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Issues and Challenges in Adopting Green Skill for TVET Pedagogy

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Abstract

Amidst urgent global agendas for a green transition, the effective integration of sustainability competencies into Technical and Vocational Education and Training (TVET) faces a persistent implementation gap. This qualitative multiple-case study investigates this disconnect by exploring the professional experiences of TVET instructors across four institutions. Utilizing an integrated "Teacher Agency Mediation Model," the research demonstrates that educators are not passive policy recipients but essential mediators who navigate complex institutional and resource constraints. Findings identify three systemic barriers: 1) the policy-practice divide, 2) resource scarcity and readiness gaps, and 3) lack of industry-institution collaboration. As a result, the burden of integration falls disproportionately on teachers' own initiative, informal networks, and uncompensated labor. The study concludes that meaningful greening of TVET must shift from relying on individual resilience to co-designing enabling ecosystems. Practical recommendations include the development of context-relevant pedagogical resources, the establishment of structured professional learning communities, and the creation of deeply embedded, reciprocal partnerships with industry. This research contributes to international discourse by framing green skills integration as a complex socio-material process, highlighting the pivotal yet often constrained agency of teachers in advancing sustainable education reform.

Keywords

Green Skills, TVET, Teacher Education

1. Introduction

The global imperative for sustainable development has elevated the cultivation of

green skills to a central priority within educational reform worldwide. Technical and Vocational Education and Training (TVET) is critically positioned at the nexus of this transition, tasked with equipping the future workforce with the specific competencies required to propel a green economy. International frameworks, notably the UN Sustainable Development Goals (SDGs), explicitly forge a link between quality education (SDG 4) and climate action (SDG 13), mandating a profound alignment of vocational training with socio-ecological transformation (UNESCO, 2021).

This alignment demands more than technical upskilling; it constitutes a systemic shift. The emerging green economy requires a workforce capable of synthesizing technical expertise with sustainable values, circular thinking, and adaptive problem-solving (ILO, 2019). Consequently, TVET institutions serve as essential mediators, translating high-level sustainability commitments into tangible, actionable workplace practices. For this study, green skills are operationally defined as the integrated set of cognitive, technical, and socio-emotional competencies that enable individuals to identify, implement, and promote environmentally sustainable solutions within their specific vocational domains. This conceptualization moves beyond a narrow technical checklist, framing green skills as a holistic pedagogical aim that positions TVET as a fundamental catalyst for systemic change (Pavlova, 2016).

Despite this clear mandate, a significant chasm persists between policy ambition and classroom reality. The effective integration of green skills into TVET pedagogy is hindered by persistent systemic barriers. Instructors often grapple with outdated curricular frameworks that divorce sustainability theory from practical application, while chronic resource constraints—spanning from obsolete equipment to a lack of specialized professional development—undermine pedagogical readiness (Moynihan & Bhandari, 2021). When institutional curricula and industry partnerships fail to evolve in tandem with rapid technological and environmental standards, a mismatch emerges: students risk graduating into a green economy for which they are inadequately prepared (World Bank, 2023). Without critically examining and addressing these structural and pedagogical disconnects, the transformative potential of green skills in TVET will remain largely unfulfilled.

2. Why Is Greening TVET Important?

The imperative to "green" Technical and Vocational Education and Training (TVET) stems from a confluence of global crises, economic transformation, and social justice imperatives. It represents a systemic response far beyond curriculum adaptation, positioning TVET as a pivotal actor in facilitating a just and competent transition to a sustainable future. This integration of green skills—conceptualized in this study as the integrated cognitive, technical, and socio-emotional competencies for environmental problem-solving within vocations—is critical across multiple, interconnected dimensions.

