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Work-Integrated Learning and Students' Employability Competences in Chinese TVET: The Mediating Role of Digital Literacy and the Moderating Role of Competition Experience

Jia Fu*
Faculty of Education, Universiti Kebangsaan Malaysia, Selangor, Malaysia Guizhou City Vocational College, Guiyang, Guizhou, China

Marlissa Omar, Fathiyah Mohd Kamaruzaman and Di Kang
Faculty of Education, Universiti Kebangsaan Malaysia, Selangor, Malaysia

Abstract. Employers increasingly report a persistent mismatch between graduates' skills and contemporary labor market demands. However, the mechanisms through which specific educational practices can address this mismatch remain underexplored, particularly in Chinese higher vocational education. Grounded in a competence-based view of employability and experiential learning theory, this study examines how work-integrated learning (WIL) influences students' employability competences (SEC) in China, focusing on the mediating role of digital literacy (DL) and the moderating role of competition experience (CE). Data were collected from 466 students enrolled in higher vocational colleges through a structured questionnaire survey; all constructs demonstrated satisfactory reliability and validity, and the mediation–moderation model was tested using PLS-SEM. Results show that WIL has a significant positive effect on SEC and an indirect effect via DL. While the main effects were supported, the moderating role of CE was not statistically confirmed in this study. These findings clarify how digitally enabled WIL supports competence development through DL. Practically, TVET institutions should embed digital capability development into WIL design and strengthen industry–education integration to better prepare students for a technology-intensive labor market.

Keywords: Digital literacy; PLS-SEM; Students' employability competences; TVET; Work-integrated learning

*Corresponding author: Jia Fu; *P117118@siswa.ukm.edu.my*

1. Introduction

The growing emphasis on "global talent" and "skilled workers" reflects global demand for adaptable professionals (ILO, 2021; Parua & Yang, 2024). Technical and vocational education and training (TVET) is expected to supply such talent, yet in many low- and middle-income countries TVET outcomes remain poorly aligned with labor market needs (Omar & Kamaruzaman, 2024). China, as a representative case, has rapidly expanded higher education but still faces concerns about graduate quality and employability. Employers report that graduates lack communication skills and the ability to apply knowledge despite holding formal qualifications (Yong & Ling, 2023; Li, 2024).

From a competence-based perspective, students' employability competences (SEC) encompass both hard and soft skills that enable them to obtain and sustain employment (Yorke, 2006; Heijde & Heijden, 2006; Healy et al., 2022). Scholars emphasize that soft skills are as essential as hard skills, since the balance between them is key to improving students' employment quality (OECD, 2017). Recent evidence shows that this balance is increasingly distorted, as employers now prioritize soft skills, which are often insufficiently developed among graduates.

In response to this mismatch, research has increasingly focused not only on employability as an outcome but also on the educational processes that cultivate employability competences. As a learning outcome, employability mainly derives from two sources: active in-class learning and continuous personal development via work-related or extracurricular experiences (Choi-Lundberg et al., 2024). Consequently, work-integrated learning (WIL) has gained prominence as a vital approach to bridging the gap between academic education and practical workforce skills. In China, WIL is typically implemented through the Post-Course-Competition-Certificate (PCCC) integrated model, which embeds workplace elements into curriculum design, teaching practices, and learning activities to enhance SEC and align educational outcomes with labor market demands (Zhang et al., 2024).

Among these elements, competitions—an integral component of PCCC—have emerged as crucial platforms for students to connect academic learning with real-world work scenarios. They simulate workplace pressure, enable practical skill application, and foster teamwork or communication capacities, all of which are highly valued by stakeholders (Lynch et al., 2022). Moreover, the competition teaches students to integrate quickly into new teams, which is crucial in rotational work. Therefore, this study focuses on competitions, as they serve as a bridge linking students and the industry—an attribute that helps enrich existing relevant studies.

While strategies for enhancing employability may involve various educational approaches such as WIL, recent studies indicate that technological proficiency and digital literacy (DL) can also significantly influence graduate employability (Adegbite & Govender, 2022). As job content becomes increasingly demanding in terms of digital and technical skills, DL has emerged as a critical competence enabling individuals to effectively use information and communication

technologies in the digital era (Morgan et al., 2022). In China, although growing attention has been given to integrating WIL into vocational education (Wang et al., 2024), limited empirical research has examined how DL mediates the relationship between WIL and SEC. Existing studies tend to examine WIL and employability as directly associated outcomes or address digital skills in isolation, leaving the underlying mechanisms through which WIL translates into employability competences insufficiently understood.

Therefore, this study addresses this gap by examining the mediating role of digital literacy and the moderating role of competition participation in the relationship between work-integrated learning and students' employability competences, offering a process-oriented contribution to employability research in the context of Chinese TVET. This study sets out to (i) examine the impact of WIL on SEC, (ii) investigate the mediating effect of DL in this relationship, and (iii) test whether participation in competitions moderates the relationship between WIL and SEC.

