Digital Literacy Competency and Graduate Employability: Evidence from Vocational Colleges in Qingdao

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ABSTRACT

In an era marked by rapid global digital transformation, digital literacy has evolved from an optional skill to a core competency that directly determines graduate employability. This study investigates the relationship between digital literacy competency and employment outcomes among students in vocational colleges in Qingdao. Against the background of China's rapidly expanding digital economy, the service sector increasingly demands talents equipped with integrated professional and digital capabilities. Adopting a mixed-methods research design, this study combines questionnaire surveys, semi-structured interviews, and document analysis to explore the current status of digital literacy development, identify skill gaps between education provision and industrial demand, and examine how digital capabilities influence graduate employability. The findings reveal that although vocational students generally demonstrate basic digital operational skills, they lack advanced professional digital application, data analysis, and cross-platform collaborative abilities. A clear perception gap exists whereby students consistently rate their digital abilities higher than employers do. Curricula remain outdated, practical training is insufficient, teacher industrial exposure is limited, and industry-education collaboration remains superficial. This study enriches empirical understanding of digital literacy development within vocational education and provides evidence-based suggestions for educators, enterprises, and policymakers to strengthen digital skill training and enhance graduate employability in the digital era.

Keywords: digital literacy; vocational education; graduate employability; Qingdao

INTRODUCTION

In recent decades, digital transformation has swept across industries worldwide, reshaping production models, service patterns, and employment structures (Goulart et al., 2022; Khuraisah et al., 2020). Driven by technologies such as artificial intelligence, big data, cloud computing, and mobile internet, the global economy has entered a new stage of digital-driven development. In this context, individuals are expected to possess not only professional expertise but also strong digital capabilities to adapt to intelligent, platform-based, and data-driven work environments. Digital literacy has thus become a fundamental requirement for sustainable employment and long-term career development rather than merely a supplementary skill (Nyale et al., 2026).

In China, the digital economy has become a major engine driving national economic growth and industrial upgrading (Yadav, 2022). Supported by national strategies such as "Digital China," digital infrastructure has been continuously improved, and digital applications have expanded into service sectors including logistics, tourism, e-commerce, finance, and healthcare. These industries urgently demand a large number of application-oriented talents who can integrate professional skills with digital capabilities. As the main channel for cultivating technical and skilled talents, vocational education shoulders an important responsibility in cultivating digital literacy and improving graduate employability (Kamaruzaman et al., 2025).

Qingdao, as an important coastal economic centre, an international shipping hub, and a pilot city for digital economy development, has witnessed rapid growth in digital services, intelligent logistics, cross-border e-

commerce, and modern tourism. Vocational colleges in Qingdao play a key role in supporting local industrial development by supplying skilled talents. However, in practice, many vocational graduates still face prominent skill mismatches in the labour market. Graduates often lack professional digital application abilities, data processing skills, and adaptive problem-solving capabilities required by enterprises. Such gaps reduce employment competitiveness, increase enterprise training costs, and restrict the high-quality development of the regional digital economy.

Although national policies have continuously emphasised strengthening digital literacy education and promoting industry-education integration in vocational colleges, real implementation remains challenging. Curricula are often rigid and slow to update; practical training lacks real enterprise scenarios; many teachers lack frontline industrial digital experience; and school-enterprise cooperation remains short-term and formalistic. As a result, digital literacy education fails to fully connect with actual job requirements. Therefore, a systematic and in-depth investigation into digital literacy development and its impact on employability is urgently needed.

Existing studies have explored digital literacy and employability mainly in general higher education contexts, with limited focus on vocational college students. Most research emphasises basic digital skills rather than professional and industry-oriented digital capabilities. Few studies use mixed methods to compare student self-perception and employer evaluation systematically. Furthermore, limited localised research focuses on vocational education in medium-sized cities such as Qingdao. These gaps leave insufficient empirical evidence for optimising digital literacy education. Against this background, this study examines the relationship between digital literacy competency and graduate employability among vocational college students in Qingdao.

This study makes significant theoretical and practical contributions. Theoretically, it enriches empirical literature on digital literacy in vocational education and expands the application of human capital theory in skill formation research. Practically, it provides evidence-based suggestions for curriculum reform, practical training improvement, and industry-education integration. The findings also support policymakers in designing more targeted strategies for digital talent development and enhancing the competitiveness of the regional service economy.

