



Developing a Transnational Collaborative Dual Education Model for China–Thailand Vocational Cooperation in the Eastern Economic Corridor

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Abstract

Background and Aim: The expansion of Chinese manufacturing investment in Thailand's Eastern Economic Corridor (EEC) has widened the gap between workforce competencies demanded by transnational enterprises and those produced by existing vocational programs. Thailand's dual vocational system, while domestically effective, lacks the institutional architecture to support cross-border enterprise partnerships or cultivate the intercultural and civic dispositions that transnational workplaces require. This study aimed to (1) develop the Transnational Collaborative Dual Education (TCDE) Model integrating institutional, interface, pedagogical, and outcome layers for China–Thailand vocational cooperation, and (2) examine its effectiveness in enhancing technical competence, public mind, and cross-cultural literacy among dual vocational students. A particular emphasis of the study is its cross-cultural literacy component, which addresses a dimension largely absent from existing China–Thailand cooperation frameworks.

Materials and Methods: A Research and Development (R&D) design was employed across four phases: documentary and interview-based analysis; model construction grounded in the Transnational Triple Helix framework and the five-step Social Contribution-Based Learning process (I Think, I Find, I Try, I Do, I Get); expert validation using the Item-Objective Congruence (IOC) index assessed by nine specialists; and pilot implementation with 36 students enrolled in cooperative programs with Chinese-invested enterprises in the EEC.

Results: Expert evaluation placed overall model appropriateness at the highest level ($\bar{x} = 4.58$, S.D. = 0.41), with all IOC values falling between 0.80 and 1.00. Post-intervention public mind scores significantly exceeded pre-intervention levels ($p < .05$). Technical achievement surpassed the 75% criterion with statistical significance ($p < .05$), and cross-cultural literacy indicators showed marked improvement, particularly in workplace adaptation and collaborative problem-solving.

Conclusion: The TCDE Model provides a replicable framework for organizing transnational dual vocational education that moves beyond skill transmission to encompass civic consciousness and intercultural competence, with demonstrated effectiveness across institutional, pedagogical, and outcome dimensions.

Keywords: TCDE Model; Social Contribution-Based Learning; Design Thinking; China–Thailand Cooperation; Eastern Economic Corridor

Introduction

Over the last ten years, Southeast Asia's vocational education landscape has undergone a profound transformation, driven by two overlapping and mutually reinforcing global trends. First, regional manufacturing supply chains have experienced rapid international integration, reshaping local industrial demands and labour market requirements across Southeast Asian nations. Second, industry stakeholders and educational practitioners have increasingly acknowledged that technical proficiency alone is no longer sufficient to equip vocational graduates with the comprehensive competencies needed to navigate the multifaceted, cross-cultural dynamics of modern transnational work environments. A compelling illustration of this dual shift can be observed in Thailand's Eastern Economic Corridor (EEC). Officially launched in 2017 as Thailand's flagship industrial development hub, the EEC spans three key eastern provinces, Chachoengsao, Chonburi, and Rayong, and has emerged as a core destination for cross-border industrial investment. The zone has attracted substantial foreign direct investment from global manufacturing players, particularly Chinese automotive enterprises, including BYD, Great Wall Motor, and SAIC CP, all of which have established large-scale local production bases. As documented by the Eastern Economic Corridor Office (2022), these multinational operations create a pressing local demand for skilled workers who can effectively adapt to cross-linguistic, cross-cultural, and cross-organisational operational scenarios in transnational production systems.

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Citation



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Thailand's dual vocational training system, centrally regulated by the Office of the Vocational Education Commission (OVEC), has undergone iterative reforms since the 1980s. The initial reform phase drew core operational principles from Germany's renowned dual apprenticeship model, laying the foundation for the country's formal vocational training framework. Despite decades of domestic optimisation and system upgrades, the entire institutional framework was primarily designed to serve Thailand's standalone national labour market, with little consideration for cross-border industrial cooperation or transnational talent cultivation needs. This structural limitation became increasingly prominent after 2017, when Chinese vocational institutions and industrial enterprises began to deeply engage with Thailand's local vocational training ecosystem. These incoming Chinese stakeholders bring distinct institutional norms, educational philosophies, and teaching methodologies that are inherently incompatible with Thailand's traditional, nationally oriented vocational education system. This disparity has ultimately led to a critical supply-demand mismatch in the local talent market: while transnational enterprises operating in the EEC urgently require bilingual and bicultural skilled talent capable of adapting to international production environments, Thailand's existing vocational education system lacks standardised, institutionalised mechanisms to cultivate such interdisciplinary, cross-border competent professionals.

Current bilateral vocational cooperation projects, prominently the Luban Workshop initiative and the Banphai–Wuhan railway workforce training programme, have proven the practical feasibility of Sino-Thai vocational education collaboration. Nevertheless, these grassroots cooperative practices also expose the inherent instability and limitations of current cross-border cooperation mechanisms. All existing projects rely on ad-hoc, case-specific institutional negotiations rather than a unified, systematic cooperation framework. There are no universal, standardised protocols for institutional governance, joint curriculum development, teacher and student mentorship, or training outcome evaluation across collaborative projects. Against this contextual backdrop, this study focuses on two interrelated core research questions. First, what institutional framework can be constructed for Sino-Thai dual vocational education to support long-term, sustainable, and systematic cross-border cooperation, replacing the fragmented, project-based negotiation model? Second, what targeted pedagogical strategies can effectively nurture students' technical capabilities, cultural literacy, and civic awareness, enabling them to fully meet the multidimensional requirements of transnational workplace scenarios?