2. Theoretical Background and Conceptual Framework

2.1 Students' employability competences and dimensions

Drawing on prior empirical and theoretical research, scholars have increasingly examined employability and its associated dimensions. The concept of employability has evolved from a binary understanding of being employable or not to a multidimensional construct that reflects individuals' ability to obtain, sustain, and re-enter employment (Hall & Mirvis, 1995; Fugate et al., 2004; Niu et al., 2019; Valadas, 2025). This shift toward multidimensionality has prompted scholars from diverse perspectives to conceptualize employability as a combination of specific and generic competences that can be intentionally developed through educational processes (Heijde & Heijden, 2006). Accordingly, a competence-based understanding of employability has increasingly been positioned as a central orientation in contemporary educational and employability research.

A competence-based perspective on employability builds on broader competence research and emphasizes employability as a developable set of capabilities. Early competence research focused more on potential, qualifications, or IQ (McClelland, 1973), and the term "competency" was once used to refer to this concept (Mulder, 2001). Currently, the continuous fulfilling, acquiring or creating of work through the optimal use of competences represents what employability manifests as (Heijde & Heijden, 2006; Blumenthal et al., 2024). Students' employability competences (SEC) refer to the comprehensive capability students need to meet labor market demands, secure employment, and advance their careers.

It integrates psychosocial resources gained during studies—including professional knowledge, practical skills, professional attitudes, and job-hunting motivation—to address complex scenarios such as job search competition, task adaptation, and early-career challenges (Heymann et al., 2022). Collectively, these perspectives converge in positioning SEC as a multidimensional, dynamic construct that can be fostered through educational interventions. There seems to be no consensus across domains on a single definition of employability, but it is

clear from the discussion above that the different conceptual approaches to employability are not mutually exclusive.

Building on the competence-based view and situated within the TVET context—where skill development is expected to be dynamic, practice-oriented, and labor-market responsive, this study conceptualizes SEC as comprising six interrelated dimensions (Table 1). Grounded in experiential learning theory, which posits that knowledge is created through the transformation of experience and that workplace-embedded learning enables students to integrate concrete experience with reflective observation and active experimentation (D. A. Kolb, 1984; A. Y. Kolb & Kolb, 2009), the dimensions of lifelong learning and integration of theory and practice capture students' abilities to continuously acquire knowledge and connect disciplinary understanding with real-world vocational tasks. The next theoretical anchor lies in the recognition of the dynamic nature of contemporary occupations, where career pathways are increasingly fluid, uncertain, and self-directed (Bridgstock, 2009).

In this regard, commencement readiness and informed decision-making reflect students' capacity to transition from education to work, make proactive career choices, and shift from passive job seeking to intentional career planning. Finally, employability also requires adaptability to evolving professional expectations and collaborative work environments (Fugate et al., 2004; Clarke, 2018). Thus, the dimensions of professional practice and standards and collaboration represent students' ability to meet industry-aligned performance expectations and to work effectively with others in complex vocational settings.

Table 1: Employability dimensions

Dimensions	Definition
Collaboration	Functioning in teams (building relationships, resolving conflicts) and communicating effectively (orally/written) to create inclusive environments. (OECD, 2011)
Informed decision making	Based on information and professional knowledge, the ability to conduct reasonable analysis and take action(Smith et al., 2014).
Commencement-readiness	The confidence and ability of students to quickly adapt and immediately be competent in entry-level roles upon entering their target industry or field (Caballero et al., 2011; Smith et al., 2014).
Lifelong learning	The ability of students to identify their knowledge/skill gaps, proactively learn to adapt to workplace needs, and optimize their professionalism (Seevaratnam et al., 2023).
Professional practice & standards	Understand and adhere to industry norms, undertake professional responsibilities, and comply with professional ethics (Tong & Gao, 2022)
Integration of theory & practice	Transform the theoretical knowledge and disciplinary principles acquired in the classroom into practical capabilities for solving real workplace problems (AGCAS, 2025)

2.2 Work-Integrated Learning and its Relationship with Students' Employability Competences

Work-integrated learning (WIL) has attracted particular attention as a key employability-oriented approach. The TVETipedia Glossary of UNESCO states that WIL may take various forms, including simulated learning, work-directed theoretical learning, problem-based learning, project-based learning, and workplace-based learning (SAQA, 2013). Integrating employability expectations into teaching and learning has become common in TVET institutions. Specifically, WIL is consistently linked to improved labor market outcomes. WIL has been shown to be instrumental in developing problem-solving, teamwork, and communication competences, and in enhancing students' work readiness, professional confidence, and capacity to perform discipline-specific tasks in authentic contexts (Macqueen et al., 2025).

