitions, yet a common theme emphasizes its role in overcoming systemic inertia by linking localized efforts to broader systems and fostering collaboration (Fullan, 2004). Originating in Scotland, the concept has attracted attention from the OECD and countries such as the United Kingdom and the United States (Dimmock, 2016; Pont et al., 2008). It is increasingly viewed as a strategic approach to advancing equity and quality across school systems, grounded in moral purpose (Dimmock, 2016; Pont & Hopkins, 2012; Spillane et al., 2023). Although system leaders may hold different hierarchical roles, they share the goal of achieving system-wide improvement through collaboration and evidence-informed practices (Hopkins et al., 2014).

System leadership is increasingly recognized for its role in promoting effective school collaboration and educational reform, has attracted global attention (Dimmock, 2016). However, empirical research in the Chinese context remains limited, despite its distinct institutional and cultural conditions. The knowledge base on inter-school collaboration/partnership is also dominated by Western perspectives, with limited exploration in East Asia. In particular, how system leaders support and sustain such collaborations within East Asia cultural settings remains under-explored. Moreover, not all school partnerships are effective; understanding the effective leadership practices that enable sustainable school collaboration is essential. The Sister School Scheme (hereafter, the Scheme) between Hong Kong and the Chinese mainland has been implemented for more than two decades, yet it has attracted limited scholarly attention. Nevertheless, it constitutes a valuable case for investigating how system leadership can support and sustain inter-school collaboration.

This study thus examines how system leaders (mainly principals, often holding multiple roles) facilitate sustainable and effective inter-school collaborations within the Scheme, using a qualitative case study to explore their leadership beyond individual schools and across system levels.

2. System Leadership

To explore how system leaders enact leadership practices, including their roles and behaviors, it is essential to first develop a clear understanding of system leaders and system leadership. This section outlines the evolution

and conceptualization of system leadership, examines the roles and practices of system leaders, and presents the theoretical foundation of the study.

2.1. Development of System Leadership

System leadership, rooted in systems theory, emerged in the early 21st century as an approach emphasizing the interactions among system components rather than the isolated actions of individual parts. In the field of education, system leadership builds on earlier theories, particularly effective school leadership, instructional leadership, and distributed leadership (Lyle et al., 2024; Mowat, 2019). One of the reasons system leadership gained prominence is the policy trend in school reform. Before the 1980s, school reforms in Western countries were largely top-down and government-led, but were often unsuccessful because the policy context became more complex (Sarason, 2002). In response, societal expectations for schools increased, and the 1990s and early 2000s saw a shift toward bottom-up approaches such as school-based management, school autonomy, and school partnerships (Dimmock, 2016). Since the early 21st century, system leadership has gained global attention from organizations like the OECD and from countries such as Scotland, the United Kingdom, the United States, Singapore, and Australia. It is increasingly recognized as a key tool for school improvement, emphasizing horizontal collaboration among professionals rather than vertical reforms (Dimmock, 2016).

To achieve effective school reform and systemic change, Fullan (2004) emphasizes the importance of systems thinkers and systems thinking. These systems thinkers are "leaders who work intensely in their own schools, or national agencies, and at the same time connect with and participate in the bigger picture" (Fullan, 2004, p. 8). Scholars have proposed varied definitions of system leadership (Beehner, 2019; Boylan, 2016; Bush, 2023; Greany, 2022; Harris, 2010), yet a common theme emphasizes its role in overcoming systemic inertia by linking localized efforts to broader systems and fostering collaboration (Fullan, 2004).

2.2. Practices of System Leaders

Scholars have proposed various frameworks to conceptualize system leadership practices, all converging on the notion that moral purpose—a commitment to equity and to supporting schools in challenging contexts—lies at its core (Mowat, 2019). Building on this foundation, Hopkins (2009) identifies five key domains of system leadership: improving student learning, fostering professional learning communities, developing collaborative networks, promoting equity and inclusion, and recognizing the interdependence between school and system levels. In line with this, Mowat (2019) emphasizes that system leaders serve as change agents by building partnerships and driving curricular and pedagogical innovations. Dreier et al. (2019) further advance the CLEAR framework, which outlines five interrelated phases of system change: convene and commit, look and learn, engage and energize, act with accountability, and review and revise.

System leadership has also been explored at multiple levels. Harris et al. (2021) synthesize the literature that distinguishes between the macro and micro levels: the former focuses on systems thinking and policy-level reforms (e.g., Fullan, 2004), while the latter highlights individual traits and functions such as collaboration, vision-setting, and leadership capacity (e.g., Boylan, 2016; Dimmock, 2016). Cheah (2023) adds that effective system leaders must operate across individual, organizational, and community levels, continually learning and adapting to lead sustainable change. Finally, system leaders often work across three nested levels—school,

local network, and national system—offering support, sharing expertise, and aligning practice with broader reforms (Fullan, 2004; Hopkins, 2009; Spillane et al., 2023).

2.3. Theoretical Foundation of This Study

Although scholars have proposed various theoretical frameworks for system leadership, their descriptions of leadership practices differ in emphasis. Drawing on frameworks developed by Hopkins and Higham (2007), and by Hopkins (2009), together with insights from system thinking and system leadership literature, this study develops an analytical framework for understanding how system leaders facilitate inter-school collaboration in China's Guangdong–Hong Kong–Macao Greater Bay Area (GBA). The framework of system leadership practices outlines four dimensions:

1) Setting Direction with Moral Purpose: System leaders focus on improving student learning while promoting equity and inclusion, aiming to raise academic standards and close achievement gaps (e.g., Cheah, 2023; Dimmock, 2016; Hopkins, 2009; Mowat, 2019).
2) Managing Teaching and Learning: They drive continuous improvement in curriculum, pedagogy, and assessment to strengthen instructional quality across schools (e.g., Beehner, 2019; Hill, 2011; Hopkins & Higham, 2007; Mowat, 2019).
3) Developing the Organization: They optimize structures, mobilize resources, and cultivate professional learning communities, fostering a supportive culture and enabling sustained improvement and innovation (e.g., Boylan, 2016; Cheah, 2023; Harris, 2010; Mowat, 2019).
4) Understanding the Interdependence of School and System Levels: They recognize that meaningful change requires engagement at multiple levels—from classrooms to schools to the broader system—and work to ensure that change meets diverse educational needs (e.g., Beehner, 2019; Chapman & Muijs, 2014; Harris et al., 2021; Spillane et al., 2023).

The synthesis of system leadership practices outlined above serves as the theoretical foundation for the data analysis in this study. Although the analysis primarily employed data-driven coding, the later stages incorporated the existing framework to facilitate deeper reflection, examining how system leadership practices manifest within the Chinese context in relation to the Western-derived framework.

3. Methods

This study explores two main issues: (a) the roles of system leaders in facilitating inter-school collaboration in China, and (b) the leadership behaviors enacted by these system leaders. To address these questions, a qualitative case study approach was adopted. Ethical approval was obtained from the institutional review board of The Education University of Hong Kong, and informed consent was secured from all participants. This section covers the study context (the Scheme in the GBA, China), participant selection, data collection, and analysis.

3.1. Context of This Study

The Scheme is a key form of inter-school collaboration in the GBA, comparable to the San Francisco and New York Bay Areas in the United States and the Tokyo Bay Area in Japan. As part of a national strategy

to deepen regional integration and educational cooperation, the Scheme serves as a platform for fostering connectivity and shared development across the region.

Launched in 2004 through a tripartite agreement among the Education Bureau of the Hong Kong Special Administrative Region, the Education and Youth Development Bureau of the Macao Special Administrative Region, and the Department of Education of Guangdong Province, the Scheme aims to strengthen mutual understanding, enrich educational experiences, and align educational practices across Hong Kong, Macao, and mainland China. Its goals include enhancing mutual knowledge, promoting international as well as cultural exchange, fostering national identity and belonging, expanding inter-school networks, and broadening the perspectives of school leaders, teachers, students, and parents.

Since its inception, the Scheme has connected schools in Hong Kong and Macao with counterparts across mainland China—including those located in Beijing, Shanghai, Guangdong, Sichuan, Zhejiang, and Fujian—as well as with overseas institutions such as schools in Singapore. To sustain and enhance these collaborations, education authorities in Guangdong, Hong Kong, and Macao have provided ongoing financial and professional support. Since the 2018/2019 academic year, the Education Bureau of Hong Kong (2025) has institutionalized the Scheme by issuing guidelines and offering annual grants. Until May 2025, eligible publicly funded and Direct Subsidy Scheme schools (excluding special schools) have received HKD 165,000 annually to support collaboration, and 1,546 sister school pairs have been established between Guangdong and Hong Kong/Macao, representing over half of all such partnerships in mainland China, largely due to the close geographic proximity between Guangdong and Hong Kong.

Today, the Scheme is the largest and most influential inter-school collaboration initiative in basic education within the GBA. Its success relies not only on sustained government support but also on the active engagement of system leaders, who play a pivotal role in fostering mutual understanding, building strong partnerships, and coordinating collaborative initiatives at both the school and regional levels.

3.2. Participants

Purposive sampling was adopted as the primary strategy (Miles & Huberman, 1994). Based on the list of model sister schools recognized by the Education Bureau of Hong Kong over the past decade, more than 10 school pairs were initially identified. Among them, School A of Hong Kong and School B of Guangdong Province were selected for their long-standing partnership since 2006. School A is an aided secondary school in Hong Kong with a strong patriotic ethos, while School B is a public junior secondary school located in urban Shenzhen, Guangdong Province. Despite leadership transitions in both schools, the collaboration has remained steady and ongoing since 2006. The two schools have carried out 39 exchange activities involving nearly 2,000 teachers and students. The depth and continuity of this collaboration made them a suitable case for exploring the conditions that sustain school partnerships.

Furthermore, five system leaders who played key roles in this collaboration—each holding multiple titles and exerting influence across different levels—were selected as research participants (see Table 1). These five system leaders served as important connectors, linking various departments and stakeholders to collectively facilitate the sister school collaboration within the GBA. While some have retired, others remain active in leadership roles.

Table 1. Participants' demographic information.

Code	Gender	Years of Experience	Current Position	Key Past Roles
P1-GD	F	35–40	Retired principal	Subject-matter expert; Vice principal; Principal; Department head of local education bureau
P2-GD	M	20–25	Principal	Subject-matter expert; School middle leader; Principal
P3-HK	M	30–35	President of a professional organization in Hong Kong	Principal; Delegate to the National People's Congress
P4-HK	F	15–20	Principal	Assistant principal; Head of the Chinese department; Vice principal; Principal
P5-HK	F	25–30	Principal	Student affairs officer; Vice principal; Principal

3.3. Data Collection

Semi-structured interviews were conducted to gain an in-depth understanding of the sister school partnership and the role of system leadership in this context. Interviews in Mandarin and Cantonese were conducted with five current or former principals who played key roles in initiating and sustaining the collaboration. Each session lasted one to two hours, was audio-recorded, and transcribed verbatim. Guided by an interview protocol, the interviews explored three key areas: (a) background information on the schools and leaders, (b) the development and practices of inter-school collaboration, and (c) the leaders' perspectives on their contributions. These interviews provided rich, first-hand insights into the processes, challenges, and leadership strategies underpinning long-term collaboration in the GBA.

Documentary evidence was also collected to contextualize how these system leaders exercised their leadership. Sources included: (a) national and local policy documents on the Scheme; (b) records of collaborative activities such as partnership agreements, event proposals, reports, and newsletters, including a book published by the Guangdong school titled *Promoting Exchanges Between Schools in Guangdong and Hong Kong and Enhancing Patriotic Education*; and (c) media reports highlighting the leaders' involvement in Scheme-related initiatives. These materials offered a comprehensive view of their system-level roles and leadership practices.