To address the above two research questions, this study proposes the innovative Transnational Collaborative Dual Education (TCDE) Model. Integrating a restructured Social Contribution-Based Learning mechanism into a refined Transnational Triple Helix institutional framework, this model revises the long-standing narrow perception that international vocational education only needs to focus on cultivating industry-specific technical skills. It further emphasises the indispensable value of cross-cultural competence, civic literacy, and comprehensive adaptive capabilities in transnational talent cultivation. The subsequent sections of this paper will systematically elaborate on the theoretical underpinnings of the TCDE model, introduce the overall research design and methodological framework, and present empirical research findings to validate the rationality and practical value of the proposed model.

Objectives

The objectives of this study were as follows:

1. To develop the Transnational Collaborative Dual Education Model for China-Thailand vocational cooperation in the Eastern Economic Corridor, integrating institutional, interface, pedagogical, and outcome dimensions.
2. To examine the effectiveness of the TCDE Model in enhancing technical competence, public mind, and cross-cultural literacy among dual vocational education students participating in cooperative programs with Chinese-invested enterprises.





Literature review

The Evolution of Dual Vocational Education in Thailand

The dual vocational education system in Thailand began with technical cooperation agreements with Germany in the 1980s. At that time, the German Agency for International Cooperation (then known as GTZ) provided advisory support for establishing enterprise–school partnerships within Thailand's vocational education system (Pilz, 2017). In the German model, industry chambers hold legal authority over training standards and examinations. In Thailand, the main governance responsibility was assigned to OVEC, a central government body under the Ministry of Education. This structural difference has fundamentally shaped how the system developed.

Taechersai (2025) identified four phases in this evolution. From 1984 to 1995, direct technology transfer characterised the relationship, with German advisors working alongside Thai vocational colleges to set up cooperative training arrangements in selected industrial sectors. The period from 1996 to 2006 saw gradual indigenisation, as OVEC developed local regulations for workplace-based training and reduced reliance on foreign technical assistance. Between 2007 and 2016, dual programs spread beyond manufacturing into service industries, hospitality, and information technology. The fourth phase began in 2017 alongside the Thailand 4.0 policy agenda, defined by the arrival of transnational actors, especially Chinese enterprises and educational institutions in Thailand's vocational education landscape.

This chronological division underscores a pivotal developmental trend in local vocational education. While the dual vocational training system has gradually evolved from passive imitation of foreign models to active contextual adaptation, its core institutional framework remains rooted in domestic institutional settings. Existing regulatory rules, quality supervision systems, and curriculum development mechanisms are all designed on the basis of a single-country operational scope for all participating parties. As Chinese vocational colleges and enterprises engage in local vocational education cooperation, they carry unique institutional operational logic, teaching philosophies, and quality assessment standards that are not fully compatible with Thailand's prevailing vocational education systems (Euler, 2013).

Social Contribution-Based Learning and Design Thinking in Vocational Contexts

The concept of social contribution as an educational objective in vocational settings reflects a broader shift in thinking about the purposes of technical and vocational education and training (TVET). The UNESCO framework articulated by Marope et al. (2015) argued that vocational education must move beyond narrow skill transmission to develop the full spectrum of capabilities that individuals need for productive and meaningful participation in economic and social life.

The above analytical perspective is particularly applicable to the context of transnational manufacturing industries. In the case of Thai students working in Chinese-invested enterprises, their affiliated community is no longer confined to traditional local residential communities. Instead, they are embedded in cross-cultural production environments governed by distinct social norms, workplace hierarchies, and behavioral expectations that differentiate them from indigenous industrial scenarios. Within such transnational workplace contexts, the connotation of civic consciousness surpasses ordinary community voluntary participation. It further entails individuals' capability to fulfill professional duties in multi-national teams, perceive the social implications of cross-cultural industrial production activities, and establish effective interactions with workers and local communities rooted in diverse institutional and cultural backgrounds. This explains why the TCDE model prioritizes the cultivation of public awareness over mere technical proficiency as its core pedagogical focus. Employees with proficient professional skills but insufficient cross-cultural social cognition and civic literacy are unable to fully adapt to the transnational working environments fostered by the EEC's industrial development initiatives.

The five-step Social Contribution-Based Learning process developed by Hoysang et al. (2021), I Think, I Find, I Try, I Do, I Get, operationalises these principles in a vocational setting. The process combines reconstructionist educational philosophy (education as an instrument of social improvement), constructionist pedagogy (learning through making), social learning theory (Bandura, 1997), and design thinking (Brown, 2008). Sasiwat Hoysang et al.'s study demonstrated that this process improved public mind scores among dual vocational students in a domestic Thai setting. Whether the same pedagogical framework could be effectively adapted to transnational cooperation contexts had not previously been examined.

The Triple Helix Framework and Its Transnational Extension

Etzkowitz and Leydesdorff (2000) put forward the Triple Helix theory to unpack the interrelationships existing among universities, industries, and government agencies. This theoretical





framework accounts for the formation and evolutionary process of innovation ecosystems, which stem from sustained interaction and collaborative practices across the three core institutional sectors. These key stakeholders engage in a constant dynamic interplay that reshapes each participant's operational scope. As collaborative ties grow increasingly mature and intensive, the rigid demarcations that once separated these independent sectors become progressively permeable. When adopted in vocational education research, the Triple Helix model offers a robust analytical perspective to interpret the interactive mechanisms linking regulatory authorities, vocational colleges, and collaborative enterprises within the national vocational education system.