The theoretical foundations of WIL are rooted in several influential learning perspectives that explain why it is effective in cultivating employability-related competences (Table 2). Drawing on Kolb's (1984) experiential learning theory, WIL is conceptualized as a pedagogical approach that transforms students' participation in authentic workplace tasks into structured learning cycles, in which real-world engagement is followed by guided reflection and conceptual integration that inform subsequent professional practice (Mesuwini et al., 2023). From the perspective of situated learning theory (Lave & Wenger, 1991), WIL can be understood as a process of legitimate peripheral participation in communities of practice, whereby students move from peripheral observation to fuller professional engagement through immersion in workplace interactions.

Informed by career development learning theory (Dacre Pool & Sewell, 2007), WIL is also seen as extending beyond skill acquisition to support students' development of career identity, vocational adaptability, and self-directed career planning through structured activities such as industry engagement, employability training, and guided career reflection. Ferns et al. (2025) further interpret WIL through progressive education, social learning theory, and other perspectives, illustrating how these theoretical lenses have been applied in WIL scholarship. Taken together, these perspectives position WIL as a theoretically grounded mechanism for enhancing students' employability competences in TVET contexts.

Table 2: Key theoretical perspectives of learning that underpin WIL

Name of Theory	Main Viewports of Theory	Integrated the Theory and WIL	Specific Manifestations in WIL
Experiential Learning (D. A. Kolb, 1984)	Experience; Reflection; Abstract Conceptualization; Application.	Emphasizes that deep understanding in learning can only be achieved through "practice and reflection in real-world context".	Practice in real or simulated work scenarios (e.g., internships, simulation tasks), reflect on their experiences through debriefing.
Situated Learning (Lave & Wenger, 1991)	Authentic environments; Socially constructed contexts; Legitimate peripheral participation.	Links WIL to authentic workplace contexts, emphasizing interaction, collaboration and progressive participation.	Students engage in legitimate peripheral participation (e.g., observing, assisting professionals) in workplace settings.
Career Development Learning (Dacre Pool & Sewell, 2007)	Career cognition; self-planning; industry adaptability.	Focus on students' full dimensions of employability	Industry lectures, resume guidance, career counseling.
Theory of progressive education (Dewey, 1926)	Experiential (psychological and social processes); Child-centered; Learning through doing.	Integrates WIL with real work experiences and social interactions, prioritizing practical doing over passive learning.	Immerse herself in collaborative projects and real-world problem-solving, learning directly through hands-on engagement with seasoned professionals.
Social Learning (later renamed Social Cognitive) (Bandura, 1977, 1986)	Observational learning; Reinforcement; Cognitive processes; Self-efficacy; Reciprocal determinism.	Students observe behaviours of professionals in the workplace and adopt these behaviours.	Observe professionals' work practices (e.g., client communication, task execution) during internships; mimic and refine these behaviors through workplace interactions and guided practice.

Accumulating evidence shows that both physical and virtual forms of WIL enhance students' adaptability, digital communication skills, and career self-management—competences increasingly recognized as central to employability in digitally transforming labor markets. Large-scale empirical evaluations indicate that high-quality WIL promotes pre-professional identity formation, which in turn strengthens career motivation and facilitates the transition to employment. Recent systematic reviews corroborate these findings, concluding that WIL has consistent positive effects on students' generic employability skills as well as domain-specific professional capabilities, particularly when reflection,

supervisor support, and theory–practice integration are deliberately embedded in its design. Overall, contemporary empirical evidence continues to position WIL as a highly effective pedagogical mechanism for enhancing SEC by providing experiential, industry-aligned, and professionally immersive learning environments that accelerate students' readiness for the labor market.
H1. WIL has a positive and significant relationship with SEC.

2.3 Digital Literacy
Digital literacy (DL) generally refers to individuals' ability to access, manage, evaluate, integrate, and communicate information safely and effectively through digital technologies (Adams, 2025). Prior research conceptualizes DL as a multidimensional competence encompassing not only operational skills but also higher-order capabilities such as information evaluation, digital communication, and responsible technology use, which are increasingly essential in digitalized learning and work settings.

In the context of employability, DL has been widely regarded as a foundational competence that enables individuals to navigate technology-mediated tasks, search and evaluate career opportunities, and participate effectively in contemporary workplaces (Bejaković & Mrnjavac, 2020). Empirical studies further suggest that the benefits of practice-oriented learning experiences partly depend on students' capacity to leverage digital tools (Xu & Zhu, 2023). Specifically, students' ability to interpret workplace information, collaborate through online platforms, and generate knowledge shapes how learning experiences translate into employability-related outcomes (Urbanek et al., 2023).

The role of DL in facilitating this translation can be theoretically grounded in conservation of resources (COR) theory which posits that individuals are motivated to acquire, retain, and protect valued resources, and that stress emerges when such resources are threatened, depleted, or insufficient to meet contextual demands (Halbesleben et al., 2014). Within this framework, DL can be conceptualized as a key personal resource that enhances individuals' capacity to acquire and mobilize information resources while reducing resource loss associated with uncertainty, inefficiency, and digital task overload. Accordingly, individuals with stronger DL are more likely to feel capable of adapting to technology-intensive environments and securing valued employment opportunities.