First, greening TVET is a direct strategic response to existential environmental

threats and binding international commitments. Global accords, most notably the Paris Agreement and the United Nations Sustainable Development Goals (SDGs), explicitly mandate a transition to low-carbon, resource-efficient economies (United Nations, 2015; UNESCO, 2021). Such a transition is untenable without a workforce proficient in the relevant competencies. TVET, by its core mandate of aligning skills with labour market evolution, serves as the critical operational bridge between these high-level policy objectives and tangible industrial transformation (CEDEFOP, 2022). Failure to integrate sustainability principles risks locking educational outputs and economic pathways into obsolete, polluting practices, leaving graduates ill-prepared for the realities of the ecological transition (ILO, 2019). Thus, greening TVET is not an optional supplement but a foundational prerequisite for meeting both national developmental targets and global cooperative obligations.

From an economic and employability perspective, greening TVET is essential to harness the opportunities of the burgeoning green economy while mitigating labour market disruptions. The sustainability transition is actively reshaping the world of work, creating novel occupations (e.g., renewable energy technicians, circular economy analysts) and transforming existing roles across all sectors (World Bank, 2023). This shift generates acute demand for skills in areas such as resource efficiency, renewable technology application, and sustainable supply chain management (OECD, 2021). TVET systems that proactively mainstream these skills endow their graduates with a decisive competitive advantage, enhancing employability, income potential, and career resilience in a volatile job market (Pavlova, 2018; McGrath & Powell, 2016). Conversely, institutions that neglect this imperative risk exacerbating skills mismatches, youth unemployment, and structural economic inequalities (Sudan, 2021).

Finally, the process is crucial for ensuring a just transition that promotes social equity and sustainable local development. A just transition requires that the benefits of the green economy are broadly shared and that vulnerable groups are not left behind (ILO, 2019). By providing accessible and inclusive training in green skills, TVET can empower marginalized communities, including women and youth, facilitating their participation in and benefit from new green job opportunities, thereby advancing social inclusion (UN Women, 2022). Furthermore, TVET institutions often function as community hubs. When they embody sustainability through campus management, engage in local environmental problem-solving, and foster green entrepreneurship, they model sustainable practices and directly contribute to local ecological and economic resilience (Pavlova & Chen, 2019; UNESCO-UNEVOC, 2022). This community-embedded role extends TVET's impact beyond individual skill provision, positioning it as a key driver of broader societal transformation towards sustainability (McGrath et al., 2020).

Teachers as Central Agents of Curricular Change

TVET teachers are universally recognized as the vital agents of green skills integration, tasked with translating abstract policy into tangible classroom practice

(Biesta, 2015; Priestley et al., 2015). Their role transcends mere content delivery, encompassing critical processes of curriculum interpretation, pedagogical innovation, and mediation among the often-competing demands of policy mandates, industry needs, and student realities. Contemporary scholarship rightly posits that the success of such complex curriculum reform hinges fundamentally on teacher agency—conceptualized as the capacity of educators to make purposeful and consequential choices within structural constraints (Eteläpelto et al., 2022). In the context of greening TVET, this agency may materialize through daily pedagogical decisions, such as selecting locally relevant environmental case studies or adapting existing materials to incorporate new green technologies (Li et al., 2023; Pavlova & Chen, 2019).

However, a significant gap persists between this scholarly recognition and the lived experience of teachers. While literature celebrates the concept of teacher agency, it often glosses over the intense emotional and intellectual labor required to exercise it within unsupported or restrictive environments. Policy rhetoric frequently idealizes the "teacher as change agent" yet routinely fails to furnish the essential enabling conditions—such as professional autonomy, institutional trust, and collaborative networks—necessary for such agency to flourish (Berger & Luckmann, 1966; Zhou et al., 2023). Consequently, the burden of curricular adaptation falls disproportionately onto individual educators, relying on their personal resilience and unofficial efforts. This study directly addresses this disconnect. It moves beyond simplistic portrayals of agency to critically examine the conditions, strategies, and systemic factors that enable or constrain how TVET teachers navigate and mediate the fraught process of green skills integration.