3.4. Data Analysis

To theorize how system leaders exercise leadership across multiple levels of the education system, we employed thematic analysis (Braun & Clarke, 2006), following an analytic sequence of data reduction, data display, and conclusion drawing (Miles & Huberman, 1994). The analysis proceeded in three stages.

In the first stage, we conducted within-case coding of interview transcripts from five current and former principals using both concept-driven and data-driven approaches (Babbie, 2014). Open coding identified leadership actions, collaboration strategies, and institutional contexts, followed by axial coding that organized categories around (a) leader and school background, (b) partnership development and practices,

and (c) perceived leadership contributions. In parallel, policy texts, partnership records, and media reports were analyzed to triangulate and enrich the interview data.

In the second stage, a cross-case analysis identified common patterns and meaningful variations in how leaders mobilized resources, bridged institutional boundaries, and influenced cross-border collaboration. Analytical rigor was strengthened through member checking and iterative inter-coder discussions to ensure reliability.

In the final stage, the analysis focused on identifying the four principal roles of system leaders, which are discussed in the findings section. The discussion section then offers a comparative analysis that draws on existing theoretical foundations to explore how system leadership practices in the Chinese context align with, diverge from, or expand upon predominantly Western-derived models.

4. Findings

The findings indicate that the five system leaders demonstrate exceptional leadership capacities. Across different stages and contexts, they assume multiple roles, including those of middle-level school leaders, (vice) principals, expert teachers, education bureau officials, and presidents of professional associations. Drawing upon their professional credibility and social capital, they build an extensive network that connects various educational sectors and stakeholder groups. Through this network, they exert considerable influence on systemic educational development. The analysis further shows that the leadership practices of principals as system leaders both align with and diverge from existing research, showing consistencies such as setting direction and building networks while also presenting notable differences. These practices are further conceptualized in four roles—thought advocate, practice pioneer, boundary spanner, and resource mobilizer—each associated with specific leadership behaviours. Within these roles, principals enact differentiated behaviours as system leaders.

4.1. Thought Advocate

As thought advocates, system leaders (five principals in this study) were responsible for setting organizational direction around a moral purpose and building a shared vision for collective progress across schools. In this study, principals were regarded as a group of insightful actors who proposed forward-looking ideas in response to evolving educational contexts, set strategic directions, and mobilized diverse stakeholders through vision-driven appeals. In this study, prior to the official launch of the Scheme, collaboration between Hong Kong and mainland schools remained limited due to various factors, including visa application difficulties between Hong Kong and Guangdong as well as differences in their educational systems. However, P3-HK, P1-GD, and P4-HK had already recognized the complementary needs of schools in both regions and identified opportunities for cooperation, making sustained efforts to overcome challenges and advance collaboration, even when it required personal investment of time and resources. As P3-HK noted, "Hong Kong's strengths lie beyond the classroom, while the Chinese mainland's strengths lie within." He believed the two regions could learn from one another. P3-HK explained:

> In Guangdong—and more broadly in the Chinese mainland—teachers engage in collaborative lesson planning, which is rare in Hong Kong. Teachers in Hong Kong prefer working independently and tend

to resist external input. Learning from the mainland's practices has improved classroom teaching in Hong Kong. Conversely, Hong Kong's international exposure offers valuable insights for the mainland.

System leaders also actively communicate their visions to others, fostering shared understanding and engagement in reform. For example, P3-HK regularly met with principals and middle leaders from both sides to highlight the benefits of cooperation. He stated, "To strengthen cross-border ties and mutual understanding of each other's economic and cultural development, and to enhance students' sense of national identity, we must promote direct student interaction." His advocacy influenced many people, including P4-HK, then an assistant principal, who remarked: "Through student exchanges, teachers and students gain firsthand understanding of the mainland's development. This enriches teaching, broadens student horizons, and facilitates mutual learning."

To operationalize partnerships, system leaders support the development of shared visions and mutually beneficial plans. As P4-HK emphasized, "The starting point must be student benefit. We must identify available resources and ensure that students truly gain from our programs." P2-GD proposed organizing student site visits to broaden perspectives; P5-HK recommended STEAM-based collaborative projects (i.e., joint initiatives integrating science, technology, engineering, arts, and mathematics) to cultivate interdisciplinary and innovative skills; P4-HK further suggested joint teacher professional learning, including collaborative research and lesson study. These leaders continue to guide the future direction of the Scheme. As P1-GD stated, "It's not just about increasing the number of sister schools—but improving the quality of exchanges." Such thought leadership continues to shape cross-border school collaboration in the Guangdong–Hong Kong–Macao context.

4.2. Practice Pioneer

After generating enthusiasm among various stakeholders, many were still uncertain about how to translate this enthusiasm for collaboration into concrete action. At this point, system leaders took on the role of practice pioneers by initiating pilot efforts to explore viable pathways for inter-school collaboration—"turning the impossible into the possible" (P3-HK). As scholars have noted, system leaders need to be both thought leaders and practical leaders (Harris et al., 2021). As one leader recalled, "Before the Scheme was officially promoted, we had already launched a pilot and had begun forming sister school partnerships with different schools" (P5-HK). P5-HK and colleagues experimented with diverse forms of collaboration by "planning and designing routinized activities." Some activities were later endorsed by authorities and developed into flagship programs. Beyond these established practices, the pair of sister schools selected in this study—School A in Hong Kong and School B in Guangdong Province—continued to explore new possibilities—"start early" and "pilot new forms of collaboration" (P5-HK)—demonstrating a commitment to ongoing innovation. As pioneers, selected principals in this study (e.g., P1-GD, P2-GD, and P5-HK) developed context-responsive practices tailored to the needs of different stakeholder groups, implemented across three levels: school leaders (principals and middle leaders), teachers, and students.

Collaboration among school leaders has focused on experience sharing between principals from the pair of sister schools selected in this study. Noting differences in leadership styles and school cultures between Hong Kong and the Chinese mainland, both sides engaged in reflective dialogues. P2-GD pointed out that "the schedule of Hong Kong schools is meticulous and systematic, a feature often lacking on the Chinese mainland."

P1-GD also stated that although the two contexts differ, "we still need to learn from Hong Kong principals" to improve goal-setting and planning for teachers. She believed that school leaders should avoid excessive administrative intervention and short-notice assignments so that "each teacher knows what to do at specific times" (P1-GD). In her view, this "meticulous and systematic school management model" (P1-GD) is worth learning from and could enhance school management on the Chinese mainland. Through such exchanges, principals gained practical insights into improving their own leadership practices.

Teacher-level collaboration aimed to improve instructional quality by introducing the Chinese mainland's school-based teaching-research system (*jiaoyan zhidu*, 教研制度) to Hong Kong schools. This included lesson co-design (*tongti yijiao*, 同题异教), peer and expert observation (*guanke*, 观课), and structured feedback (*pingke*, 评课). Although these practices are common in the Chinese mainland, they are rarely implemented in Hong Kong. To bridge the gap, the sister schools developed a joint lesson study project using a shared text, *Memory of Father's Back*, through which teachers designed parallel lessons and received feedback from expert observers. P1-GD commented, "The atmosphere and approaches of teaching-research in the Chinese mainland are very worthwhile for Hong Kong teachers to adopt." P5-HK echoed this view:

> The teaching-research system…helps teachers notice the strengths of others, reflect on their shortcomings, and refine their lessons….Although some well-prepared lessons were just "for show." I still think Hong Kong teachers can learn a lot….That's why I insist on co-organizing teaching-research activities with my partner school….We have benefited greatly.

Student-level collaboration was mainly implemented through biannual study tours aimed at broadening students' horizons and developing shared values. Activities included mutual school visits, community service, home-stays, and theme-based experiential learning. As P1-GD explained, "Hong Kong sent students to Shenzhen [a city in Guangdong], and we organized off-site activities together, such as visiting the elderly in Lianhua North Village." The most representative initiative was the home-stay exchange program, launched in 2010. In the first round, 20 Hong Kong students participated, and over 80 mainland families volunteered to host. P2-GD recalled:

> The most interesting thing was that Hong Kong students came to Shenzhen and lived with mainland students for several days….Each one had a local partner who took care of them….One of my students said she had brought her Hong Kong buddy to a three-hour extracurricular class….Some parents even took them to places like Happy Coast and museums. I think these were excellent experiences.

P5-HK also mentioned that during the three-day and two-night study tour, Hong Kong students were taken to attend various activities—"volunteering and serving in elderly homes," for example. After that, P5-HK took the opportunity to ask students to "compare issues related to the elderly in Hong Kong and Guangdong, analyze the differences between the two places, and then propose some constructive suggestions for the government." The sister schools also took students to visit urban construction projects in Shenzhen, high-tech enterprises (e.g., BYD Company in Chaozhou), natural landscapes in the GBA (e.g., Danxia Mountain in Shaoguan), and cultural heritage sites (e.g., the ancient city in Chaozhou). After each study tour, the school organized students into teams to share what they had seen and learned. P5-HK told us, "After each study tour, most of my students came back with great enthusiasm. They enjoyed the exchange activities."

4.3. Boundary Spanner

In the long-term collaboration between sister schools in Hong Kong and the Chinese mainland, system leaders serve as boundary spanners. Similar terms, such as "broker," have appeared in existing research (Hopkins & Higham, 2007). These leaders navigate through institutions, cultures, and networks, playing a pivotal role in expanding the scope and strengthening the resilience of cross-border educational partnerships. Their leadership as boundary spanners can be observed in three interrelated practices: nurturing relational networks, facilitating institutional understanding across systems, and supporting the continuity of collaboration over time.

System leaders proactively nurture multi-level relational networks that span individuals, organizations, and administrative boundaries. These relationships are grounded in interpersonal trust and sustained through long-term engagement. During the Covid-19 pandemic, they demonstrated resilience by overcoming travel restrictions and logistical barriers, leveraging digital platforms to organize online exchange activities and maintain meaningful collaboration despite unprecedented disruptions. As P2-GD explained, many school partnerships are built through "friends" and "good relationships." P4-HK similarly noted, "I try to attend their events whenever possible…these important connections take time to build."

The five participants in this study were closely connected with key organizations, including the Education Bureau of Hong Kong, the Federation of Education Workers of Hong Kong, and various Hong Kong principals' associations, as well as the International Exchange Office of the Shenzhen Education Bureau. Through these ties, they facilitated more than a dozen school partnerships across regions, including Guangdong, Zhejiang, and Chongqing. As P1-GD shared, "Each year, we independently establish around six new partnerships, and we never stopped doing so even during the three years of the Covid-19 pandemic." She added, "The federation understands both the schools' situations and the principals' intentions…when the match is right, collaboration becomes possible."

System leaders also facilitate institutional understanding across systems by mediating between different policy environments, organizational logics, and governance cultures. They often initiate partnerships through informal channels and later formalize them—adopting a flexible, adaptive approach. As P1-GD described, "I just ask them to add each other on WeChat…if they feel it works, they can coordinate directly online…they even established partnerships before the official signing ceremony with the Education Bureau." These leaders are also attuned to local policy nuances and capable of proposing context-responsive solutions. For instance, in response to the relatively relaxed textbook regulations in Hong Kong and the concurrent need to strengthen Mandarin instruction, P1-GD suggested: "[The Education Bureau of Hong Kong] doesn't regulate it like the Chinese mainland….You can write your own." With her support, the Hong Kong secondary school, in collaboration with its sister school, developed its own Chinese teaching materials for grades 7 through 11. Many system leaders possess multilingual skills and cross-cultural experiences. P3-HK, for example, studied in Hong Kong but said, "I really love Chinese mainland culture….I genuinely want to contribute to the country." This positioning enables them to balance political sensitivity with professional collaboration.