In the TVET context, pedagogy for employability typically exposes students to authentic, technology-rich work environments and requires engagement with digital platforms and tools, which may foster DL development. Given DL's resource-based function in enabling students to convert experiential learning into employability-relevant competences, the present study conceptualizes DL as a mediating mechanism linking PCCC and SEC. Accordingly, this study hypothesizes that:
H2a. WIL positively predicts DL.
H2b. DL positively predicts SEC.
H2c. DL mediates the relationship between WIL and SEC.

2.4 Competition Experience

Competitions are growing in popularity, in part because they are perceived as building the skills and employment opportunities that higher education institutions are struggling to provide (Carayannopoulos & Damnjanovic, 2024). Competitions are particularly relevant in the context of Chinese TVET, where the PCCC model has institutionalized skills competitions as an integral pedagogical mechanism to strengthen students' employability. As an experiential and performance-based learning activity, participation in competitions has been shown to enhance students' problem-solving, technical proficiency, teamwork, communication, and resilience—competences strongly associated with employability outcomes (Jackson & Bridgstock, 2021).

Empirical studies suggest that competitions provide authentic, high-pressure environments that accelerate students' professional identity formation and improve their confidence in managing workplace-like challenges. In the Chinese vocational context, skills competitions endorsed by the Ministry of Education (e.g., the National Vocational Skills Competition) function not only as assessment platforms but also as quasi-workplace simulations, creating valuable signals to employers regarding students' capabilities and industry readiness (Jackson & Tomlinson, 2022; Moula et al., 2022).

Taken together, these findings indicate that competition experience (CE) may exert a direct positive influence on students' employability competences and may also shape how effectively students benefit from work-integrated learning (WIL). Students who have previously participated in skills competitions are likely to enter WIL with more advanced technical, problem-solving, and self-regulatory resources, which may enable them to extract greater learning gains from workplace-based experiences. Accordingly, we hypothesize that WIL and CE will each be positively related to SEC and that CE will strengthen the positive effect of WIL on SEC.

H3. CE positively moderates the relationship between WIL and SEC.

Based on the literature and theoretical findings, this study proposes a conceptual framework linking WIL, CE, DL and SEC, as depicted in Figure 1. This conceptual model provides the basis for the hypotheses developed in the next section and will be empirically tested using survey data from Chinese TVET students.

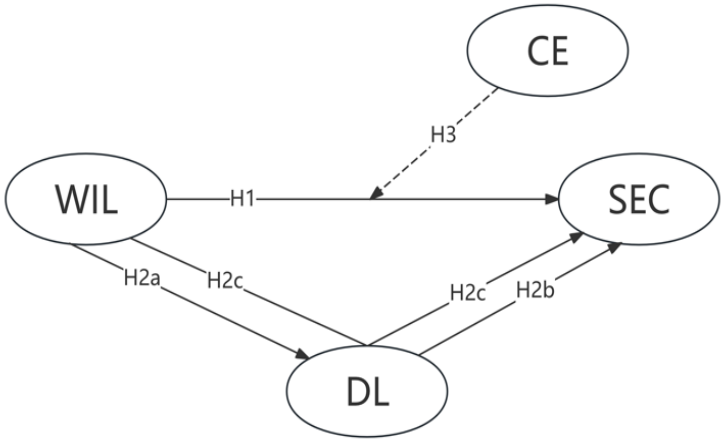

Figure 1: Conceptual framework

3. Methodology

3.1 Participants

This study employed a quantitative cross-sectional survey design to examine the effect of work-integrated learning (WIL) on students' employability competences (SEC), with digital literacy (DL) and competition experience (CE) incorporated into the model. The target population comprised students enrolled in higher vocational education institutions (HVEIs) in southeastern China that implement the PCCC model; eligibility was restricted to those who had participated in PCCC-related learning activities. A systematic random sampling strategy was used, and data were collected anonymously via an online questionnaire between 30 September and 15 October 2025.

In total, 526 questionnaires were distributed, and 466 valid responses were obtained (valid response rate = 88.6%). Prior to data collection, students were informed about the purpose of the study and the voluntary nature of participation. The survey was conducted anonymously, and no identifiable personal information was collected. Participants could exit the survey at any time without submitting their responses. Informed consent was implied through completion of the questionnaire. The final sample included 71.5% male and 28.5% female respondents (Table 3). Responses were screened for completeness and basic consistency and were retained for subsequent analyses conducted in SPSS 29.0 and SmartPLS 4.