Extending this framework to a transnational context requires recognising that each helix is internally differentiated along national lines. In China–Thailand vocational cooperation, the government helix comprises OVEC and its Chinese counterpart agencies; the institution helix pairs Thai dual vocational colleges with Chinese partner institutions; and the enterprise helix brings together Thai domestic firms and Chinese-invested companies operating in the EEC. This bilateral structure has operational consequences that go beyond theoretical refinement. It determines how coordination responsibilities are distributed across national systems, how conflicts between different quality standards are negotiated, and how accountability flows through bilateral institutional relationships. The TCDE Model's Institutional Layer is built directly on this transnational configuration, formalising what existing cooperation has left to personal networks and goodwill.

Intercultural Competence in Transnational Vocational Settings

Deardorff (2006) put forward a definition of intercultural competence, referring to people's capacity to carry out proper and efficient communication when facing different cultural contexts. Such a core capability cannot be formed without three fundamental elements: learners' comprehension of diverse cultures, hands-on practical skills, and constructive mindsets when engaging with people from other cultural backgrounds. The process-oriented model she constructed breaks this capacity down into four core dimensions. These include receptive attitudes such as cross-cultural respect, open-mindedness, and exploratory curiosity; two layers of cognitive knowledge covering self-reflection on one's own cultural identity and sociolinguistic sensitivity; practical abilities involving workplace observation, active listening, analytical reasoning, and cross-cultural meaning interpretation; as well as internal psychological gains and tangible external behavioural results that the learning process aims to achieve.

For Thai vocational students undertaking on-site training within Chinese-funded manufacturing firms, intercultural competence translates into a series of tangible workplace practices. Vocational trainees participating in this overseas cooperative training programme demonstrate cross-cultural proficiency through a wide range of on-the-job practical abilities. To begin with, they ought to grasp the top-down management systems and routine communication customs followed by Chinese firm supervisors, and adjust their daily work rhythms to fit bilingual factory environments. Furthermore, practitioners are required to coordinate diverse standards pertaining to product quality inspection and on-site safety management, while coping with intricate interpersonal interactions with multi-national workers in actual production scenarios. Purely theoretical and classroom-based teaching is insufficient to cultivate such comprehensive cross-cultural practical competencies. The development of these context-specific cultural capabilities relies on continuous engagement with real multicultural working environments, systematic and targeted reflection on practical workplace experiences, as well as the gradual optimisation and improvement of corresponding professional vocational skills. The five-phase Social Contribution-Based Learning framework was originally constructed to deliver exactly this kind of experience-led, practice-centred training model for vocational learners.

Conceptual Framework

This paper's analytical framework draws theoretical support from four separate research domains. The first encompasses classic theories on instructional and learning model design proposed by Joyce et al (1996), Dick and Carey (2015), and Kemp et al (2002). The remaining three pillars cover core educational philosophies and learning theories, accumulated practical experience of vocational education collaboration between China and Thailand, and the Triple Helix analytical lens used to examine innovation systems.

Reconstructivist thinking establishes the study's core normative stance: education carries social transformative value, instead of functioning only as a tool for individual self-development. Constructivism, meanwhile, puts forward a key guiding principle: deep, meaningful learning can only be realised when learners produce practical outputs and confront real-world industry challenges through hands-on





participation. Bandura's (1997) social learning theory explains the psychological pathway behind competency formation: repeated observation of role models, behavioural imitation, and post-practice reflection within social interactions enable learners to fully internalise professional capabilities. Brown's (2008) design thinking methodology then supplies a systematic workflow to convert abstract educational philosophies into staged, actionable learning arrangements.

Hoysang et al (2021) put forward a five-stage practical learning framework that integrates the above theoretical perspectives, with proven effectiveness in cultivating civic awareness among local dual vocational trainees. Building upon this established model, the current research expands its applicable scope to cross-border cooperative scenarios by incorporating two understudied dimensions absent from the original domestic-focused framework: institutional governance and cross-cultural interaction.

Structural logic for the institutional dimension comes from the Transnational Triple Helix paradigm. Empirical operation rules governing cross-border institutional coordination are not derived from theoretical conjecture alone; they are substantiated by official policy texts and bilateral cooperation records of the Luban Workshop initiative (Srirabuddhi et al., 2022) as well as the Banphai–Wuhan railway vocational training programme (Khamsroy, 2025).

Research Variables

The independent variable in this study is the implementation of the TCDE Model learning management process. The dependent variables are the effectiveness outcomes, which comprise: 1) public mind level of dual vocational students, 2) technical achievement, 3) cross-cultural literacy, and 4) student satisfaction with the learning management model.

Research Hypotheses

- 1) After participating in the TCDE Model learning process, students demonstrate higher public mind scores than before the intervention, with statistical significance at the .05 level.
- 2) After participating in the TCDE Model learning process, students achieve technical test scores higher than the 75% criterion, with statistical significance at the .05 level.
- 3) Students express satisfaction with the TCDE Model learning management process at a high level or above.