Finally, system leaders support the continuity of collaboration by managing leadership transitions and cultivating long-term commitments. When school leaders rotate or retire, they intentionally arrange handovers to ensure that institutional memory and collaborative momentum are maintained. As P2-GD

recalled: "Principal P4-HK recently came together with a new male principal before her retirement to discuss the exchange plans for the upcoming year." He added: "When people change, the relationship stays, and cooperation continues." Long-term collaboration is further reinforced by shared values and interpersonal trust. As P2-GD noted, "I trust Principal P5-HK because she was introduced by Principal P1-GD, whom I already trusted." P4-HK also reflected that her school's partnership with School B began in 2014: "At that time, it was Principal P1-GD who facilitated it." As P2-GD summarized: "The reason we've been able to sustain this partnership for 17 years is due to the strong personal bonds between principals…of course, shared values and a common vision for collaboration also matter."

4.4. Resource Mobilizer

System leaders serve as key enablers in sustaining cross-border partnerships by proactively constructing institutional conditions rather than merely responding to top-down mandates or resource requests. To advance school collaboration and system change, they must overcome multiple constraints while building broad support and securing resources. In this study, the obstacles to effective school collaboration included historical legacies of colonialism that fostered biases against the Chinese mainland among Hong Kong educators, resulting in limited contact and interaction; institutional constraints that differ significantly across the two regions, posing practical challenges to collaboration (e.g., restrictions on cross-border mobility); and psychological barriers such as the conservative mindset of some Hong Kong teachers, which limited their willingness to step outside their comfort zones. Addressing these challenges was essential for strengthening exchange and collaboration among schools in the GBA. In this study, system leaders adopted a range of measures aimed at overcoming these obstacles and mobilizing resources, with their practices manifested in four interrelated domains: institutional embedding, financial support, structural coordination, and pathway innovation. Together, these practices reflect a strategic transition from fragmented efforts to a coherent and sustainable ecosystem of collaboration.

First, system leaders help transform informal school-level initiatives into officially recognized and institutionally supported collaborations. As P3-HK recalled: "The Scheme started as an informal relationship, but over time, the Education Bureau recognized its value and began to promote it… Once you took the lead, it gained an official nature." This institutional embedding demonstrates how grassroots experiences can inform policy, leading to the formal launch of the Scheme in 2004 with accompanying regulatory frameworks.

Another key aspect of resource mobilization is addressing financial constraints. System leaders have actively negotiated financial resources to ease the cost burden of cross-border collaboration. As P4-HK explained:

> The Education Bureau created designated funding for us, so when we travel to the Chinese mainland, we can use that money instead of asking the host school to cover our expenses. I think that's very considerate. What used to be a difficulty has been gradually addressed by the Bureau….For example, if we need to organize a seminar, we can approach the Federation of Education Workers, and they'll provide support. Each school has a liaison…one of our teachers serves in this role and maintains regular contact. They really support us, even participating in some on-site activities as invited guests or experts.

System leaders also design flexible and adaptive pathways to initiate and expand collaborations. P1-GD described how informal connections between schools—such as principals encouraging teachers to connect via WeChat—can later be formalized through annual partnership ceremonies. "Once they feel ready, they report to the Education Bureau for official recognition," she noted. P3-HK further emphasized that partnerships are not limited to official matchmaking but can be brokered by professional associations or personal networks and later submitted to the government for support. These practices reflect system leaders' ability to navigate both within and beyond institutional boundaries, creating space for innovation and responsiveness.

Moreover, once basic mechanisms are in place, system leaders continue to expand the collaboration's reach. P4-HK observed that new policy requirements—such as the mandate for all secondary students to participate in at least one outbound learning experience—have effectively turned sister school exchanges from optional activities into institutional expectations. P2-GD highlighted how the network grew organically:

> It started with our partnership with a secondary school, but when their administrators moved to new schools, those schools also partnered with us….The network kept expanding—even schools from Singapore visited us.

In sum, system leaders act as resource mobilizers not only by securing external support but also by cultivating favorable institutional, financial, and structural conditions. Their efforts transform isolated projects into sustained initiatives, enabling cross-border partnerships to expand in scope, deepen in impact, and gain policy significance. Although the collaboration between School A and School B has become relatively mature and benefits from official support, it has nevertheless encountered challenges and still relies on the enduring commitment of successive principals.

5. Discussion

This qualitative case study explored how system leaders facilitate inter-school partnerships, offering nuanced, context-specific insights into the dynamics of system leadership in China. The findings shed light on strategies that drive effective collaboration, reveal how principals expand their leadership beyond individual schools, and highlight ways in which these practices enrich and extend system leadership theory within the Chinese context.

5.1. Insights Into Effective Inter-School Collaboration

First, while inter-school collaboration is increasingly promoted as an alternative to top-down government-led reforms (Cheah, 2023; Hargreaves, 2011), it does not automatically lead to meaningful change. Its success depends on specific conditions—among which, key individuals play a particularly crucial role. In the Chinese context, where interpersonal relationships (*guanxi*, 关系) and social networks are highly valued, the quality of interactions between key actors can significantly influence both the depth and continuity of school partnerships. Distinct from general social connections, *guanxi* denotes enduring, trust-based relationships characterized by mutual respect and reciprocal obligations. Functioning as a culturally embedded and informal mechanism, guanxi facilitates collaboration, resource exchange, and problem-solving within and across organizations, especially in contexts where formal structures are

insufficient. Accordingly, it has been widely recognized as an ethical and effective mode of organizational coordination (Chen & Tjosvold, 2007; Child, 1996; Hofstede, 2001; Su et al., 2003). In this study, the nearly two-decade collaboration between sister schools was consistently sustained by the close and harmonious relationships maintained by successive school leaders.

Second, this study supports international findings that place student development and teacher learning at the center of collaboration. However, it also points to additional factors that matter in the Chinese context—especially under the "one country, two systems" (*yiguo liangzhi*,一国两制) framework. Effective school partnerships in this context require alignment not only of educational goals but also of political values, institutional culture, and shared beliefs. In this case, both schools identified as patriotic and integrated values-oriented activities—framed as "values education" in Hong Kong—into their collaboration. Such emphasis reflects the central role of patriotic education on the Chinese mainland, particularly for secondary school students.

5.2. Expanding Understandings of Principals' System Leadership

Traditional research has primarily examined principals' roles within their own schools, often classifying leadership into types such as transformational (Leithwood et al., 2010), instructional (Hallinger et al., 2020), paternalistic (Farh et al., 2008), and distributed (Spillane, 2005). However, emerging studies suggest that principals can also lead beyond their own institutions, playing strategic roles in inter-school collaboration and broader system improvement (Dimmock, 2016; Hopkins et al., 2014; Lyle et al., 2024; Mowat, 2019; Senge et al., 2015). This study provides further empirical support for this view, situated within the unique sociocultural context of China.

The principals examined here exemplify a distinct leadership trajectory: In addition to their formal school leadership roles, they often serve as senior subject experts, lead professional networks, and hold positions in education-related associations. Their leadership is not conferred solely by their formal positions, but developed through long-term experience, accumulated recognition, and deep participation in professional communities. Many began their careers as teachers and gradually moved into administrative roles, gaining influence through a combination of expertise, titles, and institutional trust. Thus, principals can serve as system leaders beyond their own schools.

In the Chinese Confucian cultural context, professional authority is closely linked to seniority and moral credibility (*lunzi paibei*, 论资排辈). With time, these principals accumulate not only symbolic capital (e.g., honors, status), but also practical capital in the form of broad interpersonal networks and preferential access to policy platforms, expert groups, and collaborative opportunities. This combination allows them to exercise system leadership—mobilizing resources, building alliances, and shaping regional educational directions—often beyond their immediate school settings. This culturally embedded, experience-driven leadership trajectory offers a distinctly Chinese pathway to system leadership that has been largely underrepresented in international scholarship.

5.3. Enriching System Leadership Theory in the Chinese Context

As Leithwood et al. (2010) argue, while leadership practices may have broad applicability, their enactment is always shaped by specific cultural and institutional contexts. This study contributes to the ongoing theorization of system leadership by grounding it in the distinctive setting of the GBA, where political systems, school cultures, and policy frameworks vary significantly across cities.

This study confirms several key insights from existing system leadership literature. First, consistent with international research, it supports the emphasis on setting direction with moral purpose—namely, promoting equity and improving student learning, particularly in less advantaged schools (Cheah, 2023; Dimmock, 2016; Pont & Hopkins, 2012; Spillane et al., 2023). In our case, system leaders worked to enhance the overall quality of education across partner schools. Second, echoing previous studies, these leaders demonstrated a range of behaviors, including setting direction, developing the organization, fostering partnerships, and managing resources (Hopkins & Higham, 2007; Mowat, 2019; Spillane et al., 2023). Third, the influence of system leadership operated across multiple levels—from within-school improvements to inter-school collaboration, and ultimately to impact at the regional level. In the case analyzed, what began as a partnership between two schools gradually evolved into a model of innovation that influenced government policies and was subsequently incorporated into broader educational reform initiatives.

However, one dimension of system leadership practice was not fully evident in this study: managing teaching and learning as curriculum or pedagogical experts (Mowat, 2019). In the GBA, system leaders involved in school collaboration rarely prioritized curriculum reform or school change as a core objective. Instead, they placed greater emphasis on the moral and ideological development of teachers and students, fostering cultural identity and promoting values and national identity. One explanation lies in the fragmented curricular systems across the GBA: Guangdong adheres to a national standardized curriculum, while Hong Kong and Macao retain high levels of curricular autonomy. Similarly, while system leadership is thought to play a role in advancing teacher professional development (Hopkins, 2009), such collaboration remains limited in the GBA, due to differing qualification standards and promotion pathways across regions. Moreover, under the framework of "one country, two systems," school collaboration in the GBA carries not only an educational mandate to improve quality but also a political function, a distinctive feature of the Chinese context. These findings suggest that system leaders must carefully navigate structural constraints and focus on identifying areas of shared interest when fostering cross-boundary cooperation, as this forms the foundation for establishing a shared vision.

This study provides context-specific contributions by identifying leadership behaviors rarely addressed in existing system leadership frameworks. While the four proposed roles broadly resonate with international literature, their enactment in China reveals distinctive features. As "thought advocates" and "practice pioneers," system leaders not only influence teachers and students but also shape government policy. They often initiate pilot programs ahead of official reforms and act as policy consultants through feedback to policymakers. Moreover, system leaders frequently hold multiple positions. Influenced by the Confucian ideal that those who excel in learning should serve in government (*xue er you ze shi*, 学而优则仕), educational experts leverage professional capital, social networks (*renmai*, 人脉), and seniority (*zili*, 资历) to gain informal authority (Zhang et al., 2025), which gradually translates into formal legitimacy through roles such as principal, education bureau leader, or chair of a professional association. Finally, unlike Western contexts

where system leadership is primarily framed as bottom-up, in China it emerges through the interplay of bottom-up initiatives and top-down directives. Government-led reforms provide additional resources and legitimacy, explaining why system leaders in this study actively sought official support when acting as resource mobilizers. Taken together, these findings expand the typology of system leadership and offer culturally situated insights that enrich a literature that remains dominated by Western perspectives.

6. Conclusion

This qualitative case study was conducted in the GBA, China. Based on coded interviews and documentary data collected from five system leaders, the study reveals how these leaders shift between interrelated roles to drive school collaboration and educational change, enacting varied leadership practices throughout the process. As thought advocates, they articulate forward-looking ideas and actively communicate their visions to stakeholders, fostering shared goals and mutually beneficial strategies. As practice pioneers, they initiate pilot programs to explore feasible pathways and demonstrate how seemingly impossible goals can be realized. As boundary spanners, they nurture relational networks, facilitate institutional understanding across systems, and support the continuity of collaboration over time. Finally, as resource mobilizers, they not only secure external support but also create enabling institutional, financial, and structural conditions to sustain educational development.