Table 3: Demographics of the participating students

Demographic Variable		Frequency (n)	Percent (%)
Gender	Male	333	71.5
	Female	133	28.5
Grade	First Year	88	18.9
	Second Year	183	39.3
	Final Year	195	41.8
Competition	Knowledge-based	32	6.9
	Skill-based	77	16.5
	Project-based	58	12.4
	Digital technology-based	16	3.4
	Never	283	60.7
Further education	Yes	274	58.8
	No	192	41.2
Total		466	100.0

3.2 Instrument

The questionnaire consisted of four sections. The first section captured demographic information, including gender, major, year of study, and competition experience (4 items). The second section assessed students' engagement in WIL using 25 items adapted from established scales (Smith et al., 2014), covering practical exposure, industry interaction, reflective activities, and the integration of theory and practice. The third section measured SEC with 20 items adapted from Smith et al. (2019), spanning six dimensions: lifelong learning, integration of theory and practice, commencement readiness, informed career decision-making, professional practice and standards, and collaboration.

The fourth section measured DL with 10 items adapted from Ng's (2012) multidimensional framework, reflecting technical abilities, cognitive skills, and social-emotional competences. CE was measured with a single categorical item asking students which type of academic competition they had participated in. Response options listed several competition types and a "Never" option indicating no prior competition experience. All items for the latent constructs (WIL, SEC, and DL) were rated on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). To ensure linguistic clarity and conceptual equivalence for Chinese students, the instrument underwent translation and back-translation following Brislin's (1980) procedure prior to administration.

4. Results and Findings

4.1 Descriptive Statistics and Correlations

The descriptive and correlation analyses conducted in SPSS are summarized. On the five-point Likert scale, item means range from 3.92 to 4.03, with standard

deviations between 0.83 and 0.92, indicating generally high yet sufficiently dispersed responses. As CE is a nominal variable rather than a Likert-type scale, it is summarized using frequencies and percentages and is not included in the table of means and standard deviations for the continuous constructs. Zero-order Pearson correlations among the indicators are all positive and statistically significant (.r=.72–.94, p<.01), which is consistent with the original conceptualization of this instrument as capturing closely related facets of a broader construct (Panakaje et al., 2024). Although the magnitude of some correlations suggests substantial empirical overlap between dimensions, the full set of items was retained to preserve the integrity of the validated scale and ensure comparability with prior research. The implications of these high intercorrelations for discriminant validity and potential multicollinearity are examined in the subsequent measurement-model evaluation, and the structural results are interpreted with appropriate caution.

4.2 Measurement Model Evaluation

4.2.1 *Reliability and Convergent Validity*

This study evaluated construct reliability and internal consistency using standardized outer loadings, Cronbach's alpha (CA), composite reliability (CR), and average variance extracted (AVE). According to Hair et al. (2019), indicator loadings should preferably be at least 0.50–0.70 to indicate a strong relationship with the underlying construct; CA and CR values of 0.70 or higher are generally regarded as acceptable for established scales (Nunnally & Bernstein, 1994), and an AVE of 0.50 or above indicates adequate convergent validity (Fornell & Larcker, 1981). All standardized outer loadings exceed 0.85, CR values range from 0.946 to 0.981, CA from 0.886 to 0.977, and AVE from 0.857 to 0.955, all comfortably above these benchmark values. Thus, none of the indicators falls below the 0.70 criterion that would warrant exclusion from the structural model, and the constructs demonstrate very good reliability and convergent validity.

4.2.2 *Discriminant Validity*

Discriminant validity was examined using the Fornell–Larcker criterion and the heterotrait–monotrait ratio of correlations (HTMT). As shown in Table 4, the correlations between CE and the other constructs are small and slightly negative (r = –.20 to –.23), indicating that CE is empirically distinct and not affected by multicollinearity. The diagonal entries for CE, DL, SEC, and WIL all exceed the corresponding inter-construct correlations, so the model meets the Fornell–Larcker criterion. HTMT provides a stricter assessment by comparing between-construct correlations with within-construct correlations; values below about 0.85 (or 0.90 for very similar concepts) are typically taken as evidence of adequate discriminant validity (Henseler et al., 2015).

In Table 5, the HTMT values for WIL with DL and SEC (0.877 and 0.882, respectively) are high but still below the 0.90 cut-off, suggesting that these constructs are closely related yet still distinguishable. By contrast, the HTMT between DL and SEC (0.932) exceeds 0.90, indicating substantial empirical overlap and therefore limited discriminant validity for this pair. Overall, discriminant validity is acceptable for most construct pairs, but the strong similarity between

DL and SEC should be noted, and their unique effects in the structural model should be interpreted with caution.