Methodology

Research Design

This study used a Research and Development (R&D) approach, following the same four-phase structure that Hoysang et al. (2021) employed but adapted considerably for the transnational scope of the research. The R&D method was chosen because it allows a researcher to build a theoretical model, test it with experts, try it out with actual students, and then refine it based on what happens in practice. That iterative quality matters here, since no established blueprint exists for organising cross-border dual vocational education between China and Thailand.

It bears acknowledging at the outset that this study's pilot phase employed a one-group pretest–posttest design, a pre-experimental structure that, by its nature, cannot fully isolate the TCDE Model as the sole cause of the observed changes. No matched control group receiving standard vocational instruction was included in the pilot. This design decision reflected the practical constraints of the first-cycle R&D implementation: at two colleges with limited cohort sizes, randomly assigning students to treatment and control conditions was neither logistically feasible nor ethically straightforward, given that the partner enterprises had committed to hosting the full cohort under the new model. The design is therefore best understood as providing initial proof-of-concept evidence suitable for an exploratory R&D study rather than definitive causal inference. Future research incorporating quasi-experimental designs with matched control groups would substantially strengthen the causal claims that the present findings only preliminarily support.

Research Phases

Phase 1: Study and Analysis of Components, Indicators, and Development Guidelines (R1)

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The first phase aimed to establish a solid understanding of what the model should contain, involving documentary review and field interviews with people directly involved in China–Thailand vocational cooperation.

On the documentary side, the research examined policy documents from OVEC and the EEC Office related to vocational workforce development, bilateral agreements between Thai and Chinese educational institutions (including the Luban Workshop protocols and the Banphai–Wuhan railway cooperation documents), and the broader academic literature on dual vocational systems, Triple Helix innovation theory, social contribution-based learning, design thinking pedagogy, and intercultural competence.

This study collected primary field data through semi-structured interviews with 12 core participants, who were recruited based on purposive sampling strategies. The informant group comprised three types of practitioners closely involved in transnational vocational education cooperation: four vocational education administrators (including two Thai and two Chinese officials) with rich practical experience in Sino-Thai collaborative programs, four training managers working for Chinese-funded enterprises in Thailand's Eastern Economic Corridor (EEC), and four frontline vocational teachers responsible for delivering dual education programs in partnership with Chinese enterprises. The interview topics centered on the practical operation status of current cross-border cooperation, existing operational deficiencies, institutional obstacles restricting bilateral collaborative governance, and the core professional competencies required for vocational graduates engaged in transnational workplace scenarios. Adopting the content analysis methodology proposed by Krippendorff (2018), this study processed all interview records and supporting documentary materials. The coding system was developed through a mixed analytical approach, combining deductive categorization based on the established theoretical framework and inductive summarization of emerging characteristic patterns from the original data.

Phase 2: Model Construction (D1)

Drawing on Phase 1 findings, the TCDE Model was built as a four-layer framework.

The Institutional Layer defines the key bilateral stakeholders and their interactive relationships within the cooperation framework. It is structured around a Transnational Triple Helix model that integrates governmental authorities, vocational institutions from both China and Thailand, as well as participating enterprises covering local Thai businesses and Chinese-invested firms operating in Thailand's Eastern Economic Corridor (EEC). The Interface Layer establishes practical operational mechanisms to underpin sustainable cross-border vocational cooperation, which covers multiple core practices including collaborative curriculum design, a dual mentorship mechanism involving Thai and Chinese workplace supervisors, cross-border internship rotation arrangements, and standardized credit transfer systems for mutual academic qualification recognition. As for the Pedagogical Layer, it adapts the five-stage Social Contribution-Based Learning framework and revises each procedural step to fit the contextual characteristics of transnational enterprise training and practical teaching scenarios. I Think becomes cross-cultural problem identification; I Find involves drawing on resources and data from both Thai and Chinese sources; I Try means collaborative prototyping with mixed-nationality teams; I Do involves community engagement that crosses cultural boundaries; I Get incorporates bilingual reflective practice.

The Outcome Layer sets out three measurable assessment criteria for the model, encompassing professional technical abilities, social literacy, and cross-cultural communication competence. Corresponding detailed evaluation indicators were developed for each dimension to enable standardized quantitative assessment. Before the official validation of the established model, the research team consulted five professionals from diverse academic and practical backgrounds to examine the original framework. These experts brought multidisciplinary insights, with individual specializations covering vocational education policy, cross-border educational partnership, instructional system development, and cross-cultural management practices. The study incorporated their constructive comments to refine the initial model structure, further enhancing the framework's theoretical soundness and real-world adaptability.



Phase 3: Expert Validation and Pilot Implementation (D2)

Expert Validation. This study adopted purposive sampling to recruit nine professional experts for model evaluation. The eligibility criteria for participant selection included a doctoral qualification and a minimum of ten years of working experience in vocational education, international educational cooperation, or other relevant professional fields. The expert panel consisted of professionals with diverse research and practical backgrounds, including three specialists in vocational education policy, two scholars specializing in instructional design, two researchers engaged in cross-cultural education studies, and two training directors working for Chinese-funded enterprises in Thailand.

All components and indicators of the TCDE Model were assessed by these invited experts via a standardized evaluation questionnaire. The assessment framework covered two core dimensions: the overall appropriateness of each indicator (scored on a five-point Likert scale) and content validity, which was examined using the Item-Objective Congruence (IOC) index. During the evaluation, each item was rated independently by experts with three optional scores: +1 for items that precisely matched the corresponding research objectives, 0 for items with ambiguous correspondence, and -1 for items that failed to reflect the intended measurement objectives. The final IOC value of each indicator, ranging from 0.00 to 1.00, was calculated by averaging the total scores from all participating experts. In this research, an IOC score of 0.80 was set as the cut-off standard for retaining valid model indicators.