This study has some potential limitations. First, data were collected from five system leaders who were involved in a successful sister school partnership. As a result, the findings cannot be generalized to all principals acting as system leaders across China. However, as a qualitative study, the primary aim is to explore the meaning and role of principals' system leadership in school collaboration, rather than to produce generalizable findings. Second, the current study focuses only on interactions within the GBA, and the findings cannot be generalized to all principals acting as system leaders across China or in other contexts. Future research could extend to other Bay Areas worldwide (e.g., San Francisco Bay Area, New York Bay Area, Tokyo Bay Area) and to cross-school collaborations in different countries, thereby enhancing the generalizability of the findings.

Despite these limitations, this study makes important contributions and offers implications for both theory and practice. Theoretically, it extends the Western concept of system leadership into the Chinese context, particularly in the domain of cross-border inter-school collaboration rather than within a single district or city. By using principals involved in a successful sister school partnership as a case study, the article enriches international understandings of how system leadership operates to facilitate school collaboration. It also expands the knowledge base related to inter-school partnerships and system leadership in the Chinese context.

Future research could explore differences in system leadership practices across various cultural and social contexts beyond China, employing quantitative or mixed-method approaches, as core leadership practices may differ internationally (Leithwood et al., 2010). In addition, subsequent studies could examine how teachers act as system leaders, building on this study by adopting a "leader-plus" perspective (Boylan, 2016).

Acknowledgments

This study draws on insights developed through two research projects: Analyzing Needs and Exploring Practical Pathways for Collaborative Teacher Education Development in the Guangdong–Hong Kong–Macao Greater Bay Area (Project No. 2024GXJK117), supported by the 2024 Guangdong Provincial Education Science Planning Program-Higher Education Special Project, and Exchange and Collaboration Policy Between Hong Kong and Shenzhen Schools: Obstacles, Enabling Conditions, and Policy Recommendations, conducted at The Education University of Hong Kong. The authors are grateful for the academic support and institutional resources provided through both research projects.

Conflict of Interests

The authors declare no conflict of interests. In this article, editorial decisions were undertaken by Ulf R. Hedetoft (University of Copenhagen).

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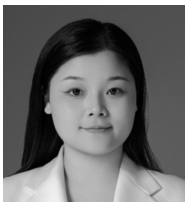

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III.

A Future Story

Social Inclusion
2026 • Volume 14 • Article 10894
https://doi.org/10.17645/si.10894

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REVIEW

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A Review of Digital Technology in Informal Education and Its Role in Educational Equity

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Submitted: 1 July 2025 **Accepted:** 15 September 2025 **Published:** 13 January 2026

Issue: This article is part of the issue "Educational Equity and Sustainable Development: Stories From the Greater Bay Area in China" edited by Huinan Liu (The Education University of Hong Kong) and Meng Zhang (South China Normal University), fully open access at https://doi.org/10.17645/si.i543

Abstract

Digital technologies have profoundly transformed the landscape of education, enhancing learning approaches while raising concerns about digital equity. This review pays particular attention to informal education settings (e.g., public libraries, museums, and telecentres) and examines the application of digital technologies in these settings and their role in educational equity. Specifically, it focuses on the diverse Guangdong–Hong Kong–Macao Greater Bay Area (GBA), exploring the implications of digital technologies from a global perspective. Through a scoping review of 31 studies, this study synthesizes a broad spectrum of digital technologies employed in informal education, ranging from conventional digital tools (e.g., internet-enabled computers, printers, and CD-ROMs) to advanced digital technologies (e.g., online public access catalogs, immersive technologies, and artificial intelligence). By applying the PROGRESS-PLUS framework's equity dimensions, the review reveals the dual role of digital technologies: On one hand, the integration of digital technologies in informal education fosters inclusion for minority groups and improves accessibility to learning resources; on the other hand, it exacerbates disparities for individuals lacking access to digital infrastructure or sufficient digital literacy. The discussion explores the challenges and opportunities of digital integration in informal education, with specific implications for the GBA in China.

Keywords

digital technology; equity; Greater Bay Area; informal education

1. Introduction

Digital technology, ranging from personal computers and tablets to cameras, calculators, digital toys, software, apps, augmented reality (AR), virtual reality (VR), and "pervasive platforms" like the Internet, has

profoundly shaped the educational landscape (Haleem et al., 2022). The increasing use of digital technology in educational settings has made it a topic of global interest, and a growing number of studies focus on the integration of digital technology in education. Nevertheless, digital technologies are considered to be a double-edged sword. On one hand, digital technologies could promote educational equity by facilitating the teaching of students with special learning needs, fostering inclusive learning environments, and improving access to educational resources (Haleem et al., 2022). On the other hand, some argue that digital technologies might widen existing gaps and inequalities due to limited digital experiences and inadequate digital capabilities (Timotheou et al., 2023). These issues of digital equity tend to be especially pronounced in informal educational settings. Given the significant role that digital technologies play in informal education, particularly in facilitating learners' participation in simulations and the exploration of multimedia materials (Ramsurrun et al., 2024), this review focuses on informal settings. This emphasis on informal education, an area relatively under-researched or under-theorized compared to formal education, is crucial to enhance our understanding and to map the integration of digital technologies across the educational landscape more effectively.

1.1. Formal, Non-Formal, and Informal Education

Education features three distinct learning environments where digital technologies are deeply integrated: (a) formal education, (b) non-formal education, and (c) informal education (European Union, 2001; Johnson & Majewska, 2022). Formal education is characterized by its structured nature and the attainment of formal qualifications like degrees or diplomas through established educational institutions, such as elementary schools and bachelor's degree programs. Non-formal education, while typically structured, is more flexible than formal education and is usually offered outside of conventional classrooms, in settings such as fitness programs and swimming courses. In contrast, informal education does not adhere to a formalized structure and lacks predefined objectives. Informal education often arises from everyday experiences without a formalized structure or certification. Informal educational activities are unregulated and encompass a diverse array of experiences, including visits to museums, trips to public libraries or science fairs, listening to educational radio broadcasts or watching informative TV programs, reading scientific journals and magazines, and participating in scientific competitions. Informal education serves as a supplement to both formal and non-formal education (European Union, 2001). For example, children's understanding of science may develop through taking science courses at school (i.e., formal education), participating in STEM after-school programs, and tutoring services (i.e., non-formal education), and visiting science museums (i.e., informal education).

1.2. Digital Equity and Educational Equity

The concept of equity in digital technology integration within informal education is complex and multifaceted. Two core concepts are closely related to and intertwined with the equity issue: digital equity and educational equity. The current review study adopts educational equity to represent all equity-related issues in the integration of digital technologies in informal education environments, which includes the concept of digital equity.

Digital equity in education encompasses five dimensions: (a) access to hardware, software, and internet connectivity; (b) access to meaningful, high-quality, and culturally relevant content in local languages;

(c) access to the creation, sharing, and exchange of digital content; (d) access to educators who are proficient in using digital tools and resources; and (e) access to high-quality research on the application of digital technologies to enhance learning (Resta et al., 2018, p. 991).

Educational equity ensures that all individuals have access to the resources and support they need to succeed, regardless of their socio-economic background or other demographic factors (Gorski, 2005). Equity here does not mean achieving equal educational outcomes; rather, it means that differences in educational outcomes should not be attributed to an individual's background or to economic and social circumstances over which the individuals have no control (Levinson et al., 2022).

1.3. Greater Bay Area

The Guangdong–Hong Kong–Macao Greater Bay Area (GBA) is a cluster of cities in the Pearl River Delta region of southern China, encompassing nine cities in Guangdong Province (Guangzhou, Shenzhen, Zhuhai, Foshan, Dongguan, Huizhou, Jiangmen, Zhaoqing, Zhongshan) along with the two special administrative regions of Hong Kong and Macao. This region exhibits significant variations in economic development, culture, and language (Zheng, 2019), which are closely linked to challenges in educational equity (OECD, 2018). Consequently, targeted guidance is essential.

Official organizations in the GBA have launched a variety of activities and projects to foster educational equity. For instance, universities and educational institutions in the GBA have initiated collaborative educational schemes, student exchanges, and vocational programs (GBA, 2025). In recent years, digital technologies have been increasingly used in educational exchanges within the GBA. For example, the establishment of the GBA University Online Open Course Alliance provides access to 1,600 courses for students (The Chinese University of Hong Kong, n.d.).

While existing research on education in the GBA has predominantly focused on formal education (e.g., A. Xie et al., 2021; X. Xie et al., 2023), the GBA is also actively engaging in exchanges within the realm of informal education. For example, cultural and artistic collaborations have been established in museums and galleries, and Hong Kong films and television works have been integrated into Mainland online platforms (GBA, 2025). This review focuses on the application of digital technologies in informal educational settings. By doing so, it offers valuable insights and suggestions for enhancing educational equity and inclusion across the diverse context of the GBA. This approach is crucial for understanding and improving educational outcomes in this dynamically evolving region.

2. Previous Reviews

Given the burgeoning interest in digital technologies in informal education, there has been a notable increase in studies reviewing the field's development and synthesizing its findings. We identified seven review studies from reputable journals focusing on the use of digital technologies in informal education. As detailed in Table 1, these review studies exhibit a diversity of focal areas. For instance, some reviews targeted specific digital technologies such as AR (Markouzis et al., 2022), digital media (Degner et al., 2022), and mobile devices (Jin et al., 2019). Others explored digital technology applications in various informal education subjects, including science (Ramsurrun et al., 2024) and English language learning (Guo & Lee,

2023; Liu et al., 2025; Soyoof et al., 2023). While the existing review studies offer valuable insights into the application of digital technologies in informal education, we identified several gaps. First, some review studies have focused solely on specific types of digital technologies within informal learning contexts (Degner et al., 2022; Jin et al., 2019; Markouzis et al., 2022). Second, some review studies have focused narrowly on particular subjects of informal education, such as science education (Ramsurrun et al., 2024) and English language learning (Guo & Lee, 2023; Liu et al., 2025; Soyoof et al., 2023). While the focused approaches allow for an in-depth analysis of the digital technologies or the subjects of informal education, they cannot provide a comprehensive overview of digital technologies in informal learning environments. Our review study expanded the scope, moving beyond the exclusive examination of particular digital technologies or specific informal education subjects. We aimed to provide a holistic view of how digital technologies are employed across different dimensions of informal learning environments. More importantly, despite the significant concerns and growing interest related to equity issues within this field, there is a noticeable lack of review studies addressing the role of digital technologies in promoting educational equity within informal education settings. This review contributes more rigorous evidence regarding the application of digital technologies in informal education and deepens the understanding of how these digital technologies can benefit educational equity in informal educational settings.

Table 1. Previous review studies of digital technologies in informal education.

Former reviews	Years	No. of studies	Focus	Databases
Markouzis et al. (2022)	2012–2022	29	AR applications for mobile devices related to informal education	ERIC, ScienceDirect, Google Scholar
Degner et al. (2022)	2005–2020	26	The use of digital media in institutional informal learning places	Scopus, FIS
Jin et al. (2019)	2005–2017	28	The informal learning of older adults in using mobile devices, both academically and practically	EBSCOhost, ScienceDirect, ProQuest, SAGE, Taylor & Francis
Ramsurrun et al. (2024)	2017–2022	17	The use of digital tools and technologies in informal science education settings	ACM Digital Library, ERIC, Google Scholar, Sage, Web of Science
Guo and Lee (2023)	2010–2021	103	Informal digital learning of English	A&HCI, SSCI journals
Soyoof et al. (2023)	2017–2019	30	The extramural and extracurricular types of IDLE	Web of Science
Liu et al. (2025)	2014–2024	49	IDLE in Asian English as a foreign language context during	Scopus, Web of Science

3. Research Questions

The present study aims to illustrate how digital technologies have been used in informal education and evaluate their role in educational equity. Specifically, this study seeks to answer the following three research questions (RQ):

RQ1: What are the general characteristics of the reviewed studies, such as year of publication, geographical distribution, target populations, informal learning venues, methodologies employed, and research themes?

RQ2: How are digital technologies described in terms of their types and target users in the reviewed studies on informal educational settings?