Table 4: Fornell-larcker criterion

	CE	DL	SEC	WIL
CE	1			
DL	-0.218	0.923		
SEC	-0.229	0.919	0.925	
WIL	-0.203	0.866	0.875	0.906

Table 5 : Hetero-trait mono-trait ratio

	CE	DL	SEC	WIL
CE				
DL	0.220			
SEC	0.230	0.932		
WIL	0.203	0.877	0.882	0.203

4.3 Structural Model Evaluation

Before testing the hypotheses, the structural model was assessed for collinearity, explanatory power, and overall fit. Inner VIF values for the predictor constructs were all below the commonly used threshold of 5 for PLS-SEM, indicating no problematic multicollinearity. The model explains 75% of the variance in DL and 87.1% of the variance in SEC (R^2_DL = 0.75; R^2_SEC = 0.871). Following Hair et al.'s (2019) guidelines, R^2 values of 0.25, 0.50, and 0.75 can be interpreted as weak, moderate, and substantial, respectively. Thus, the present model exhibits substantial explanatory power for both endogenous constructs. In terms of model fit, the SRMR for the estimated model is 0.03, which is well below the conventional cut-off of 0.08 for good fit. The NFI of 0.818 is slightly below the often-cited 0.90 guideline, but when considered together with the very low SRMR and high R^2 values, it still indicates an acceptable level of model fit for a prediction-oriented PLS-SEM model.

4.4 Hypotheses Testing

As shown in Figure 2 and Table 6, WIL has a significant positive effect on SEC, supporting H1 (β = 0.315, t = 4.75, p < .001, 95% CI [0.187, 0.445]). WIL also strongly predicts digital literacy (DL) (H2a: β = 0.866, t = 43.41, p < .001, 95% CI [0.825, 0.902]), and DL in turn positively predicts SEC (H2b: β = 0.640, t = 9.74, p < .001, 95% CI [0.511, 0.766]). The specific indirect effect of WIL on SEC via DL is positive and significant (H2c: β = 0.554, t = 9.38, p < .001, 95% CI [0.438, 0.670]), indicating that DL mediates the relationship between WIL and SEC. Because the direct path from WIL to SEC remains significant, this mediation is partial rather than full. By contrast, the interaction between CE and WIL is not significant (H3: β = 0.007, t = 0.47, p = .641, 95% CI [–0.022, 0.039]), suggesting that CE does not moderate the effect of WIL on SEC in this sample. These results highlight the central mediating role of DL in the WIL–SEC relationship, while indicating that

competition experience, at least as operationalized in this study, does not condition the strength of this effect.

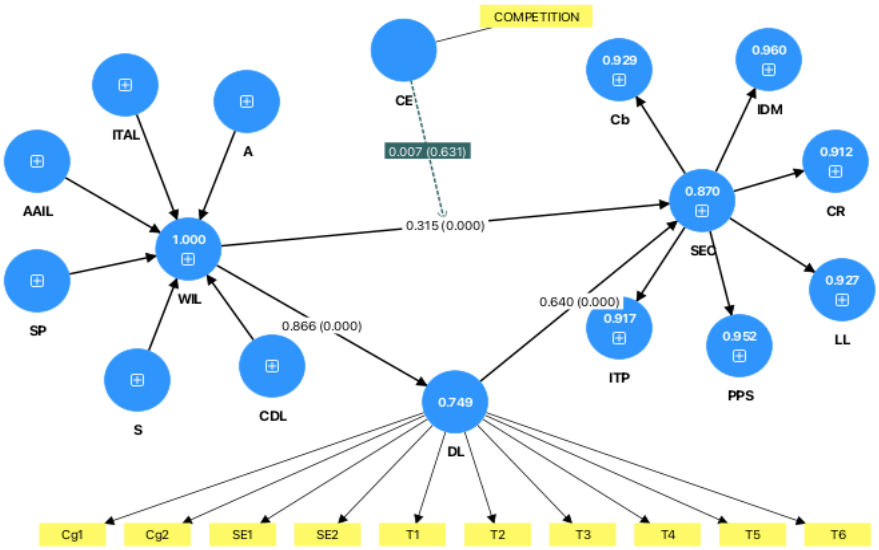

Figure 2: Empirically tested structural model

Table 6: Structural model results and hypotheses testing

Hypothesis Path	T-Value	F-Square	Decision
H1: WIL → SEC	4.745	0.192	Accepted
H2a: WIL → DL	43.405	2.999	Accepted
H2b: DL → SEC	9.741	0.784	Accepted
H2c: WIL → DL → SEC	9.380	–	Accepted
H3: CE X WIL → SEC	0.467	0	Rejected

5. Discussion

The structural model results show that work-integrated learning (WIL) exerts a significant, moderately strong positive effect on students' employability competences (SEC). WIL also has a very strong positive effect on digital literacy (DL), and DL in turn positively predicts SEC, indicating that DL functions as an important mechanism through which students transform WIL experiences into employability-related competences. The specific indirect effect of WIL on SEC via DL is significant, while the direct path from WIL to SEC remains significant, suggesting partial mediation. By contrast, the moderating role of competition experience (CE) in the WIL–SEC relationship was not supported. This result should be interpreted cautiously, as the categorical measurement of competition experience may have limited its ability to capture qualitative differences in competitive learning.