LITERATURE REVIEW

Digital Literacy

Digital literacy refers to the comprehensive ability of individuals to appropriately use digital tools and platforms, efficiently access, screen and evaluate digital information, accurately process and interpret data, conduct online communication and collaborative tasks, and solve practical work problems in technology-rich digital environments (Van Laar et al., 2020). Rather than being a single or basic technical skill, digital literacy represents a holistic, integrated and developmental competency that enables individuals to participate effectively in social and economic activities, adjust to constant technological changes, and create sustainable value in the digital era. With the rapid advancement of digital technologies such as artificial intelligence, big data, cloud computing and mobile internet, the definition and structure of digital literacy have expanded significantly beyond basic computer operation and simple online browsing. At present, it covers a wide range of interrelated dimensions, including information literacy, data literacy, media literacy, intelligent technology application, critical thinking, digital security awareness and professional digital ethics (Cedefop, 2020). Recognizing its growing importance, global organizations including UNESCO and OECD have formally identified digital literacy as one of the core transversal competencies for citizens in the 21st century, highlighting its essential role in education, employment and social inclusion.

In educational research and policy debates, digital literacy is widely recognized as a key component of human capital and a critical determinant of individual employability, job adaptation and long-term career sustainability (Nguyen & Bartlett, 2022). Graduates with strong digital literacy are more capable of learning new technologies efficiently, improving work productivity, responding flexibly to workplace changes and maintaining competitive advantages in the labour market. For vocational education, which aims to cultivate practical and application-oriented talents for industrial and service sectors, digital literacy should be deeply

industry-oriented, scenario-based and practice-centred. It should be closely integrated with professional courses so that students can apply digital capabilities directly to real operational tasks and meet actual job requirements (Li & Pilz, 2021). However, in many vocational colleges, digital literacy education remains relatively traditional and fragmented. Most institutions still focus excessively on theoretical instruction and basic software operation training, while neglecting professional digital application, data analysis ability and enterprise-oriented practical training. Consequently, the digital skills provided by vocational education are often inconsistent with the dynamic demands of industries, leading to serious skill mismatches, lower employment competitiveness for graduates and higher training costs for employers (Cai, 2020)..

Graduate Employability

Employability refers to the comprehensive, integrated, and sustainable competency that enables individuals to successfully acquire employment, maintain job security and stability, adapt flexibly to dynamic workplace changes, and achieve continuous long-term career development (Zhang & Chen, 2022). It is a multi-dimensional construct that covers not only professional knowledge and technical operational skills but also practical work experience, interpersonal communication, teamwork, learning agility, critical thinking, and environmental adaptive capacity (Wahab et al., 2025). In the era of rapid digital economy development and industrial intelligent transformation, the connotation of employability has been further expanded (Monteiro et al., 2025). The deep integration of professional expertise and digital capabilities has gradually become the core component and key standard for measuring graduate employability in the modern labour market.

For vocational college graduates, whose education orientation emphasizes application and practice, employability is more prominently reflected in hands-on operational ability, rapid post adaptation, independent problem-solving skills, and the capacity to complete real work tasks efficiently (Ahmad & Ismail, 2021). In the service sector, which includes digital services, logistics, tourism, e-commerce, and finance, employers increasingly prioritize graduates who can independently operate professional digital systems, process online business processes, use industry-specific software, and solve practical digital problems in daily work (Jackson & Dean, 2023). However, in reality, many vocational graduates are still weak in targeted digital capabilities and enterprise-oriented practical experience. They often lack professional digital application skills, data processing capacity, and scenario-based problem-solving competence required by enterprises. These deficiencies directly lead to unsatisfactory employment stability, frequent job changes, slow on-the-job growth, and weak long-term career competitiveness in the labour market (Zhou & Lin, 2021).

Digital Literacy and Graduate Employability

The positive and significant relationship between digital literacy and graduate employability has been widely supported and empirically verified in a large number of international and local educational studies. As a core competency in the digital era, digital literacy effectively enhances individual employability by improving job adaptation speed, work efficiency, independent learning ability, and on-the-job problem-solving capacity (Van Laar et al., 2020). Individuals with high-level digital literacy can quickly access high-quality information, accurately complete operational tasks, flexibly respond to workplace changes and technical updates, and thus maintain stable and sustainable competitiveness in the labour market.

In the field of vocational education, targeted and systematic digital skills training plays an even more critical role in boosting employment outcomes. Well-designed digital literacy education helps vocational students master practical, industry-matched technical abilities required by frontline enterprises, thereby significantly improving their employment opportunities, post adaptation speed, and job stability (Nguyen & Bartlett, 2022). Nevertheless, obvious skill gaps still widely exist in the current training system. Outdated curricula, insufficient practical training, low industrial participation of teachers, and superficial school-enterprise cooperation have restricted the effectiveness of digital education. Most students can only master basic office software operations, but lack professional digital application, data analysis, and cross-platform collaboration capabilities that enterprises truly value. As a result, graduates often fail to meet employer expectations, leading to low evaluation scores and reduced employment competitiveness (Chen & Li, 2021).