It should be noted that the IOC index functions primarily as a measure of content validity at the item level; it assesses whether each indicator appropriately reflects its intended construct. As a systemic validation method for a complex multi-layer model, it has recognised limitations: high expert consensus on item appropriateness does not by itself confirm that the model's layers function coherently as an integrated system in real institutional contexts. To partially compensate for this, the validation panel was designed to include practitioners with direct operational experience (the two enterprise training directors), not only academic specialists, so that judgements about appropriateness were grounded in operational as well as theoretical knowledge. Additional validation through Structural Equation Modelling or Confirmatory Factor Analysis on larger datasets would provide more robust evidence of systemic structural validity and is recommended for subsequent research cycles.

Pilot Implementation. The validated model was implemented with 36 dual vocational students from two colleges participating in cooperative programs with Chinese-invested enterprises in the EEC region.

Students were selected through purposive sampling based on three criteria: enrolment in a dual program with a Chinese enterprise training component during the second semester of the 2024 academic year, confirmed placement at a Chinese-invested EEC enterprise for the practicum component, and programme-level matching across the two colleges to ensure that both cohorts were receiving equivalent vocational preparation in related technical fields (automotive manufacturing and industrial electronics). The two colleges were selected because they had the most established Chinese enterprise partnerships in the EEC at the time of the study, making them the sites where the institutional mechanisms described in the TCDE Model's Interface Layer were most likely to be operationally testable. While 36 students from two institutions cannot represent the full diversity of vocational programs and enterprise types across the EEC, the sample was constructed to maximise internal consistency rather than breadth, an appropriate priority for a first-cycle R&D pilot whose primary purpose is model refinement rather than population-level generalisation.

Before implementation, all participating instructors completed a four-day orientation workshop covering the theoretical foundations of the TCDE Model, the pedagogical sequence of the adapted Social Contribution-Based Learning process, procedures for administering the research instruments, and guidelines for the dual mentorship arrangement. The workshop was co-facilitated by the research team and one enterprise training director from a Chinese-invested company in the EEC. This training was designed to ensure that the intervention was delivered with fidelity to the model's design, reducing the risk that variability in instructor understanding would confound the pilot results.



The educational intervention lasted 16 weeks, corresponding to a complete academic semester that combined in-class instruction and on-the-job workplace training. The entire intervention period was structured into sequential stages aligned with iterative learning procedures. The first three weeks were dedicated to cross-cultural adaptation training and the I Think stage, where students identified and sorted out practical problems existing in local communities and cooperating enterprises. From Week 4 to Week 7, students entered the I Find stage, during which they carried out field research by collecting and analysing professional industrial documents in both Thai and Chinese languages. The subsequent four weeks (Weeks 8–11) served as the I Try stage, enabling students from different cultural backgrounds to form mixed teams and complete practical prototype development at enterprise sites. Weeks 12 to 14 fell into the I Do stage, where students participated in systematic and standardized community practice activities. The final two weeks (Weeks 15–16) corresponded to the I Get stage, in which students submitted bilingual reflective portfolios and received comprehensive summative evaluations to conclude the whole learning process.

Phase 4: Model Refinement (R2)

After the pilot, the model was revised based on implementation results and feedback collected through focus group discussions with participating students and instructors. The changes were documented, and the refined model was presented as the final output of the research.

Research Instruments

Four instruments were developed for this study. The process for creating each followed three steps: reviewing relevant literature and interview data to draft the items, submitting the draft to experts for content validity checking and language review, and calculating IOC values and revising items based on expert feedback. All instruments were evaluated by the same nine-member expert panel.

1) *Public Mind Assessment Scale*. This study adopted a five-point Likert scale with 30 items to measure the public mind, which was revised based on the scale developed by Hoysang et al. (2021). We adjusted the original scale's contextual settings to match the transnational workplace and community scenarios targeted in this research. Expert content validation confirmed satisfactory item quality, as all retained items produced IOC scores from 0.80 to 1.00. Data collected from the pilot test further validated the scale's excellent psychometric properties. Specifically, item discrimination coefficients (r) ranged from 0.50 to 0.97, and the overall Cronbach's alpha reliability coefficient reached 0.98.

2) *Technical Achievement Test* The 40-item multiple-choice test was developed as a criterion-referenced assessment tool to evaluate students' technical learning outcomes. All test questions were designed strictly in line with the unified curriculum standards formulated in the Interface Layer of this research. Review feedback from the expert panel verified strong content validity, with all individual items registering IOC scores spanning 0.80 to 1.00. Data analysis from the pilot study generated valid item statistics, with discrimination coefficients ranging from 0.20 to 0.80 and difficulty indices falling within 0.25 to 0.80, demonstrating appropriate item differentiation and difficulty distribution for student assessment. The overall KR-20 reliability score of the test was 0.76, which supports adequate internal consistency for academic evaluation use.