The positive direct effect of WIL on SEC supports the view that practice-based learning is central to employability development in TVET. In China, WIL has been institutionalized through initiatives such as modern apprenticeship pilots, extended internships, and school–enterprise collaborative training, which embed

students in authentic work settings and promote close guidance from both educators and industry practitioners. These arrangements facilitate the development of key employability competences, including collaboration, informed decision-making, readiness for job entry, and the integration of theory and practice. Consistent with cross-national evidence, studies conducted in Oman and New Zealand similarly show that WIL-enriched curricula enhance transferable skills, teamwork, communication competence, and professional identity (Fleming & Pretti, 2019; Srivastava & Haghi, 2024). The present results align with growing scholarly consensus on the role of well-designed WIL in strengthening employability outcomes. By providing evidence from the Chinese TVET context, this study further highlights how national initiatives, such as modern apprenticeship schemes, contribute to employability development within specific institutional and policy environments.

The mediating role of DL in the WIL–SEC relationship is particularly salient and is consistent with previous studies that identify DL as a key channel that enhances graduate outcomes (Adegbite, 2024; Zakir et al., 2025). Although focusing on Turkish educators, Yılmaz et al. (2025) further confirmed that DL acts as a mediator linking practice-based learning to career-relevant skills. In Chinese TVET, recent WIL reforms are explicitly digitally enabled: internships are coordinated through enterprise–school platforms, virtual-simulation facilities are used to model work processes, and many WIL tasks are now completed and assessed on online learning systems.

Within this digitally supported environment, our model shows that WIL strongly predicts DL and that DL, in turn, exerts a substantial positive effect on SEC, with a significant indirect effect of WIL on SEC via DL. This pattern indicates that when WIL is infused with digital technologies, improvements in students' DL help them use technology to solve work-related problems, communicate with employers, and navigate labor-market information, thereby enhancing their employability competences. At the same time, the remaining direct effect suggests that DL is an important—but not the only—mechanism through which WIL improves employability.

In contrast, CE did not exhibit a significant direct or moderate effect on SEC. However, this finding does not suggest that CE lacks importance; instead, it highlights the complexity of the relationship between CE, WIL, and employability beyond the scope of the present measurement. One plausible explanation relates to measurement constraints, as CE was assessed using a single item that aggregated heterogeneous competition types and levels, potentially obscuring the effects of high-quality, WIL-aligned competitive experiences.

In addition, the high proportion of students without competition participation may have limited statistical power to detect moderation effects. Prior research suggests that competitions can contribute meaningfully to employability when they are closely integrated into curricula and supported by structured reflection and mentoring, whereas their impact remains limited when participation is sporadic or credential-oriented (Chang & Lin, 2024). Taken together, these

findings caution against equating the absence of a detectable moderating effect with the absence of value in CE and instead highlight the nuanced and context-dependent nature of how competition experiences interact with WIL in shaping employability outcomes.

6. Conclusion

Drawing on survey data from 466 students in Chinese higher vocational institutions, this study confirmed that WIL has a positive effect on SEC, that DL partially mediates this relationship, and that CE does not significantly moderate it. Theoretically, studying contributes in three ways. First, it operationalizes SEC as a multidimensional competence construct in the TVET context and provides empirical support for this competence-based view of employability. Second, it clarifies the mechanism through which WIL enhances employability by demonstrating that DL partially mediates the WIL–SEC relationship, thereby extending prior work that has mainly examined DL in relation to learning outcomes rather than employability. Third, by testing CE as a potential moderator and finding no significant effect, the study nuances the assumption that competition participation automatically strengthens WIL's benefits for students' employability.

Practically, the findings speak directly to China's ongoing agenda of deepening industry–education integration as a strategy for upgrading vocational education. Beyond institutional practice, the results also have policy implications for accreditation bodies and ministries of education, suggesting that employability-oriented standards and evaluation frameworks should place greater emphasis on digitally enabled work-integrated learning. In line with national policies promoting school–enterprise cooperation, workplace-based training, and digitally supported practice environments, this study highlights the importance of designing WIL arrangements that are closely aligned with real work processes and systematically integrated with digital technologies, thereby strengthening students' digital literacy and, through it, their employability competences. At the same time, the findings indicate that competitive activities require deliberate curricular integration and quality assurance; simply encouraging greater participation in competitions is unlikely to substitute for well-designed WIL.

Overall, the study underscores that, within the context of Chinese TVET reforms, digitally enabled WIL constitutes a central pathway for cultivating employability competences and supporting students' transition into an increasingly technology-rich labor market.