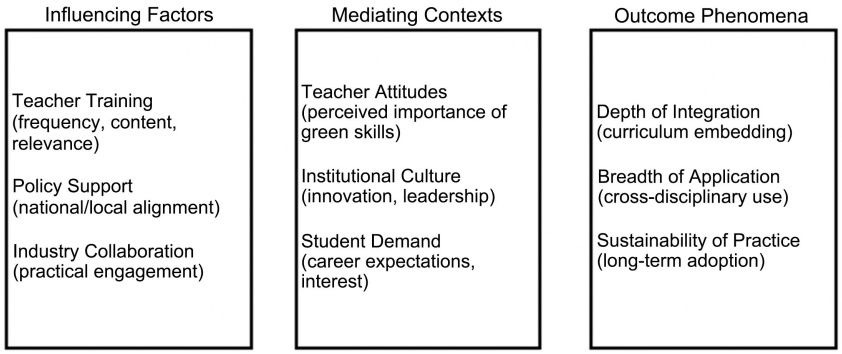

Figure 1. Teacher agency mediation model.

To guide this examination, this study develops and employs an integrated theoretical framework termed the "Teacher Agency Mediation Model" (see **Figure 1**). This framework is not merely a presentation of existing theories, but a synthesis designed to provide an original analytical lens. It posits that the integration of green skills is not a linear, deterministic outcome of policy prescription or individual intention alone. Instead, it is a mediated process. The model specifically frames teachers as active mediators whose agency is the crucial mechanism through which broader policies and institutional contexts are translated (or not) into classroom

practice. Furthermore, this teacher agency is itself dynamically shaped by a continuous interplay of three core elements: the teachers' own individual beliefs and competencies, the prevailing social and professional norms within their context, and the tangible perceived institutional constraints and affordances (e.g., resources, time, administrative support).

Grounded in the identified problem and theoretically framed by this model, the present study is designed to fulfil the following specific purposes: 1) to explore the institutional, resource, and pedagogical challenges that hinder TVET teachers from effectively integrating green skills into their daily practice; 2) to investigate how teachers' lived experiences and their perceived preparedness shape the exercise of their agency and their capacity to enact meaningful green pedagogy; 3) to identify the enabling factors deemed most critical by practitioners for supporting sustainable and effective green skills integration; and 4) to critically examine, from the teachers' perspective, the dynamics of existing industry-TVET collaborations and to outline the conditions necessary for nurturing deeper, pedagogically generative partnerships.

3. Method

This study employs a qualitative multiple-case study design. A qualitative approach was deliberately selected for its capacity to generate in-depth, contextualized understanding of the complex, process-oriented "how" and "why" questions central to this research—specifically, how TVET teachers navigate the integration of green skills within their specific institutional realities (Creswell & Poth, 2018; Merriam & Tisdell, 2015). The multiple-case study strategy was chosen as optimal for investigating this context-bound phenomenon across varied settings, allowing for cross-case comparison while maintaining a deep, interpretive engagement with each unique case, consistent with the study's overall interpretivist paradigm (Yin, 2018).

The research was conducted in Jiangsu Province, a strategically significant region for this inquiry due to its status as one of China's most economically developed and environmentally progressive areas. As a leading hub for manufacturing, logistics, and vocational education, Jiangsu provides a critical context to examine the tensions and possibilities in aligning TVET with sustainability goals. The provincial context is actively shaped by policy directives such as the Jiangsu Green Economy Action Plan (2021-2025), making it a pertinent site to study the translation of high-level green policy into pedagogical practice (Wang, 2021).

Four TVET institutions within Jiangsu were selected as individual cases. The selection followed a purposive sampling strategy aimed at achieving theoretical replication, where cases were chosen to provide meaningful variation across key institutional dimensions anticipated to influence the process of green skills integration (Yin, 2018). The primary dimensions guiding selection were institution type (public vs. private), geographic and economic sub-region within the province, and program specialization related to key economic sectors. This strategic

variation allows for a robust exploration of how contextual factors shape teacher agency and experience. The profile of the four selected cases is summarized in Table 1.

Table 1. Profile of selected case institutions.