RQ3: What roles do these digital technologies play in promoting educational equity within informal education settings?

4. Theoretical Framework: PROGRESS-PLUS Model

This scoping review utilizes the PROGRESS-PLUS framework to explore the role of digital technologies in promoting educational equity within informal education settings. Originally developed by Evans and Brown (2003), the PROGRESS framework identified core social determinants contributing to health disparities. It was later expanded to include PROGRESS-PLUS, incorporating additional context-specific characteristics such as age and disability (O'Neill et al., 2014). The enhanced framework encompasses nine key dimensions: place of residence, race/ethnicity/culture/language, occupation, gender/sex, religion, education, socioeconomic status, social capital, and additional context-specific factors linked to stigmatization and exclusion, such as disability and age. As outlined by O'Neill et al. (2014), this analytical tool serves dual purposes: systematically categorizing research data while ensuring equity considerations remain central to evidence synthesis. Due to its comprehensive approach, the PROGRESS-PLUS framework has become a widely used framework in systematic reviews focusing on equity. In this scoping review, we adopt it to methodologically assist in identifying relevant participant characteristics that reflect individual-level social determinants of informal education. Theoretically, it aids in reporting and discussing how digital technologies used in informal education can influence educational equity.

5. Methodology

Research on digital technology in informal education is still nascent, and literature on this topic remains limited. The review process is not suitable for meta-analyses or systematic reviews, which depend on a large corpus of relatively homogeneous publications to draw valid conclusions (Laupichler et al., 2022). Consequently, this study adopted a scoping review approach, commonly used to explore the scope of existing literature on a specific topic in terms of volume, nature, and characteristics of primary research (Arksey & O'Malley, 2005; Pham et al., 2014). We adhered to the PRISMA guidelines for scoping reviews (Tricco et al., 2018). The review process entailed five main stages: (a) identifying the research question(s), (b) identifying relevant studies, (c) selecting studies, (d) charting data, and (e) collating, summarizing, and reporting results (Arksey & O'Malley, 2005).

5.1. Literature Search

For the literature search, we utilized prominent databases, including Scopus, Web of Science, and EBSCOhost (which includes ERIC). These databases were selected because they are the most commonly used databases for searching eligible studies in review studies in the education field (e.g., Su et al., 2023).

Our search targeted three key terms integral to our study: digital technology, informal education, and educational equity. To ensure comprehensive coverage, we explored synonyms for these terms, refining our search to include more relevant literature. The resulting search string was: ("digital technology" OR "digital tools" OR "ICT" OR "edtech" OR "online platforms" OR "digital media" OR "mobile technology" OR "virtual tools" OR "augmented reality" OR "virtual reality" OR "mobile apps") AND ("informal education" OR "informal learning" OR "non-formal education" OR "self-directed learning" OR "lifelong learning" OR "experiential learning" OR "social learning" OR "community learning" OR "peer-to-peer learning" OR "museums" OR "libraries" OR "cultural institutions") AND ("educational equity" OR "equity in education" OR "inclusive education" OR "education equality" OR "equal access to education" OR "equity gaps" OR "education disparities" OR "learning equity" OR "digital divide" OR "access to education" OR "underserved populations" OR "low-income learners").

We also employed the backward snowballing method by reviewing the references of identified articles to discover further relevant studies. To maintain scientific rigor, this review was restricted to peer-reviewed journal articles published between 2006 and April 2025, and written in English. The literature search yielded 224 articles, with 121 from Scopus, 43 from Web of Science, and 60 from EBSCO.

5.2. Literature Selection

From an initial pool of 224 articles, we first screened titles and abstracts to remove those clearly irrelevant to our research topics. This process also involved the elimination of 51 duplicate articles. We then conducted a full-text review of the remaining papers, during which one article could not be retrieved and was subsequently excluded. Two researchers independently selected the documents based on predetermined criteria, detailed in Table 2. Inclusion criteria required that the articles (a) focused on the use of digital technologies such as AI, mobile apps, online platforms, VR, and AR, (b) addressed educational equity, (c) focused on informal educational activities such as research on personal interests using resources like books, libraries, online platforms, or seeking guidance from informal mentors, (d) included empirical data to support their conclusions, (e) were published in peer-reviewed journals, (f) were written in English, and (g) were published between 2006 and 2025. Articles were excluded if they (a) focused on non-digital technologies or formal/non-formal educational activities, (b) did not address educational equity, (c) lacked empirical data, (d) were published before 2006, (e) were written in a language other than English, or (f) were not peer-reviewed. Following this selection process, we identified a total of 31 empirical research articles. The complete search and selection process is illustrated in Figure 1.

Table 2. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Digital technologies: Studies must focus on the use of digital technologies such as AI, mobile apps, VR, and online platforms in informal education.	Other tools: Studies that focus on non-digital tools or technologies such as traditional media (e.g., television, radio), or non-technology-based educational methods.
Educational equity: The objective of the study must be to explore or improve educational equity within the context of informal education.	Different objectives: Studies with objectives unrelated to educational equity, or those focusing exclusively on other educational outcomes.

Table 2. (Cont.) Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Informal educational activities: Studies must focus on informal educational activities, such as research on personal interests using resources like books, libraries, online platforms, or seeking guidance from informal mentors.	Formal and non-formal educational activities: Studies that focus on formal educational activities (e.g., elementary school education, bachelor's degree program) and non-formal educational activities (e.g., fitness programs, swimming courses).
Empirical evidence: The study must include empirical data supporting conclusions.	Non-empirical studies: Studies that are theoretical, such as literature reviews, meta-analyses, or book reviews.
Peer review: The study must be peer-reviewed to ensure academic rigor and credibility.	Non-peer reviewed: Studies that have not undergone the peer-review process.
Language: The article must be written in English to ensure accessibility and comprehensibility for the review team.	Other languages: Studies published in languages other than English.
Publication date: Studies published between 2006 and 2025 to capture recent and relevant developments.	Outside publication date range: Studies published before 2006 or after 2025.

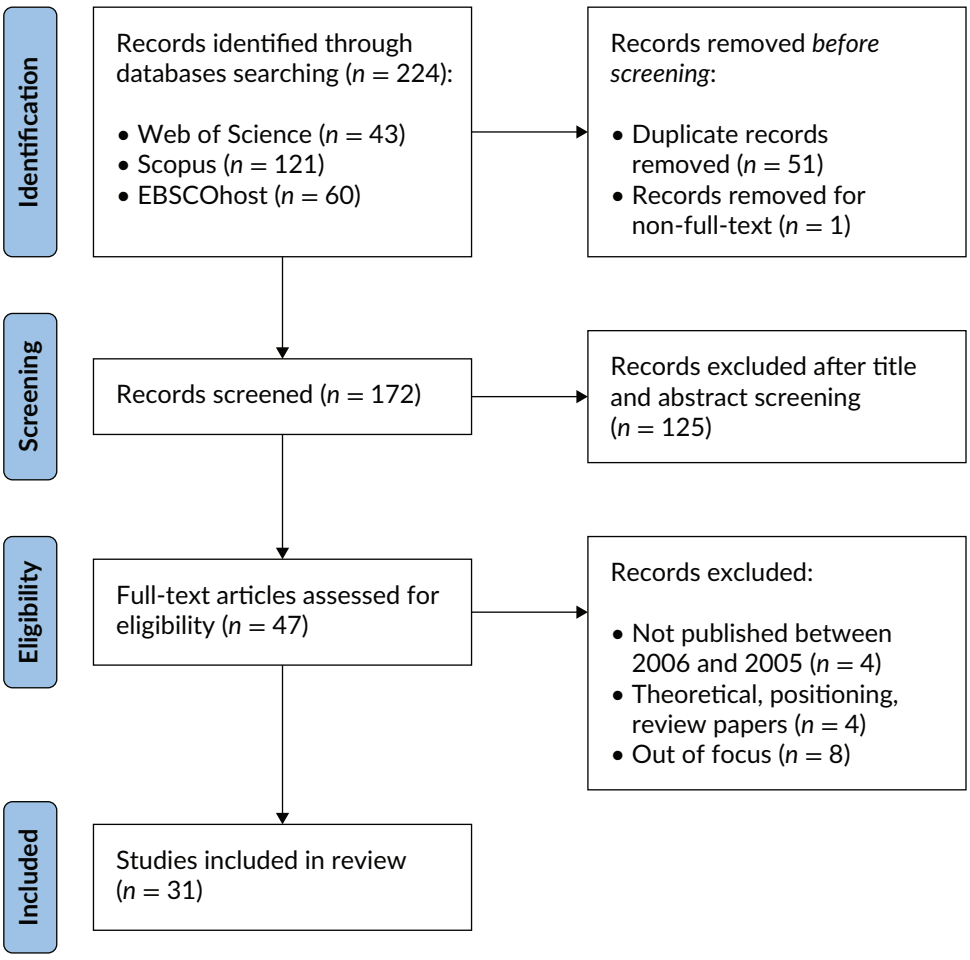

Figure 1. PRISMA flow diagram.

5.3. Data Analysis

To address RQ1 and capture the general characteristics of the 31 studies, we performed a content analysis on each article. This analysis helped us extract information including: (a) publication details such as authors and year of publication, (b) geographical regions where the studies were conducted, (c) study samples such as librarians, the general public, disabled individuals, and the elderly, (d) informal education settings such as public libraries, homes, and museums, (e) methodologies employed, categorized into qualitative, quantitative, or mixed methods, and (f) key research themes that emerged from the studies. To address RQ2 regarding the digital technologies used in the reviewed studies, we extracted and analyzed the following information: (a) types of digital technologies employed, including specific tools such as AR, VR, digital information platforms, and virtual environments; and (b) targeted users, including the general public and specific groups. To examine the role of digital technologies in educational equity (RQ3), we utilized the PROGRESS-PLUS framework. This framework guided our extraction and analysis of the following information: (a) place of residence, such as urban versus rural settings; (b) race, ethnicity, culture, and language, noting issues like social perceptions and language barriers; (c) occupation, assessing employment status, occupational status, and professional rank; (d) gender, considering gender identity and transgender minorities; (e) education, focusing on literacy levels and educational levels; (f) socioeconomic status, examining income and poverty levels; and (g) social capital and support, looking at institutional support and family support. Throughout the analysis, two researchers coded the data and resolved any discrepancies through discussion to ensure consensus and accuracy in the findings.

6. Results

6.1. General Characteristics of Reviewed Studies

A summary of the general characteristics of the reviewed studies is presented in Table 3.

Table 3. A summary of the general characteristics of the reviewed studies.

References	Geographical regions	Informal learning venues	Study samples	Methodology	Theme
Moisey (2007)	Canada	Library	Disabled	Qualitative (documentary review)	Outcomes
Russell and Huang (2009)	US	Library, home	General public	Quantitative (secondary data and survey)	Factors, outcomes
Gomez et al. (2009)	Cross-country	Library, telecentre, cybercafe	General public	Mixed (integrated iterative approach)	Factors
Greyling and Zulu (2010)	South Africa	Library	Indigenous	Mixed (interview, case study, documentary data)	Outcomes
Terry and Gomez (2010)	Cross-country	Library, telecentre, cybercafe	Women	Qualitative (interviews)	Factors, outcomes

Table 3. (Cont.) A summary of the general characteristics of the reviewed studies.