3) *Cross-Cultural Literacy Rubric* This study employed a performance-based rubric to evaluate students' cross-cultural literacy, with assessments grounded in participants' real-task performance during training. Tailored to the transnational learning and professional workplace contexts of this research, the rubric focuses on evaluating learners' practical cross-cultural competencies cultivated throughout the programme. The assessment framework covers key practical abilities essential for cross-border study and work, including effective cross-cultural communication, positive workplace adaptation, competent bilingual application in professional affairs, inclusive cultural empathy, and the capability to resolve team problems through collaboration with culturally diverse partners.

4) *Satisfaction Questionnaire*. This study designed a 25-item five-point rating scale to investigate students' learning satisfaction. The questionnaire focuses on three core evaluation dimensions: the practical effect of learning management procedures, the rationality of collaborative training arrangements, and the



overall implementation effect of the proposed teaching model. Expert verification demonstrated good content validity for the questionnaire, with all items achieving IOC scores between 0.80 and 1.00.

Data Analysis

Quantitative data were analysed using descriptive statistics (means and standard deviations), dependent samples t-tests for comparing pre- and post-intervention scores on public mind and technical achievement, and percentage-based analysis against the 75% criterion for achievement. Qualitative data from focus group discussions and open-ended questionnaire responses were analysed through content analysis, with themes validated through member-checking with a subset of participants.

Results

TCDE Model Components and Structure

The Phase 1 analysis yielded a four-layer model comprising 4 main components, 12 sub-components, and 47 indicators. The Institutional Layer identified six actor categories organised into three bilateral helices: the Government Helix (Thai OVEC and the Ministry of Education paired with Chinese provincial education commissions), the Institution Helix (Thai dual vocational colleges paired with Chinese partner institutions, including Luban Workshop host schools), and the Enterprise Helix (Thai domestic enterprises paired with Chinese-invested enterprises in the EEC). The Interface Layer specified four coordination mechanisms: joint curriculum standard development, dual mentorship pairing of Thai and Chinese workplace supervisors, cross-border practicum rotation, and credit transfer with mutual qualification recognition. The Pedagogical Layer comprised the five-step adapted Social Contribution-Based Learning process with transnational contextual modifications for each step. The Outcome Layer defined three competence dimensions with 15 measurable indicators.

Expert Validation Results

The overall appropriateness of the TCDE Model was rated at the highest level ($\bar{x} = 4.58$, S.D. = 0.41). Component-level ratings are presented in Table 1.

Table 1. Expert Appropriateness Ratings for TCDE Model Components

Component	$\bar{x}$	S.D.	Level
Institutional Layer	4.62	0.38	Highest
Interface Layer	4.51	0.44	Highest
Pedagogical Layer	4.64	0.39	Highest
Outcome Layer	4.53	0.42	Highest
Overall	4.58	0.41	Highest

All individual items achieved IOC values between 0.80 and 1.00, indicating strong agreement among the nine experts that each component and indicator measures what it is intended to measure. No items required elimination. Minor wording adjustments were made to three items in the Interface Layer, primarily to make credit transfer mechanisms more operationally specific for contexts involving different national qualification frameworks.

Pilot Implementation Effectiveness

Public Mind. Paired statistical tests confirmed clear growth in students' public mind following the implemented intervention. Participants recorded a mean post-intervention score of 4.21 (SD = 0.34), a marked upgrade from the pre-intervention average of 3.42 (SD = 0.47). This numerical difference was statistically significant ($t(35) = 8.74$, $p < .05$). Every sub-dimension under the public mind framework saw positive growth after the training. In particular, learners made the most remarkable advancement in understanding community responsibility and building collaborative problem-solving mindsets, demonstrating the intervention's strongest practical effects in these two areas.

Technical Achievement. The intervention also delivered positive outcomes in learners' technical mastery. After completing the full training programme, students achieved an average technical proficiency





score of 81.47%. This outcome significantly exceeded the 75% benchmark set for competent technical performance in the curriculum, as validated by statistical testing ($t(35) = 4.92, p < .05$). Improvements were evenly reflected across different assessment components, including both theoretical technical knowledge and hands-on practical skills. This consistent growth proves that the designed model effectively helped students strengthen their overall professional technical competencies.

Cross-Cultural Literacy. Students' cross-cultural literacy gains were assessed through standardised performance rubrics. Of the 36 student participants, 30 individuals reached competent or advanced levels in the overall cross-cultural competency assessment, equating to 83.33% of the total sample. When breaking down dimensional performance, learners achieved the highest scores in workplace adaptation ($M = 3.31/4.00$) and collaborative problem-solving within multicultural teams ($M = 3.22/4.00$). Comparatively, students scored lowest on professional bilingual communication ($M = 2.89/4.00$). This outcome reveals that professional language application remained a notable weakness for participants. It also implies that the one-semester training period was limited in supporting students to fully develop professional bilingual competence for real-world workplace use.

Student Satisfaction. Overall satisfaction with the TCDE Model implementation was at the highest level ($\bar{x} = 4.67, S.D. = 0.31$). Students rated the cross-border practicum experience and dual mentorship arrangements most favourably. The credit transfer component received comparatively lower satisfaction ratings ($\bar{x} = 3.94$), a pattern that reflects the unresolved structural tension between Thai and Chinese national qualification frameworks rather than dissatisfaction with the model's design per se. Students and administrators both reported uncertainty about how competencies assessed in Chinese enterprise settings would be formally recognised within Thai qualification records, an ambiguity that the model's Interface Layer specifies but cannot by itself resolve without corresponding policy action at the national level.