Case Identifier	Institution Type & Location	Specialization	Rationale for Selection
Case A	Public College; Southern Jiangsu (Suzhou)	Renewable Energy	Represents a high-support, policy-pilot context, likely facilitating teacher agency.
Case B	Public College; Central Jiangsu (Nanjing)	Advanced Manufacturing	Represents a traditional industrial context under pressure to transform, testing teacher adaptation.
Case C	Private College; Northern Jiangsu (Xuzhou)	Mechanical Engineering	Represents a resource-constrained, market-driven context, where agency may be challenged.
Case D	Private College; Coastal Jiangsu (Yancheng)	Agriculture & Eco-Tourism	Represents a niche context where sustainability is inherent, offering a unique perspective on agency.

Within each case institution, participants were recruited using a stratified purposive sampling approach to ensure diversity across three strata relevant to the research problem: disciplinary field (e.g., directly "green," adjacent, or traditionally non-green), teaching experience (ranging from novice with under 5 years to veterans with over 15 years), and institutional role (frontline teacher and department head). A total of 16 participants (four from each institution) were recruited. Recruitment continued until data saturation was achieved, which was determined when subsequent interviews yielded no substantively new themes or insights related to the core research questions, indicating informational redundancy (Saunders et al., 2018). The final participant pool included 10 male and 6 female teachers, with experience ranging from 3 to 22 years, specializing in fields from renewable energy technology to foundational engineering.

Semi-structured interviews served as the primary data collection method, chosen for their capacity to elicit rich, detailed narratives about teachers' lived experiences, perceptions, and strategies. Each interview, conducted in Mandarin, lasted 45 - 75 minutes. With prior informed consent, all interviews were audio-recorded and subsequently transcribed verbatim. Transcripts were meticulously checked against recordings for accuracy, and all data were immediately anonymized upon transcription. Participants were assigned pseudonymous codes (e.g., T_A1 for the first teacher from Case A), and all identifying details were removed. Data were stored securely on an encrypted drive with access restricted to the research team.

The data analysis followed an iterative thematic analysis process, facilitated by the software NVivo 20, and was guided by the study's theoretical framework, the Teacher Agency Mediation Model. The process involved several distinct, recursive phases to ensure rigor and depth. First, the research team immersed themselves in the data through repeated reading of transcripts alongside listening to audio

recordings. Initial coding was then conducted openly, attaching labels to segments of text that captured key ideas. This was followed by a focused coding phase, where initial codes were compared, clustered, and organized into potential themes. Throughout this phase, the theoretical constructs of the framework (individual beliefs, social norms, institutional constraints) served as sensitizing concepts, helping to organize emerging themes without forcing the data. These candidate themes were then reviewed and refined, checking for coherence within themes and clear distinctions between them, both within and across the four cases. This cross-case comparison was crucial for identifying context-specific patterns and broader commonalities. To enhance the trustworthiness of the analysis, several verification strategies were employed, including peer briefing, where emerging themes and coding decisions were discussed with a colleague familiar with qualitative research; the maintenance of a detailed audit trail within NVivo to document the analytic decisions; and a form of member checking, where preliminary interpretations were shared with a subset of participants for feedback and clarification. Finally, the themes were clearly defined, named, and integrated into the narrative presented in the findings section, with careful selection of vivid, representative quotations to illustrate and substantiate each thematic point.

4. Results and Discussion

This section presents the findings and discussion derived from a thematic analysis of in-depth interviews with 16 TVET teachers in Jiangsu Province, China. The presentation follows a two-phase structure to ensure both descriptive depth and analytical rigor. First, the empirical findings are systematically organized around the three primary themes that emerged from the data. Second, each theme is critically discussed by integrating the findings with existing literature and the study's theoretical framework, the Teacher Agency Mediation Model, to explain the "how" and "why" behind the observed phenomena. To enhance methodological transparency, it is pertinent to note that the thematic analysis was an iterative process. Following data familiarization, initial open coding of all transcripts was conducted in NVivo 20 to capture salient ideas. These codes were then clustered into candidate themes through focused coding, actively guided by the framework's constructs (e.g., institutional constraints, agentive responses). Themes were refined through constant comparison within and across the four cases to ensure internal coherence and distinctiveness. The trustworthiness of the analysis was supported by peer briefing sessions and the maintenance of a detailed audit trail documenting analytical decisions.