References	Geographical regions	Informal learning venues	Study samples	Methodology	Theme
Gomez and Baron-Porras (2011)	Colombia	Library, telecentre, cybercafe	General public	Mixed (survey, interview, focus group secondary data)	Factors, outcomes
Baron-Porras and Gomez (2012)	Colombia	Library, telecentre, cybercafe	General public	Mixed (interviews, focus groups, secondary data)	Factors, outcomes
Ani et al. (2014)	Nigeria	Library, home	Academic staff	Quantitative (questionnaire)	Factors
Nwakwuo and Nwakwuo (2014)	Nigeria	Library	Experts	Quantitative (questionnaire)	Factors, outcomes
Houghton (2014)	Australia	Library	Experts	Qualitative (interviews)	Outcomes
Gomez (2014)	Cross-country	Library, telecentre, cybercafe	General public	Mixed (interview, survey)	Factors, outcomes
Nyahodza and Higgs (2017)	South Africa	Library	Students, experts	Qualitative (interview, questionnaire)	Factors, outcomes
Beyene (2018)	Norway	Library	Disabled	Qualitative (interview)	Factors, outcomes
Mihelj et al. (2019)	UK	Museum, gallery	General public	Quantitative (secondary data)	Factors, outcomes
Ayoung et al. (2020)	Ghana	Library	Students, experts	Qualitative (interviews, focus groups, observations)	Outcomes
Rana et al. (2020)	Pakistan	Library	Experts	Quantitative (questionnaire)	Factors, outcomes
Manžuch and Macevičiūtė (2020)	Lithuania	Library	Experts	Qualitative (recordings of discussions)	Factors, outcomes
Ledwaba (2020)	South Africa	Library	Experts	Qualitative (interviews)	Factors
Sefyrin et al. (2021)	Sweden	Library	Experts	Qualitative (interviews, focus groups, and observations)	Factors
Gee and Aguilera (2021)	US	Library	Students	Qualitative (recordings of conversation)	Outcomes
Tserklevych et al. (2021)	Ukraine	Museum	Students	Mixed (observation, questionnaire, collection of materials)	Outcomes
Appel et al. (2022)	Canada	Library	Older	Mixed (survey, interviews, recordings of observation, and debriefing)	Outcomes
Casselden (2023)	UK	Library	Older	Qualitative (interviews)	Outcomes
Suman Barath and Sudhier (2023)	India	Library	Users	Quantitative (questionnaire)	Factors, outcomes

Table 3. (Cont.) A summary of the general characteristics of the reviewed studies.

References	Geographical regions	Informal learning venues	Study samples	Methodology	Theme
Kelly et al. (2023)	Canada	Library	Experts, students	Qualitative (observations, interviews, and feedback questionnaires)	Outcomes
Beltrán and Huertas (2024)	Colombia	Community	Indigenous	Qualitative (recordings)	Outcomes
Subaveerapandiyan et al. (2024)	India	Library	Experts	Quantitative (questionnaire)	Factors, outcomes
Ehtasham and Jabeen (2024)	Pakistan	Library	Experts	Qualitative (interviews)	Factors, outcomes
Matsumoto (2025)	Spain	Home	Students	Qualitative (interviews, background questionnaire, activity sheet)	Factors, outcomes
Jung et al. (2025)	US	Library	Older, experts	Mixed (surveys, interviews)	Outcomes
Rahmanova (2025)	Azerbaijan	Library	Students, experts	Mixed (existing data, questionnaire, and interviews)	Factors, outcomes

6.1.1. When: Year of Publication

The earliest study of the 31 empirical research articles on digital technologies in informal education was published in 2007. As shown in Figure 2, there was a noticeable increase in the number of studies post-Covid-19, particularly since 2019. This rise in studies after 2019 likely reflects the rapid adoption of digital tools and platforms in response to the pandemic. The continued growth after 2019 may indicate a heightened focus on how digital technologies can address equity issues and raise new concerns about educational equity in informal education settings. This emerging trend aligns with prior reviews on the studies about the utilization of digital technologies in formal education settings (e.g., Timotheou et al., 2023) and in museums (e.g., Tham et al., 2025), which also show an uptick of studies after 2019. This increase reflects the global pandemic having accelerated paradigm shifts in visitor, learner, and educator behaviors, promoting the expanded use of digital technologies in schools, museum sectors, and tourism industries.

6.1.2. Where: Geographical Regions and Informal Learning Venues

Approximately half of the included articles emanate from Western regions. In specific, the geographical distribution shows that the research on digital technologies in informal education was diverse, spanning multiple continents, with seven studies (22.58%) conducted in Europe (one each from Lithuania, Norway, Spain, Sweden, and Ukraine; two from the UK), six studies (19.35%) in North America (three each from Canada and the US), six studies (19.35%) in Africa (one from Ghana, two from Nigeria, and three from South Africa), and five studies (16.13%) in Asia (one from Azerbaijan, two from India, and two from Pakistan).

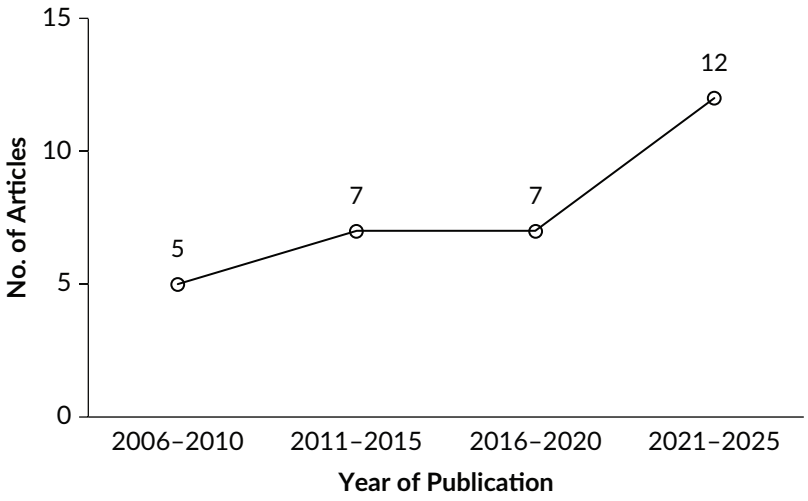

Figure 2. Number of articles published from 2006 to 2025.

Additionally, there were three studies conducted in Colombia (9.68%) and one in Australia (3.23%). Notably, three studies (9.68%) explored cross-cultural differences across 25 countries. This finding differs from other review articles on digital technology in informal education, which typically have identified a predominance of Western-focused research (e.g., Holdgaard & Olesen, 2025). This discrepancy may suggest that studies addressing equity-related issues in digital educational applications may adopt more geographically diverse perspectives.

With regards to informal learning venues, researchers have investigated a diverse range of informal learning environments, such as museums and galleries. Our review study reveals that the majority of research has examined library settings (n = 27), while fewer investigations have focused on alternative environments: cybercafés (n = 5), telecentres (n = 5), homes (n = 3), museums (n = 2), galleries (n = 1), and community settings (n = 1). Notably, five studies simultaneously analyzed libraries, cybercafés, and telecentres, collectively referred to as public access computing (PAC) venues. These diverse settings highlight the multifaceted nature of informal education and demonstrate how digital technologies can be employed across different contexts to promote educational equity and improve learning outcomes.

6.1.3. Who: Study Samples

The studies reviewed targeted a diverse range of population groups. Six of the 31 studies drew participants from the general public, with two of those studies involving participants from multiple countries. Ten studies focused on specific demographic cohorts, including seven studies covering student populations ranging from primary school to postgraduate levels, three investigations focusing on elderly populations, two studies centering on people with disabilities, and one study exploring women; one study examined ethnic minorities (i.e., Indigenous communities). Within the library setting studies, both library experts and users have been included. To be specific, thirteen studies gathered the perspectives from library experts, such as information technology librarians, library managers, information center staff, and library consultants; while twelve studies gathered the perspectives of library users. Importantly, five of these library-focused studies incorporated both perspectives.

In terms of sample size, ten of the 31 studies reviewed did not explicitly report their sample sizes. Specifically, five of the ten studies used datasets from the publicly available results of the Landscape of Public Access to ICT in 25 Countries, which was conducted between 2007 and 2009 by the University of Washington (Gomez, 2010). For the remaining studies, it was suggested that the sample sizes ranged from four to 3,720 participants.

6.1.4. How: Methodologies Employed

The methodologies used in these 31 studies show significant diversity. Specifically, qualitative methods were the most commonly used approach, with a total of fifteen studies employing this method. These typically involved methods of data collection, such as in-depth interviews, focus groups, and participant observation. Seven studies utilized quantitative methods, such as surveys or the analysis of existing datasets. Nine studies employed a mixed-methods approach that combines qualitative and quantitative methods.

6.1.5. What: Research Theme

Empirical research on digital technologies in informal education settings has primarily focused on two themes: (a) factors influencing the use of digital technologies in informal education and (b) outcomes of digital technologies in informal education.

6.1.5.1. Factors Influencing the Use of Digital Technologies in Informal Education

Nineteen studies examined or discussed factors that influence the usage of digital technology in informal education. Van Dijk's (2012) hierarchical model has posited three prerequisite conditions for successful usage of digital services, including motivation to employ digital services, physical and material access to digital technologies, and requisite digital skills. The reviewed studies indicate that cultural attitudes toward technology and gender disparities may impact people's motivations to engage with digital learning resources, while the physical and material access to digital technologies is closely associated with socioeconomic and geographic factors. Rural residence, unemployment, lower occupational status, poverty, and constrained income limit device ownership and access to PAC venues. Moreover, digital literacy levels have been found to be associated with gender and place of residence. For instance, girls and women in developing communities frequently receive inadequate ICT training, or sometimes none at all, compared to males. Individuals in developing nations such as South Africa, India, and Pakistan have been documented to possess lower levels of digital literacy and skills.

Beyond individual determinants, the reviewed literature also identifies significant environmental influences on the usage of digital technology in informal education. Crucially, effective engagement with public digital services requires not only individual motivation, access, and competence, but also "governmental literacy," which refers to the knowledge of how these organizations and services are organized and interrelated (Bernhard et al., 2019). The systematic organizational support infrastructure is critical for resolving unexpected technical disruptions and sustaining user engagement with digital technologies. In the present review, three studies emphasized the importance of library professionals' data literacy and care in determining users' abilities and motivations to integrate digital technology into informal learning.

6.1.5.2. Outcomes of the Use of Digital Technologies in Informal Education

The outcomes of integrating digital technologies in informal education settings have been examined across twenty-nine studies. Among these, a notable emphasis has been placed on the role of digital technology within public libraries, emphasizing it as a crucial tool in bridging the digital divide between rural and urban populations, different age groups, and individuals from varying socioeconomic backgrounds. The nineteen studies collectively suggest that the utilization of digital technologies in informal education environments has proven to be effective in enhancing digital skills and informal learning experiences, and it is applicable to a wide range of populations. For example, indigenous populations have notably enhanced their skilled trades and knowledge in carpentry through the application of AR technologies. Children have exhibited improved learning outcomes, including enhanced digital skills, critical literacies, and social connections, as a result of engaging with various digital technologies in informal learning settings such as game-making practices and VR experiences. Elderly individuals have reported reduced feelings of loneliness through participation in VR activities, while also enhancing their digital literacy via library digital literacy programs. Individuals with disabilities have found additional avenues for learning through the use of specialized digital tools. Patrons of libraries have displayed a heightened interest in informal learning facilitated by immersive technologies deployed in library settings.

6.2. General Characteristics of Digital Technologies

The digital technologies covered in the studies reviewed are characterized by two dimensions: the types of digital technologies and their target users (Table 4). Digital technologies can be divided into three main types: general digital technologies, advanced digital technologies, and digital-related programs and services. General digital technologies refer to basic tools like internet-equipped computers, printers, and CD-ROMs. Advanced digital technologies encompass digital information platforms (e.g., online public access catalogues, e-libraries, e-museum, e-gallery, and community web portals), virtual environments, VR, AR, AI, and natural language processing (NLP). Digital-related programs and services include initiatives like workshops that enhance digital literacy and coding games. In terms of target users, the technologies are tailored for two main groups: the general population and specific demographics, which include individuals such as those with disabilities, the elderly, and children.