Discussion

The findings warrant examination along three lines: the model's contribution to addressing the institutional gap in transnational vocational cooperation, the pedagogical implications of embedding social contribution objectives in cross-border training contexts, and the practical challenges that emerged during implementation.

Institutional integration beyond bilateral agreements

The TCDE Model's Institutional Layer structures what has previously been an ad hoc process. Existing China–Thailand vocational cooperation, including the Luban Workshop (Srirabuddhi et al., 2022) and the Banphai–Wuhan railway program (Khamsroy, 2025), has operated through bilateral institutional agreements without a unifying framework specifying how government, institutional, and enterprise actors from both countries interact systematically. The Transnational Triple Helix configuration extends Etzkowitz and Leydesdorff's (2000) original formulation by recognising that in cross-border vocational education, each helix is internally differentiated along national lines. This is not merely a theoretical refinement; it has operational consequences for how coordination responsibilities are distributed, how conflicts between different national standards are negotiated, and how accountability flows across bilateral lines.

The expert validation results support the structural coherence of this approach, with the Institutional Layer receiving the highest appropriateness rating ($\bar{x} = 4.62$). Experts from both Thai and Chinese institutional backgrounds recognised the model's capacity to formalise relationships that currently depend on personal networks and individual institutional goodwill. This finding is consistent with previous research indicating that the long-term sustainability of international vocational education initiatives is strengthened by institutional integration, sustained policy support, and enduring collaboration among governments, educational institutions, and industry partners, rather than by short-term, project-based activities (Wang, 2025; Zhu, 2025).



Pedagogical adaptation across cultural boundaries

The adaptation of Hoysang et al.'s (2021) five-step Social Contribution-Based Learning process The adaptation of Hoysang et al (2021) five-step Social Contribution-Based Learning process to transnational settings produced measurable gains in public mind scores comparable to those reported in the original single-country study. This suggests that the pedagogical mechanism retains its effectiveness when the "community" encompasses a cross-cultural enterprise and its surrounding locality. Structured identification of community problems, research-based analysis, prototype development, implementation, and reflection appear to work across national contexts when each step is deliberately recontextualised for cross-border settings.

The cross-cultural literacy outcomes, while generally positive, revealed the unevenness that characterises any competence developed within a bounded intervention. Workplace adaptation and collaborative problem-solving, both of which benefit from direct immersion in enterprise settings, showed the strongest gains, whereas bilingual professional communication, which depends substantially on prior linguistic preparation, showed more modest improvement. This pattern is not surprising, but it clarifies where future program design effort should be concentrated.

The question of why civic consciousness in the public mind functions as the primary pedagogical driver in a technical training context deserves explicit justification, as it is not self-evident that a manufacturing workforce program should prioritise social orientation alongside occupational skills. The argument rests on three interconnected claims. Chinese-invested manufacturing environments in the EEC are inherently social spaces where workers from different national backgrounds must negotiate shared norms, responsibilities, and expectations daily. Technical competence without the social orientation to deploy it across cultural lines produces friction rather than productivity. Reconstructionist educational philosophy, from Brameld (1956) onward, has argued that education bears a responsibility to the communities it affects, and in transnational industrial settings, those communities include both the host locality and the multinational workforce. Design thinking, which the Social Contribution-Based Learning process operationalises, requires precisely the empathic, community-facing orientation that the public mind describes. The technical and civic dimensions of the model are therefore not in tension; they are mutually constitutive. A worker who has been trained to identify community problems, research them bilingually, prototype solutions collaboratively, and reflect on outcomes across cultural lines is both a more effective technical contributor and a more responsible community member.

Implementation challenges and institutional friction

The pilot implementation revealed several tensions worth candid acknowledgement. Credit transfer between Thai and Chinese institutions remained the least resolved component, with students and administrators expressing uncertainty about how competencies assessed in Chinese enterprise settings would be recognised within Thai qualification frameworks. This was the single most frequently cited source of dissatisfaction in post-pilot focus group discussions. The issue is not a failure of the model's design; the Interface Layer specifies the need for mutual recognition protocols precisely because their absence was identified as a gap in Phase 1 analysis. Rather, it reflects a structural challenge that no educational model can resolve unilaterally: national qualification systems were built for domestic contexts and resist seamless cross-border articulation (Remington, 2018). The comparison with the German–Thai cooperation history is instructive here. Even in that longer-established bilateral relationship, standardized qualification equivalence took decades to develop incrementally. China–Thailand cooperation is still in its early institutional phase, and expecting immediate resolution of qualification recognition through a single model rollout would be unrealistic. What the TCDE Model does contribute is a documented set of interface specifications that can inform the policy-level discussions required to make recognition eventually workable.

The dual mentorship arrangement, while well-received by students, imposed significant coordination costs. Matching Thai and Chinese workplace supervisors required not only technical alignment but also interpersonal compatibility and willingness to engage in cross-cultural communication, factors difficult to



systematise. The Banphai–Wuhan experience documented by Khamsroy (2025) reported similar coordination challenges in teacher exchange arrangements, suggesting that this is a persistent rather than incidental feature of bilateral vocational cooperation.