The analysis crystallized around three core themes that directly address the research questions: 1) a policy-to-practice divide that encourages symbolic compliance; 2) a structural resource bottleneck that undermines pedagogical readiness; and 3) superficial, transactional industry-institution partnerships. Within each theme, vivid and illustrative quotations from participants are embedded to anchor the analysis in their authentic voices and lived experiences. The subsequent dis-

cussion for each theme explores its implications, contextualizes findings within broader literature, and examines theoretical insights related to teacher agency and constraint.

Theme* 1: *The Policy-Practice Divide

The first theme examines the significant disconnect between macro-level green skills policies and the daily realities of TVET classrooms in Jiangsu. Findings reveal that teachers act not as passive implementers but as active "interpretive agents" who navigate ambiguous directives and institutional constraints through strategic mediation. The analysis highlights how policy ambiguity, misaligned incentives, and pragmatic navigation collectively shape teacher agency, as summarized in Table 2.

Table 2. Theme 1.

Core Concept	Representative Codes	Illustrative Data Evidence	Initial Interpretation
Policy Vagueness	Lack of Practical Guidance, Abstract Mandates	"The policy shouts 'what to do' but whispers nothing about 'how to do it.' We are left guessing." (JS_T7)	Policies are high-level and non-operational, failing to provide actionable steps for classroom translation.
Eroded Perceived Control	Low Self-Efficacy, Inadequate Scaffolding	"We are told to 'incorporate circular economy principles' with no examples or tools. It feels like building without a blueprint." (JS_T3)	Teachers' confidence in implementing green skills is undermined by a lack of supportive resources and clear protocols.
Interpretive Labor	Decoding Directives, Improvisation	"Each teacher becomes an independent experimenter—we all interpret the guidelines differently, leading to inconsistent outcomes." (JS_T4)	Teachers shoulder the burden of translating abstract policies into practice, resulting in fragmented implementation across institutions.

Participants consistently described provincial green skills policies as broad, aspirational statements that lacked granular, practical guidance for classroom application. This ambiguity directly eroded their perceived behavioral control, a key construct from the Theory of Planned Behavior (TPB), which refers to individuals' beliefs about their ability to perform a behavior successfully (Ajzen, 2020). For instance, directives such as "integrate sustainability competencies" were rarely accompanied by subject-specific exemplars or assessment rubrics, forcing educators to rely on personal intuition (JS_T7). This absence of scaffolding heightened professional anxiety and led to inconsistent pedagogical practices, as each teacher's interpretation varied. Another participant emphasized that without explicit benchmarks, integration devolved into a "symbolic exercise" (JS_T3). These findings align with studies on policy implementation in hierarchical systems, where top-down mandates often fail to account for frontline practitioners' needs (Priestley et al., 2015). In Jiangsu, this gap is exacerbated by the rapid policy rollout outpacing support system development. The resulting cognitive load on teachers—who must simultaneously decode policies, design pedagogy, and locate resources—

highlights the critical need for operational clarity to enhance agency.

The prevalence of symbolic compliance in Jiangsu's TVET system—where teachers perform superficial adherence without deep pedagogical change—differs from patterns observed elsewhere. In European systems, gaps often stem from participatory deficits where teachers critique top-down approaches (Berger & Luckmann, 1966). In Jiangsu, however, the gap arises from an implementation ecosystem that fails to equip teachers for mandated change, reflecting a top-down policy tradition coupled with a performance-based accountability culture prioritizing economic metrics. This phenomenon resonates with TPB. The subjective norm—represented by institutional incentives—signals that traditional outcomes are valued over sustainability, reducing motivation for deep integration. Simultaneously, low perceived behavioral control from ambiguous policies inhibits action. Consequently, even teachers with positive attitudes may resort to symbolic compliance as a rational response to structural constraints. This underscores that teacher agency is profoundly mediated by institutional structures, extending TPB by showing how macro-level environments can override individual intentions.