The majority of the reviewed studies primarily focus on general digital technologies (87.10%) and target the general population (64.52%). Recent years have witnessed the emergence of advanced digital technologies in informal education settings. For instance, online platforms (48.39%) are among the most frequently utilized advanced digital technologies in libraries, museums, and galleries. These platforms not only provide digital information but also offer virtual environments, enabling remote access to resources and enhancing individuals' understanding of the locations of these institutions and exhibits without physical visits. Furthermore, the integration of other advanced digital technologies has significantly enriched informal education experiences. The incorporation of AI and NLP in libraries has improved search accuracy, personalized recommendations, and automated various tasks. Additionally, the use of AR in conjunction with mobile learning environments has facilitated Indigenous peoples in comprehending the entire carpentry manufacturing process more easily. Moreover, the elderly have reported decreased feelings of isolation, improved social connections, and enhanced confidence in adopting innovative technologies as a result of engaging in activities such as watching VR films. These advancements underscore the growing potential of

advanced digital technologies to enhance informal education experiences, catering to diverse audiences, and fostering enriched learning opportunities beyond traditional educational frameworks.

Table 4. A summary of the general characteristics of digital technologies.

References	Types of digital technologies			Target users	
	General	Advanced	Program/service	General	Specific
Moisey (2007)	✓				Disabled
Russell and Huang (2009)	✓			✓	
Gomez et al. (2009)	✓			✓	
Greyling and Zulu (2010)		Digital information platforms			Indigenous
Terry and Gomez (2010)	✓				Women
Gomez and Baron-Porras (2011)	✓			✓	
Baron-Porras and Gomez (2012)	✓			✓	
Ani et al. (2014)		Digital information platforms, virtual environment		✓	
Nwakwuo and Nwakwuo (2014)		Digital information platforms		✓	
Houghton (2014)	✓			✓	
Gomez (2014)	✓			✓	
Nyahodza and Higgs (2017)	✓	Digital information platforms	✓	✓	
Beyene (2018)	✓				Disabled
Mihelj et al. (2019)		Digital information platforms, virtual environment		✓	
Ayoung et al. (2020)	✓	Digital information platforms	✓	✓	
Rana et al. (2020)		Digital information platforms		✓	
Manžuch and Macevičiūtė (2020)	✓	Digital information platforms	✓	✓	
Ledwaba (2020)	✓			✓	
Sefyrin et al. (2021)	✓	Digital information platforms	✓	✓	
Gee and Aguilera (2021)			✓		Children
Tserklevych et al. (2021)		Digital information platform, virtual environment			Children
Appel et al. (2022)		VR	✓		Older

Table 4. (Cont.) A summary of the general characteristics of digital technologies.

References	Types of digital technologies			Target users	
	General	Advanced	Program/service	General	Specific
Casselden (2023)			✓		Older
Suman Barath and Sudhier (2023)	✓	Digital information platform, virtual environment	✓	✓	
Kelly et al. (2023)			✓		Children
Beltrán and Huertas (2024)		AR	✓		Indigenous
Subaveerapandiyan et al. (2024)	✓	Virtual environment, AR, VR, AI, mixed reality, NLP, and extended reality		✓	
Ehtasham and Jabeen (2024)		Digital information platform		✓	
Matsumoto (2025)	✓				Children
Jung et al. (2025)			✓		Older
Rahmanova (2025)	✓	AR, VR		✓	

6.3. The Role of Digital Technologies in Educational Equity: PROGRESS-PLUS Framework

The findings on the role of digital technologies in promoting educational equity within informal education are organized according to the dimensions of the PROGRESS-PLUS framework (Table 5). Since no studies pertaining to the dimension of religion were found, our analysis primarily concentrated on the other eight dimensions. Notably, out of the 31 studies reviewed, fifteen studies have addressed multiple aspects of the PROGRESS-PLUS framework.

6.3.1. Place

In the current review, eighteen studies provide insights into the impact of digital technology on informal education for residents in diverse places. The reviewed studies underscore the positive effects of digital technology, such as PAC venues and e-libraries, on residents in rural and urban areas, developing countries and cities, as well as marginalized and underserved communities. These technologies help bridge the digital divide, enhance access to informal learning materials, and empower individuals to engage in self-directed learning processes. However, these places often lack access to digital infrastructure due to the absence of personal computers in households, limited ICT services, and challenges in internet accessibility.

6.3.2. Race, Ethnicity, Culture, and Language

Twelve reviewed studies have explored the associations between the use of digital technologies in informal education and individuals' race, ethnicity, culture, and language. Their findings present a mixed picture regarding the impacts of digital technology on ethnic and racial minorities. Two studies suggest that these groups have limited access to ICT and visit online museums and galleries less frequently, while another study indicates that AR technology has benefited Indigenous populations. In terms of culture, three studies have

Table 5. A summary according to PROGRESS-PLUS framework.

References	Place	Race, ethnicity, culture, language	Occupation	Gender and sex	Education	Socioeconomic status	Social capital	Plus
Moisey (2007)	Rural							Disability
Russell and Huang (2009)	Rural	Ethnicity	Unemployment		Educational attainment	Income		
Gomez et al. (2009)	Rural	Language		Gender			Institutional support	
Greyling and Zulu (2010)		Language				Income		
Terry and Gomez (2010)	Rural	Language, culture		Gender, transgender	Educational attainment, literacy			
Gomez & Baron-Porras (2011)	Marginalized Community		Unemployment					
Baron-Porras and Gomez (2012)	Marginalize community						Institutional support	
Ani et al. (2014)	Developing country		Professional rank	Gender				
Nwakwuo and Nwakwuo (2014)							Institutional support	
Houghton (2014)	Urban							
Gomez (2014)	Developing country	Language, culture		Gender	Educational attainment	Income		
Nyahodza and Higgs (2017)	Developing country	Race, language				Income	Institutional support	
Beyene (2018)		Language						Disability
Mihelj et al. (2019)	Rural	Ethnicity	Occupational class	Gender	Educational attainment			Older
Ayoung et al. (2020)	Rural							

Table 5. (Cont.) A summary according to PROGRESS-PLUS framework.

References	Place	Race, ethnicity, culture, language	Occupation	Gender and sex	Education	Socioeconomic status	Social capital	Plus
Rana et al. (2020)							Institutional support	
Manžuch and Macevičiūtė (2020)	Rural					Income		
Ledwaba (2020)	Rural							
Sefyrin et al. (2021)		Language					Institutional support	Older
Gee & Aguilera (2021)								Children
Tserklevych et al. (2021)								Children
Appel et al. (2022)								Older
Casselden (2023)								Older
Suman Barath & Sudhier (2023)					Literacy			
Kelly et al. (2023)	Rural							Children
Beltrán & Huertas (2024)		Language, ethnicity						
Subaveerapandiyan et al. (2024)		Language, culture					Institutional support	
Ehtasham & Jabeen (2024)	Rural	Language						
Matsumoto (2025)						Income	Family support	Children
Jung et al. (2025)	Rural							Older
Rahmanova (2025)	Rural							

indicated that cultural attitudes towards digital technology can impact the incorporation of digital technologies into informal education. In cultures where digital technologies are deemed inappropriate or distrusted, individuals may have limited access to informal education through digital means. In cultures where digital activities are perceived as exclusive to certain groups, the opportunities for individuals to engage with digital technologies in informal education may be further restricted. Language has also been identified as a significant challenge in utilizing digital technologies. For example, issues include the lack of instructions for digital tools and platforms in users' native languages or plain language, as well as a shortage of content available in local languages on online resource platforms.

6.3.3. Occupation

Our review identified four studies that examined how occupation influences the use and access to digital technologies. Two of these studies suggest that PAC venues, particularly public libraries, can help unemployed individuals receive digital literacy training and, in turn, access more opportunities to secure employment. In contrast to individuals in lower professional positions, those in higher professional positions were found to be less likely to access digital resource platforms, which was attributed to their age. Academic staff in higher professional positions tend to be older than their counterparts in lower positions. Furthermore, individuals in higher occupational classes demonstrated a greater inclination to visit online museums and galleries.

6.3.4. Gender

Five studies have revealed that gender is associated with patterns of using digital technologies in informal learning settings. The development of digital technologies in informal education offers women individual benefits, such as increased self-esteem, reduced isolation, and access to markets, as well as collective benefits, including economic growth, improved health, and education. However, women have been found to have less access to digital technologies in informal education compared to men. Gender also influences the choice of venues for accessing digital technologies, with women more likely to opt for public libraries while men are more inclined to choose cybercafes. Additionally, women are more likely to visit online museums and galleries than men. One study also highlights the challenges faced by transgender minorities in accessing digital technologies in PAC venues.

6.3.5. Education

Four reviewed articles indicate that educational attainment and literacy play vital roles in shaping individuals' utilization of digital technologies for informal education. Two studies indicate that educational attainment is positively correlated with the frequency of using digital technologies and access to digital infrastructures. Moreover, individuals with higher educational levels exhibit a greater tendency to explore online museums and galleries than their less-educated counterparts. Interestingly, individuals with a high school education represent the most common demographic visiting PAC venues, exceeding the number of college-educated individuals. This trend could be explained by the fact that college-educated individuals often have personal computers at home. In addition to educational attainment, two studies underscore the significance of literacy. Individuals with lower levels of literacy encounter more obstacles when utilizing digital technologies in their informal educational pursuits.

6.3.6. Socioeconomic Status

Six studies have examined the relationship between socioeconomic status and the impact of digital technologies. Individuals with lower incomes are less likely to own computers, have limited internet access, and are more inclined to visit PAC venues due to the absence of personal computers at home. Consequently, the provision of free internet in libraries and digital literacy programs organized by libraries can significantly benefit individuals with low incomes.

6.3.7. Social Capital

Six studies discuss the concept of social capital. Specifically, four studies concentrate on the support and care provided by library staff. The assistance not only aids individuals in utilizing digital technologies for informal education but also enhances their confidence and willingness to engage with these tools. The current review reveals that many informal educational environments, such as libraries and museums, are deficient in technical expertise and adequate digital training for their staff. One study has explored the impact of family support on children's informal learning during the Covid-19 period, indicating the potential influence of family support on children's access to digital technology for informal education.

6.3.8. PLUS: Other Characteristics

6.3.8.1. Age

A broad spectrum of age groups has been encompassed in the eight studies reviewed. For instance, in a library's digital technology-related project, elderly individuals may alleviate feelings of loneliness and enhance their digital literacy and digital inclusion. Nevertheless, the integration of digital tools in informal educational settings poses challenges for elderly individuals, who often encounter barriers such as limited access to digital infrastructure and lower digital proficiency levels. Furthermore, the utilization of digital technologies in household and museum settings results in enhanced learning engagement and outcomes for children.

6.3.8.2. Disability

Two reviewed studies have presented findings related to individuals with disabilities. One study examined the impact of providing web-based ICT and traditional library resources to individuals with developmental disabilities, demonstrating improvements in information acquisition, social network expansion, and bridging the digital divide. One study emphasized the advantages of digital technology in informal education for individuals with print disabilities, highlighting the use of digital text formats to cater to their specific needs and preferences, while also addressing the challenges faced. Another study, while not directly focusing on individuals with disabilities, explored the potential of digital technology to promote inclusivity in informal education, drawing insights from interviews with library staff and regular users. Additionally, two studies have expressed concerns that individuals with certain disabilities, such as visual impairments, may not derive benefits from online museums, online galleries, and immersive technologies; instead, these technologies could potentially exacerbate existing inequalities.