Research Gaps

Although existing international and domestic literature has extensively explored the concepts of digital literacy and graduate employability, as well as the potential link between them, three prominent and critical research gaps still exist in the current research field. First, most existing studies focus on undergraduate or postgraduate students in general higher education, while paying relatively limited attention to vocational college students. Vocational education has distinct training objectives, curriculum systems, and employment scenarios, meaning conclusions drawn from general university samples cannot be directly applied or generalized to vocational learners. This leads to insufficient empirical evidence specifically for vocational education contexts. Second, the majority of current research overly emphasizes basic digital operation skills such as using office software and searching online information, while neglecting professional, industry-oriented, and scenario-based digital capabilities that are highly demanded by the service sector, such as professional digital system application, data analysis, online business processing, and cross-platform collaboration. As a result, existing findings fail to fully reflect real job market demands.

Third, there is a lack of localized empirical research using mixed-methods designs to investigate vocational students in medium-sized developed cities represented by Qingdao. Few studies systematically compare and analyze students' self-perception and employers' evaluation toward digital literacy, leading to an incomplete understanding of the actual skill gaps. These limitations jointly restrict the guidance value of existing research for curriculum reform, practical teaching, and industry-education integration in local vocational colleges. Therefore, this study aims to fill the above gaps by focusing on vocational colleges in Qingdao, providing targeted and reliable evidence for digital literacy education and employability promotion.

RESEARCH METHODOLOGY

Research Purpose and Target Population

The primary purpose of this study is to examine the relationship between digital literacy competency and graduate employability among vocational college students in Qingdao. Amid rapid digital transformation and continuous upgrading of the service industry, vocational education is undergoing profound reform to better align with labour market demands. As digital skills become increasingly critical for employment, vocational colleges face growing pressure to cultivate high-quality applied talents with strong digital competencies. Understanding how digital literacy affects employment outcomes can help optimise talent training models, update curriculum systems, strengthen practical teaching, and support the high-quality development of regional education and the economy.

The target population of this study covers three key stakeholder groups. The first group consists of final-year students from vocational colleges in Qingdao, who represent the talent supply side and are the direct subjects of digital literacy education. The second group includes enterprise employers and human resource managers from service and digital-related industries, who reflect actual labour market demand and employment standards. The third group comprises college administrators and digital course teachers, who provide institutional perspectives on curriculum design, teaching arrangements, practical training, and industry-education cooperation. The inclusion of these three groups ensures comprehensive, multi-perspective data and enhances the authenticity and reliability of the research.

Sampling Method

This study adopts a mixed sampling strategy that combines random sampling and purposive sampling to ensure data representativeness, diversity, and reliability. First, four vocational colleges in Qingdao offering typical service-related majors were selected purposively to reflect the general situation of digital literacy education in the region. Second, within the selected colleges, 320 final-year students were randomly recruited to complete questionnaires, reducing selection bias and ensuring sample representativeness.

Meanwhile, 62 employers and human resource managers from digital services, logistics, tourism, e-commerce, and finance enterprises were selected purposively based on enterprise scale, business type, and recruitment

experience. In addition, 12 college administrators and digital course teachers were selected purposively according to their management or teaching experience. In total, 320 valid student questionnaires, 62 valid employer interviews, and 12 valid institutional interviews were obtained after screening. This sample size is sufficiently large for descriptive statistics, correlation analysis, and thematic analysis, ensuring stable, scientific, and credible analytical results.

Questionnaire Design and Measurement

The research instruments used in this study include a structured student questionnaire and a semi-structured interview outline, both developed based on mature international scales and revised to fit the vocational education context in China. Before formal use, the instruments were reviewed and revised by academic supervisors and vocational education practitioners to ensure clarity, validity, and applicability.

The student questionnaire includes two main sections. The first section collects demographic information such as gender, age, major, and academic background. The second section measures digital literacy across five dimensions: basic digital operation, information acquisition and evaluation, data processing and analysis, digital communication and collaboration, and professional digital application. All items use a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Employers were invited to evaluate graduates' digital skills, job adaptation, and overall employment performance using a parallel evaluation structure. The semi-structured interview outline covers digital skill demands, curriculum rationality, practical training conditions, industry-education cooperation effects, and employment promotion suggestions. In addition, document analysis is used to supplement data, including curriculum plans, teaching syllabi, talent training programs, school-enterprise cooperation agreements, and relevant policy documents. Multiple data sources are used for triangulation to improve research validity.