Theme 2: Resource Scarcity and Readiness Gaps

This theme examines the critical systemic constraints that extend beyond policy ambiguity to. The second theme examines the critical systemic constraints that create a tangible "readiness gap" between the expectation for green skills integration and TVET teachers' capacity to deliver it effectively. The analysis reveals an environment of material deficits and underdeveloped support structures, severely limiting the translation of pedagogical intentions into practice. The core dimensions are summarized in Table 3.

Table 3. Theme 2.

Core Concept	Representative Codes	Illustrative Data Evidence	Initial Interpretation
Material & Equipment Deficits	Obsolete Tools, Outdated Textbooks, Lack of Modern Kits	"We teach photovoltaics with decade-old textbooks. The industry has moved through three generations, but our teaching is stuck in the past." (JS_T12)	A critical gap exists between the technology used in industry and the resources available for teaching, directly hindering the delivery of relevant, current skills.
Ineffective Professional Development	Theoretical PD, Lack of Practical Focus, No Follow-up	"Training is a lecture on high-level concepts. Back in my classroom designing a green packaging project, I'm still on my own. How do I grade it?" (JS_T9)	Professional development fails to bridge the theory-practice divide, leaving teachers without the pedagogical tools for classroom application.
Self-Directed Learning & Grassroots Innovation	Guanxi for Resources, Personal Learning Networks, Compensatory Labour	"I follow engineers on WeChat, take online courses, compile my own case studies. My teaching resource folder is my personal project." (JS_T8)	In the absence of systemic support, teachers exercise agency through high-cost individual efforts to compensate for institutional failures.

The most frequently cited barrier was the profound misalignment between rapid industrial technological change and obsolete teaching resources. This gap directly eroded teachers' Perceived Behavioral Control (TPB), as they felt incapable of providing training that met current standards. Participants in technical fields reported using textbooks and equipment outdated by a decade or more (JS_T12, JS_T2). This deficit diminished instructional quality and relevance, causing professional frustration and a chasm between curricular "green skills" aspirations and teachable "brown skills." While most attended professional development (PD), they characterized it as ineffective due to a pervasive "theory-practice divide." PD sessions were generic lectures, silent on "how" to teach green skills within specific disciplines (JS_T9). This model of "PD as policy ritual" lacked continuity and collaborative support, failing to build the practical Green Pedagogical Content Knowledge (GPACK) needed, thus perpetuating the readiness gap.

Confronted with these gaps, teacher agency manifested as resilient, self-reliant "compensatory labour." Teachers proactively sought knowledge through personal channels: compiling cases online, attending paid webinars, and leveraging guanxi for industry access (JS_T8). This demonstrates individual commitment but represents a form of privatized professional development that individualizes systemic failure. This reliance on high-cost individual effort contrasts starkly with PD models in systems like Germany's Fachschule, where development is systematically integrated with industry exchange. The situation in Jiangsu resembles challenges in other rapidly developing economies, but is accentuated by the speed of its green transition. Theorized through the lens of teacher agency under constraint, this compensatory labor is a direct agentive response to the failure of the socio-contextual dimension to provide support. It aligns with the Teacher Agency Mediation Model, showing that when systemic support is low, agentive effort is diverted from pedagogical innovation to basic resource acquisition. Celebrating this "resourcefulness" is problematic; it should be seen as an indicator of a system failing its educators.

Theme* 3: *Lack of Industry-Institution Collaboration

The third theme examines the significant gap between the policy ideal of deep industry-education partnerships and the reality of largely superficial, transactional interactions. The data reveal a "dislocated" bridge between TVET and industry, failing to provide the dynamic, reciprocal exchange necessary for curriculum relevance. In the absence of robust institutional mechanisms, teachers act as solitary "bridge-builders," relying on personal networks. The core dimensions are summarized in Table 4.