7. Limitations and Recommendations

Despite these contributions, several limitations should be acknowledged. First, the data were drawn from a single sample of Chinese TVET students, which may limit the generalizability of the findings to other regions, educational levels, and disciplinary fields. Future studies could employ multi-site or cross-national samples to test the robustness and external validity of the proposed model. Second, all variables were measured through self-report questionnaires at a single time point, raising concerns about common method bias and constraining causal

inference. Longitudinal designs and the incorporation of additional data sources (e.g., employer or supervisor ratings, institutional records) would therefore be valuable. Third, competition experience (CE) was captured using a single, coarse indicator that did not distinguish the frequency, level, or quality of competitions. Future research could develop more fine-grained measures of CE that better reflect its intensity and pedagogical characteristics. Fourth, the relatively high mean scores across items may indicate a tendency toward agreement, which could have influenced participants' responses and the interpretation of the findings. Finally, this study relied solely on quantitative PLS-SEM; mixed-method designs that integrate structural modeling with qualitative interviews or case studies could provide a richer understanding of how students experience digitally enabled WIL and how they perceive the development of their employability competences.

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Appendix 1

Descriptive statistics and Pearson correlations among variables

	Descriptive		Correlation														
	Mean	SD	A	ITLA	AAIL	SP	S	CDL	T	Cg	SE	Cb	IDM	CR	LL	PPS	ITP
A	3.97	0.88	1														
ITLA	4.03	0.86	.926**	1													
AAIL	3.98	0.85	.870**	.919**	1												
SP	3.93	0.91	.843**	.882**	.920**	1											
S	3.93	0.92	.841**	.858**	.878**	.917**	1										
CDL	3.93	0.9	.837**	.872**	.878**	.901**	.924**	1									
T	3.92	0.85	.772**	.800**	.850**	.828**	.833**	.852**	1								
Cg	3.92	0.87	.721**	.764**	.814**	.798**	.806**	.811**	.930**	1							
SE	3.94	0.86	.749**	.781**	.818**	.773**	.792**	.808**	.927**	.911**	1						
Cb	3.99	0.84	.769**	.813**	.847**	.823**	.809**	.852**	.900**	.882**	.888**	1					
IDM	4	0.84	.767**	.805**	.847**	.808**	.810**	.828**	.885**	.867**	.881**	.936**	1				
CR	3.94	0.86	.772**	.798**	.846**	.818**	.809**	.817**	.878**	.818**	.844**	.892**	.933**	1			
LL	3.96	0.85	.765**	.799**	.833**	.796**	.787**	.819**	.872**	.830**	.843**	.907**	.930**	.944**	1		
PPS	4.02	0.83	.756**	.792**	.828**	.782**	.791**	.820**	.861**	.839**	.872**	.921**	.943**	.898**	.924**	1	
ITP	3.99	0.86	.748**	.793**	.831**	.797**	.785**	.814**	.870**	.846**	.845**	.906**	.919**	.904**	.914**	.938**	1

*Note. A=Authenticity; ITLA=Integration in Teaching and Learning Activities; AAIL=Assessment Aligned with Integrative Learning; SP=Supervision & Preparation; S=Simulation; CDL=Career-development Learning; T=Technical; Cg=Cognitive; SE=Social-emotional; Cb=Collaboration; IDM=Informed Decision Making; CR=Commencement-Readiness; LL=Lifelong Learning; PPS=Professional Practice & Standards; ITP=Integration of theory & Practice. **. Correlation is significant at the 0.01 level (2-tailed)*

Appendix 2
Constructs' reliability and validity

Construct	Indicator	Factor loadings	CR	Cronbach's alpha	AVE
WIL	A	.855	0.96	.944	.857
		.857			
		.853			
		.880			
	ITLA	.910	0.981	.976	.912
		.907			
		.940			
		.916			
		.915			
	AALI	.920	0.977	.971	.896
		.894			
		917			
		.913			
		.924			
	SP	.912	0.981	.977	.896
		.923			
		.888			
		.910			
		.927			
		.908			
	S	.913	0.977	.953	.955
		.921			
	CDL	.909	0.979	.968	.941
		.914			
		.912			
DL	T	.924	0.976	.970	.871
		.931			
		.925			
		.926			
		.937			
		.909			
	Cg	.931	0.968	.934	.938
		.930			
	SE	.917	0.946	.886	.898
		.899			

SEC	Cb	.903	0.973	.963	.899
		.887			
		.928			
		.938			
	IDM	.910	0.975	.966	.909
		.956			
		.936			
		.932			
	CR	.915	0.965	.945	.901
		.897			
		.908			
	LL	.934	0.968	.934	.938
		.931			
	PPS	.927	0.981	.976	.911
		.939			
		.928			
		.931			
		.930			
	ITP	.939	0.974	.946	.949
		.927			

Note. WIL=Work-Integrated Learning; DL=Digital Literacy; SEC=Students' Employability Competence; A=Authenticity; ITLA=Integration in Teaching and Learning Activities; AAIL=Assessment Aligned with Integrative Learning; SP=Supervision & Preparation; S=Simulation; CD=Career-development Learning;T=Technical; Cg=Cognitive; SE=Social-emotional; Cb=Collaboration; IDM=Informed Decision Making; CR=Commencement-Readiness; LL=Lifelong Learning; PPS=Professional Practice & Standards; ITP=Integration of theory & Practice.