Regarding methodological limitations, two should be stated plainly. The one-group pretest–posttest design does not permit confident attribution of the observed outcome improvements to the TCDE Model as opposed to maturation effects, seasonal workplace learning that would have occurred regardless of the model's pedagogical structure, or the Hawthorne effect arising from students' awareness that they were participants in a research study. The sample of 36 students from two colleges, while internally consistent and purposively selected, does not support generalisation to the broader EEC vocational population. These limitations do not invalidate the findings as exploratory evidence within an R&D framework. The purpose of a first-cycle pilot is model refinement and feasibility testing, not definitive effectiveness proof, but they do mean that the results should be read as promising preliminary data rather than confirmed causal evidence. Future research incorporating quasi-experimental designs with matched control groups, expanded across multiple industrial sectors and EEC sub-regions, is necessary before the model's effectiveness claims can be stated with full empirical confidence.

Relationship to Existing Models

The Luban Workshop's EPIP (Exploration, Production, Innovation, Practice) teaching model is the closest existing analogue to the TCDE Model's pedagogical layer, and comparing them clarifies what is new in the present proposal. The EPIP model focuses on skill transmission through enterprise-embedded project work and has demonstrated effectiveness in introducing Chinese manufacturing techniques to Thai vocational learners (Srirabuddhi et al., 2022). What it does not address are the institutional governance structure, the cross-cultural outcomes, and the civic consciousness dimension. The two approaches are complementary rather than competitive; the EPIP could function as one instructional strategy within the TCDE Model's Pedagogical Layer.

Conclusion

This study developed and validated the Transnational Collaborative Dual Education (TCDE) Model as a framework for organising China–Thailand vocational cooperation in the Eastern Economic Corridor. The model integrates four layers that collectively address the structural, procedural, instructional, and evaluative dimensions of cross-border dual vocational education.

Three principal findings emerged. The model's four-layer architecture was assessed as highly appropriate and internally consistent by a panel of nine experts, with all IOC values between 0.80 and 1.00, indicating that the proposed components and their relationships reflect both theoretical coherence and practical relevance. Pilot implementation with 36 dual vocational students demonstrated statistically significant improvements in public mind scores and technical achievement, alongside positive cross-cultural literacy development and high student satisfaction. These findings provide initial proof-of-concept evidence for the model's feasibility and preliminary effectiveness as an organising framework for transnational dual vocational education, while the design limitations of the pilot necessitate cautious interpretation and a clear call for more rigorous validation in subsequent research cycles.

The model's most distinctive contribution lies in its insistence that intercultural and civic outcomes belong alongside technical competence in any serious framework for transnational vocational education. As Chinese manufacturing investment in the EEC continues to deepen, the workforce needs of that industrial landscape will increasingly require graduates who can navigate not just technical processes but the social and cultural dimensions of bilingual, bi-national workplaces. The TCDE Model offers both a theoretical architecture and an empirically tested starting point for building that capacity systematically, rather than leaving it to the incidental outcomes of underformalised bilateral cooperation. Its longer-term value to the communities it is meant to serve, Thai vocational students, partner enterprises, and the localities where transnational industry intersects with local life, will depend on whether the institutional policy action



it implies, particularly regarding qualification recognition and dedicated coordination infrastructure, is eventually taken up by the relevant government and industry bodies.

Recommendation

OVEC and its Chinese counterpart agencies should consider establishing a joint standing committee specifically tasked with developing mutual recognition protocols for competencies acquired in cross-border dual training programs. The current absence of such mechanisms generates uncertainty for students, employers, and educational institutions alike, and the TCDE pilot's credit transfer difficulties illustrate the practical costs of that gap. The EEC Office, given its coordinating role in regional workforce development, is positioned to convene the relevant stakeholders from both countries and move this discussion from the project level to the policy level.

National qualification frameworks in both Thailand and China would benefit from the inclusion of cross-cultural competence indicators, particularly for occupational standards in sectors with significant transnational enterprise presence. The TCDE Model's Outcome Layer provides a preliminary specification that could inform such revisions.

Recommendations for Institutional Practice

Vocational colleges participating in China–Thailand cooperative programs should allocate dedicated coordination resources, including bilingual administrative staff and cross-cultural liaison officers, rather than relying on existing personnel to absorb coordination responsibilities alongside their regular duties. The dual mentorship component, while effective, requires institutional support infrastructure that extends beyond matching individual supervisors.

The Social Contribution-Based Learning process, particularly the I Think, and I Do steps, should be integrated into workplace training plans from the outset of cooperative program design, not added as a supplementary activity. The pilot implementation demonstrated that civic and cultural learning outcomes depend on deliberate curricular embedding rather than incidental exposure to cross-cultural settings.

Recommendations for Future Research

The present study's sample of 36 students from two colleges limits the generalisability of the effectiveness findings. Future research should employ larger and more diverse samples across different industrial sectors and EEC sub-regions, and should incorporate a quasi-experimental design with a matched control group receiving standard vocational instruction. A minimum sample of 120 students distributed across at least four colleges and two industrial sectors would provide adequate statistical power for meaningful between-group comparisons and support more confident generalisation claims.

Longitudinal studies tracking graduates' career trajectories, workplace integration outcomes, and sustained civic engagement following TCDE Model participation would provide evidence on the long-term impact that cross-sectional pre–post designs cannot capture.

Comparative research examining the TCDE Model's applicability in other ASEAN countries hosting significant Chinese manufacturing investment, Vietnam, Indonesia, and Malaysia being the most obvious candidates, would test whether the Transnational Triple Helix configuration and the civic-cultural pedagogical approach translate beyond the specific China–Thailand bilateral context.

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