The most common form of collaboration described by participants was transactional and limited in scope. The dominant model was the "use-oriented" internship, where companies provided student placements but systematically avoided deeper involvement in curriculum design, teacher development, or competency assessment. This model offered limited pedagogical value, as internships often failed to provide meaningful learning experiences related to green skills. One

teacher noted that students ended up performing repetitive manual tasks, "learning to tighten a bolt, not about battery systems or sustainable design" (JS_T6). This created a significant feedback gap, wherein industries complained about graduate skills but were not structured to provide precise, timely input on evolving competency needs, leaving teachers to interpret vague signals from a distance.

Table 4. Theme 3.

Core Concept	Representative Codes	Illustrative Data Evidence	Initial Interpretation
Transactional Partnerships	Use-Oriented Internships, Point-Based Cooperation, Lack of Deep Engagement	"Enterprises want a finished product. Cooperation is 'point-based'—an internship here, a donation there. It's not a continuous, ecological relationship." (JS_M2)	Collaboration is characterized by one-off, resource-based transactions rather than continuous, pedagogically meaningful engagement in curriculum development or teacher upskilling.
Relational Bridge-Building	Guanxi for Access, Personal Network Leveraging, Informal Knowledge Sharing	"The real collaboration happens because I play badminton with a technical director. He invites me to their internal tech talks. That's where I learn." (JS_T1)	In the absence of formal systems, teachers exercise agency by leveraging personal relationships (guanxi) to gain access to industry knowledge and practices, but this is fragile and inequitable.
Aspiration vs. Reality	Unrealized Dual-Teacher Model, Institutional Barriers, Rhetoric-Practice Gap	"We are told about 'industry-embedded' teaching, but the system doesn't allow for engineers to co-teach or for us to have regular industry sabbaticals. It's just a slogan." (JS_T10)	A stark contrast exists between the official rhetoric of deep collaboration (e.g., dual-teacher systems) and the institutional barriers that prevent its realization.

Confronted with the inadequacy of institutional partnerships, proactive teachers exercised agency through relational bridge-building, primarily leveraging personal networks. This involved using informal connections to secure valuable opportunities that the formal system failed to provide. For instance, several participants described gaining access to industry sites, internal training sessions, or technical data through personal contacts with engineers or managers (JS_T1, JS_T14). While this demonstrates remarkable initiative and provides crucial, authentic insights, it represents a form of compensatory agency that is inherently problematic. This reliance is fragile, highly dependent on individual teachers' social capital, inequitable (favoring those with pre-existing networks), and ultimately unsustainable as a primary mechanism for curriculum alignment. It effectively privatizes the responsibility for maintaining vital industry-education links.

Participants consistently articulated a clear and sophisticated understanding of what effective collaboration should entail, expressing a strong desire for deep, "industry-embedded" models. They envisioned co-teaching arrangements with industry experts ("dual teacher" systems), regular industry sabbaticals for teachers,

and joint curriculum committees that would ensure continuous alignment. However, a stark gap was evident between this aspiration and their lived reality. Teachers criticized the "dual teacher" model as often being merely a "slogan" (JS_T10), with institutional bureaucracy, inflexible schedules, and a lack of financial or contractual incentives for companies preventing its meaningful implementation. This gap highlights a critical implementation failure at the systemic level, where policy rhetoric is not supported by the operational structures needed for execution.

The prevalence of superficial collaboration can be theorized through the lens of clashing institutional logics. TVET institutions often operate under an educational logic focused on comprehensive student development and curriculum cycles, while industries are driven by a market logic prioritizing efficiency, productivity, and immediate returns on investment. Transactional partnerships represent a low-effect compromise between these logics. The reliance on professional network highlights the role of social capital as a compensatory mechanism when formal institutions fail to facilitate exchange. This aligns with social capital theory, which posits that personal networks can act as a substitute for weak formal institutions. However, as this study shows, this substitution comes at the cost of equity and scalability.