7. Concluding Remarks

This scoping review examines the use of digital technologies in informal education and their roles in promoting educational equity, acknowledging several limitations. First, certain digital technologies implemented in educational settings were not originally designed for educational purposes (Major et al., 2018) but have been adapted for use in informal education. While the current databases provided access to a wealth of digital-related articles, specialized databases focusing on digital technology, such as IEEE Xplore Digital Library, Engineering Village (Compendex), ACM Digital Library, and ScienceDirect, were not included in this review. Future review studies are recommended to include these prominent databases to achieve a more comprehensive review. Second, we included equity-related terms to strengthen the relevance of our review study findings. However, some prior reviews using the PROGRESS-PLUS model did not explicitly include equity-related terms in their research methodologies. Instead, these studies indirectly assessed the level of equity by analyzing the proportions and characteristics of participants according to the dimensions of the PROGRESS-PLUS framework (e.g., Woolley et al., 2023). Future research could benefit from a deeper examination of participant characteristics relating to the use of digital technology in informal education settings, with the aim of uncovering the underlying dynamics of equity.

Despite these limitations, this scoping review has offered valuable insights into the use of digital technologies in informal education, with a specific focus on educational equity, particularly within the GBA context. The following sections will discuss: (a) the challenges of digital technologies in informal education, (b) the opportunities provided by digital technologies in informal education, and (c) insights for advancing informal education equity in the GBA.

7.1. Challenges of Digital Technologies in Informal Education

The integration of digital technologies in informal education faces various challenges due to organizational limitations and individual variances. Our review has identified that organizational support plays a crucial yet often inadequate role in addressing two categories of challenges. For one, many professionals in informal education, such as librarians, lack sufficient training, leading to difficulties in utilizing digital technologies, mastering digital resources integration, addressing privacy concerns, and ensuring accessibility for all users (Ehtasham & Jabeen, 2024; Manžuch & Macevičiūtė, 2020; Rana et al., 2020; Subaveerapandiyan et al., 2024). In addition to the challenges experienced by professionals in informal education, the institutions grapple with a variety of obstacles. Public libraries, for instance, often struggle with limited funding, insufficient digital infrastructure, challenges related to institutional and governmental policies, lack of expertise, and the necessity for infrastructure upgrades (Ayoung et al., 2020; Ehtasham & Jabeen, 2024; Manžuch & Macevičiūtė, 2020; Nwakwuo & Nwakwuo, 2014; Subaveerapandiyan et al., 2024). These organizational challenges lead to a lack of timely support and care for individuals, further exacerbating the difficulties people face when using digital technologies in informal settings.

Regarding individual variances, the findings of this scoping review align with Dawson's (2014) framework, which identifies three fundamental challenges concerning access, equity, and inclusion in informal education: infrastructure accessibility, literacy levels, and community acceptance. First, infrastructure accessibility serves as a fundamental element of inclusion, denoting the degree to which individuals can access the institutions and resources under consideration (Porter, 1998). It is closely linked to users' socioeconomic and

geographic factors. Our review has found that the factors such as rural residency (Gomez et al., 2009; Ledwaba, 2020; Nwakwuo & Nwakwuo, 2014; Nyahodza & Higgs, 2017; Rahmanova, 2025; Russell & Huang, 2009; Terry & Gomez, 2010), unemployment (Gomez & Baron-Porras, 2011; Gomez et al., 2009; Russell & Huang, 2009), lower occupational status (Ani et al., 2014), poverty (Gomez & Baron-Porras, 2011; Gomez et al., 2009; Terry & Gomez, 2010), and limited income (Gomez, 2014; Russell & Huang, 2009) restrict device ownership and access to PAC facilities. These individual factors, such as occupation status and income, are intertwined, potentially leading to compounded effects on digital inequity. The second challenge lies in the varying levels of digital literacy and skills. Digital literacy is about the ability to effectively utilize an infrastructure and its associated resources for personal benefit (Porter, 1998). Our scoping review has suggested that gender and place of residence are key factors associated with digital literacy disparities. For example, women in developing communities often receive inadequate ICT training compared to men (Terry & Gomez, 2010). Residents of developing countries like South Africa, India, and Pakistan have been reported to exhibit lower levels of digital literacy and skills (Ehtasham & Jabeen, 2024; Nyahodza & Higgs, 2017; Suman Barath & Sudhier, 2023). These gaps in digital literacy are not merely a reflection of unequal access to digital technology but also an outcome of existing digital inequities. Lower digital literacy can perpetuate a cycle where marginalized groups remain at a disadvantage in terms of accessing digital opportunities and benefits. Third, community acceptance poses a notable challenge to integrating digital technologies in informal education. Community acceptance, in particular, centers on fostering inclusivity for groups that have historically been marginalized (Porter, 1998). Therefore, in addition to creating more accessible informal learning opportunities, considering the utilization of a wider array of languages could be crucial (Dawson, 2014). Cultural attitudes toward technology significantly influence individuals' willingness to engage with digital educational tools. Societies that view digital technology as inappropriate or belonging to specific groups may exhibit lower motivation to access informal education through digital platforms (Gomez et al., 2009; Subaveerapandiyan et al., 2024; Terry & Gomez, 2010). Language barriers further compound the issue (Beltrán & Huertas, 2024; Ehtasham & Jabeen, 2024; Nyahodza & Higgs, 2017; Sefyrin et al., 2021).

To address organizational challenges and reduce the impact of individual variances, it is essential to tailor training programs for professionals to suit audience characteristics and digital technology features. Apart from pursuing formal degree programs like a master's degree in library science, professionals in the field can also enhance their knowledge through other institutions and platforms, such as the American Library Association and Library Juice Academy. Organizations must guide professionals on utilizing their digital technologies because proficiency in digital technologies equips professionals to effectively support audiences facing challenges in utilizing these resources. Advocating for increased funding and support for public institutions like libraries and museums to enhance their access and digital infrastructure is crucial. Noteworthy initiatives include the European Commission's proposals and financial aid to encourage museum collaborations with creative and technology partners (European Union, 2023). Additionally, non-profit organizations like the Hong Kong Jockey Club have partnered with entities such as the Palace Museum to promote Chinese cultural and arts tech talent development in Mainland China and Hong Kong (Hong Kong Palace Museum, 2025).

7.2. Opportunities of Digital Technologies in Informal Education

Our scoping review highlights the substantial opportunities that digital technologies present in informal education, particularly in promoting educational equity and inclusivity. First, public libraries are pivotal,

providing access to digital tools and literacy programs, thereby helping to bridge the digital divide for a variety of communities. Specifically, one crucial aspect involves providing affordable or free access to digital tools in informal learning settings and digital literacy programs. Public libraries serve as key locations where individuals lacking personal digital devices can access these resources (Gomez, 2014; Greyling & Zulu, 2010; Houghton, 2014; Russell & Huang, 2009). Efforts focused on digital technologies within public libraries and community spaces show promise in bridging the digital gap across diverse demographics, including rural and urban populations as well as individuals across various age groups; through these programs, societal engagement and professional opportunities are enhanced for participants (Appel et al., 2022; Beltrán & Huertas, 2024; Casselden, 2023; Ehtasham & Jabeen, 2024; Jung et al., 2025; Kelly et al., 2023; Manžuch & Macevičiūtė, 2020).

Second, in line with prior reviews on AR in informal science learning settings (Goff et al., 2018), our review suggests that the use of advanced technologies such as AR and VR has enriched learning experiences for individuals across all age groups and backgrounds. Specifically, indigenous communities have enhanced carpentry skills through AR technologies (Beltrán & Huertas, 2024). Children, engaging with digital tools such as game-making practices and VR experiences, have demonstrated improvements in digital skills, critical literacies, and social connections (Ayoung et al., 2020; Gee & Aguilera, 2021; Kelly et al., 2023; Tserklevych et al., 2021). Elderly individuals have reported diminished feelings of isolation as a result of participating in VR activities (Appel et al., 2022). Library patrons have exhibited heightened interest in informal learning opportunities facilitated by immersive technologies integrated into library environments (Subaveerapandiyan et al., 2024).

Third, the application of digital technologies in informal education not only enhances educational engagement but also has been shown to improve digital skills and social connections, enhancing the inclusivity of disadvantaged groups. Local public libraries serve as invaluable resources for adults with developmental disabilities, providing not only traditional library amenities but also access to web-based Information and communication technology (Moisey, 2007). Within these spaces, individuals facing print disabilities acknowledge the advantages of digital text formats, which cater to their diverse needs and preferences (Beyene, 2018). These findings are consistent with prior research in formal education. For example, a recent meta-analysis by Baragash et al. (2022) involving 119 participants with various disabilities demonstrated a significant positive effect of AR on their acquisition of functional skills. Koh's meta-analysis (2022) also indicated that students with intellectual and developmental disabilities showed improvement in competence and performance through the use of digital games in educational settings.

7.3. Insights for Educational Equity in Informal Education in GBA

Considering the multifaceted challenges and opportunities identified in the review, several key insights emerge for enhancing informal education equity in the GBA in China. Strategies focusing on digital accessibility, cultural diversity, multilingual support, and digital literacy empowerment can collectively promote inclusive and equitable educational opportunities for all residents within the diverse and dynamic GBA.

On the basis of the PROGRESS-PLUS framework, further insights for enhancing educational equity in informal education in the GBA can be made. First, it is essential to consider regional disparities, which may

cause discrepancies in physical and material access to digital technologies. This scoping review highlights that rural residents and individuals with lower incomes often encounter barriers to obtaining physical and material access to digital technologies. While a significant number of individuals reside in urban areas in the GBA, there are still individuals living in rural areas (Zheng, 2019). Second, income gaps may exist among different cities in the GBA, with Hong Kong and Macau exhibiting higher per-capita GDP compared to the other nine cities (HKTDC Research, 2024). Public libraries may play a crucial role in bridging this access gap by providing essential resources and opportunities for underserved communities. Therefore, public libraries and PAC venues could help to bridge access gaps for underserved communities.

Furthermore, diverse cultural representation in digital learning resources plays a vital role in sustaining individuals' motivation and willingness to engage in informal education. Within the reviewed studies, a predominant focus on mainstream cultures on the digital information platforms is observed, neglecting the dissemination of minority community cultures. By broadening the scope of cultural representation in digital platforms, minority communities can feel more engaged and connected to the educational content, fostering a sense of belonging and cultural appreciation. The GBA stands out for its diverse social ideologies and cultural contexts (X. Xie et al., 2023). Therefore, inclusivity and representation of various cultural backgrounds on the information platforms are important. Language barriers may present additional hurdles to digital technology utilization in informal education settings. In the GBA, where Cantonese, Mandarin, and English are predominantly spoken, alongside languages such as Portuguese in Macau, and Pakistani and Tamil in Hong Kong, accommodating linguistic diversity is crucial (Zheng, 2019). The adoption of multilingual features, such as AI-powered translation tools and audio guides, could enhance accessibility for these diverse language groups (Yang & Mustafa, 2024).

It is also crucial to address disparities in digital literacy. The reviewed studies have illustrated that low digital literacy leads to more barriers and less confidence in using digital technologies in informal learning processes. Diverse levels of digitization across the GBA can result in similar barriers for individuals. For example, older individuals from Hong Kong may encounter more challenges in utilizing digital technologies when they are in the more digitally advanced city of Shenzhen (Yang et al., 2023). The Covid-19 pandemic has accelerated the use of digital technologies in informal education within the GBA. For example, a series of online exhibitions during the Covid-19 pandemic has influenced the GBA's museum to develop its collections from offline to online (Zhang & Liu, 2025). This adjustment highlights the importance of bridging disparities in digital literacy. Targeted interventions, such as digital literacy workshops and expert support in public libraries, are pivotal in bridging these gaps and ensuring equitable access to digital resources.

Funding

This research was supported by the Hangzhou Office for Philosophy and Social Sciences Planning (Grant No. 24JD121) and the Department of Education of Zhejiang Province (Grant No. jg20220677).

Conflict of Interests

The authors declare no conflict of interests.

Data Availability

Due to the nature of the research, data sharing is not applicable to this article.

LLMs Disclosure

During the preparation of this work, the authors used LLMs (ChatGPT-4-Turbo and AI-powered DeepL) for language proofreading to ensure clarity of presentation. After using the tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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SOCIAL INCLUSION
ISSN: 2183-2803

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