The findings from Jiangsu present a revealing contrast with TVET systems known for strong industry integration, such as the German dual system or Swiss apprenticeship model. In these systems, collaboration is institutionalized through legislation, standardized contracts, and joint governance bodies that ensure shared responsibility and deep engagement. The challenge in Jiangsu appears not to be a lack of policy vision but a deficit in the middle-level infrastructure—the specific protocols, funding models, and intermediary organizations—that broker and sustain deep partnerships. This suggests that moving beyond superficiality requires building this intermediary infrastructure to translate high-level policy into operational reality.

The dislocated industry-education bridge has profound implications for teacher agency and the relevance of green skills training. It forces teachers into a precarious position of being the primary mediators between the education system and the labor market, a role for which they are not adequately supported. This increases their workload and creates a systemic vulnerability, as curriculum relevance becomes dependent on individual teachers' motivation and social capital rather than on a reliable institutional process. For the green transition, this is particularly critical. The rapid evolution of green technologies means that curricula can quickly become obsolete without strong, structured feedback loops from industry. Therefore, strengthening this bridge is not merely an improvement but a necessity for ensuring that TVET in Jiangsu can effectively contribute to the province's sustainable economic goals.

5. Conclusion

This study set out to investigate the complex, situated challenges of integrating

green skills into TVET pedagogy within the dynamic context of Jiangsu Province, China. Grounded in the empirical experiences of 16 teachers across four distinct institutions and analyzed through the lens of the Teacher Agency Mediation Model, the findings converge on a central, unequivocal argument: the success of this integration hinges decisively not on the heroic, individual resilience of teachers but on the deliberate construction of a systemic empowerment ecosystem. Such an ecosystem must actively recognize, resource, and sustain TVET educators in their essential role as the primary mediators between policy ambition and classroom reality.

The empirical analysis compellingly demonstrates that teachers are not passive implementers but active, interpretive agents. However, their agency is currently channeled into a dual modality of pragmatic navigation and exhausting compensatory labour—a direct response to a constraining hierarchy of obstacles. These obstacles, crystallized in the three core themes of policy-practice ambiguity, critical resource scarcity, and superficial industry links, collectively shape and often limit how agency is exercised. This refines the theoretical understanding of teacher agency within sustainability transitions, underscoring that what may be misread as a deficit in individual will or capability is, in fact, a deficit in systemic support (Priestley et al., 2015; Eteläpelto et al., 2022). The reliance on personal networks (guanxi) and self-directed learning to compensate for institutional gaps, while testament to individual commitment, ultimately highlights a systemic failure that privatizes and burdens the vital work of curriculum greening.

Therefore, the recommendations arising from this study—for the co-creation of disciplinary-specific pedagogical toolkits, the establishment of structured professional learning communities, and the fostering of deep, reciprocal industry partnerships—are not merely incremental suggestions. They represent fundamental shifts toward building the missing middle-level infrastructure necessary to close the persistent policy-practice gap. This infrastructure is crucial for translating the Teacher Agency Mediation Model from an analytical framework into an enabling condition, reducing the need for compensatory labour and redirecting teacher agency toward sustained pedagogical innovation.

For Jiangsu Province, and by extension for regions pursuing similar "dual carbon" and green economy ambitions, investing in this empowerment ecosystem is a strategic imperative that transcends educational reform. It constitutes an investment in the human infrastructure required to transform high-level sustainability pledges into tangible workplace competencies and to drive a genuinely inclusive and competitive green economic transition (World Bank, 2023; UNESCO, 2021). The ultimate objective must be to catalyze a shift from an over-reliance on the precarious, individual agency of teachers to the cultivation of a resilient collective professional agency. Only through such a systemic reorientation can the green skills imperative be met not as a fragmented burden shouldered by isolated individuals, but as a shared responsibility enabled by a thoughtfully designed and robustly supported ecosystem.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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