Data Analysis Strategy

This study employs a mixed-methods data analysis strategy combining quantitative and qualitative approaches. For quantitative questionnaire data, descriptive statistics are used to present the overall status of digital literacy and employability, including mean values and standard deviations. Correlation analysis is further conducted to explore the strength and direction of the relationship between digital literacy dimensions and employment outcomes. For qualitative interview data, all recordings are transcribed verbatim, and thematic analysis is used to code, classify, and summarise key viewpoints. Through systematic coding, core themes such as curriculum problems, training shortcomings, teacher constraints, and industry collaboration barriers are extracted and interpreted. Finally, triangulation is conducted by comparing quantitative results, qualitative themes, and document information to ensure data consistency, enhance research credibility, and form comprehensive and rigorous research conclusions.

RERULTES

Quantitative Results

Table 1 shows the comparison between students' self-evaluation and employers' evaluation of digital literacy. First, students' self-evaluation scores are significantly higher than employers' evaluations in all five digital literacy dimensions. As shown in Table 1, the mean scores given by students range from 3.35 to 4.05, while all mean scores from employers are lower, ranging from 2.69 to 3.81. This consistent difference reveals a clear overestimation bias among students, who tend to perceive their own digital capabilities as considerably stronger than employers judge them to be. Second, the two groups demonstrate the highest level of agreement in the dimension of basic digital operation. The student self-rating is 4.05 (SD = 0.64) and the employer rating is 3.81 (SD = 0.69), with only a small gap between them. This result indicates that both students and employers recognize that vocational college students possess relatively solid and acceptable basic digital operational skills.

Table 1. Student and employer ratings of digital literacy competency

Digital Literacy Dimensions	Student Self-Rating (M, SD)	Employer Rating (M, SD)	Gap
Basic digital operation	4.05 (0.64)	3.81 (0.69)	Small
Information acquisition & evaluation	3.76 (0.71)	3.23 (0.76)	Medium
Data processing & analysis	3.42 (0.75)	2.76 (0.83)	Large
Digital communication & collaboration	3.68 (0.69)	3.08 (0.80)	Medium
Professional digital application	3.35 (0.78)	2.69 (0.85)	Largest

Third, the most substantial evaluation gaps are observed in professional digital application and data processing & analysis. Professional digital application shows the largest gap, with a student score of 3.35 versus an employer score of 2.69. Data processing & analysis also presents a large gap, with a student score of 3.42 compared to an employer score of 2.76. These two dimensions represent the advanced and job-related digital competencies that enterprises value most in recruitment. Finally, correlation analysis further supports the importance of advanced digital capabilities. The results indicate that professional digital application ability has the strongest positive correlation with employment success, and data processing and analysis ability shows the second strongest correlation. These findings confirm that advanced, industry-oriented digital competencies, rather than basic operational skills, are the key factors in enhancing graduates' employment competitiveness in the labour market.

Qualitative Themes

Three core themes emerged from the qualitative analysis. First, curriculum lag and structural misalignment were widely identified as key constraints. Existing digital literacy courses placed excessive emphasis on foundational knowledge and general computer operation, while content related to professional digital applications, emerging technologies and industry-updated modules was seriously insufficient. Digital skills were rarely integrated systematically into professional courses, resulting in a disconnect between teaching content and actual job requirements. Second, insufficient practical training and limited authentic learning opportunities significantly restricted students' skill development. Most students lacked access to enterprise-level digital platforms, real-world business data and professional simulation systems. Many internships only involved simple auxiliary work rather than substantive digital practice, making it difficult for students to form practical and operational digital capabilities that meet employer demands.

Third, teacher professional capacity constraints and superficial industry-education cooperation further limited the quality of digital literacy education. Many instructors lacked front-line industrial experience and systematic professional updating opportunities, making it difficult to deliver workplace-oriented teaching. School-enterprise cooperation was mostly short-term, formalistic and project-oriented, lacking strategic and long-term mechanisms. Employers consistently emphasized an urgent need for graduates who can master professional digital tools and solve practical problems independently. Similarly, students expressed strong expectations for more scenario-based, practical and industry-linked digital skills training.

DISCUSSION

The results of this study provide robust empirical evidence that digital literacy competency exerts a statistically significant and positive influence on the employability of vocational college graduates in Qingdao. Although students in this study demonstrate relatively solid competence in general digital operations, such as using daily office software, conducting online information searches, and performing basic network tasks, they exhibit substantial and consistent deficiencies in high-value, job-related capabilities including professional digital application, data processing and analysis, cross-platform collaborative communication, and adaptive

problem-solving in real workplace contexts. A notable and consistent perception gap exists between student self-ratings and employer evaluations, revealing that students tend to overestimate their actual digital readiness while employers highlight critical skill shortages in advanced and industry-specific digital capabilities. This misalignment strongly indicates that the current digital literacy education provided by vocational colleges remains overly focused on foundational technical skills and fails to adequately cultivate workplace-oriented, industry-adapted, and practice-centred advanced digital competencies that are urgently required by the modern labour market. More critically, such persistent gaps in higher-order digital competencies may lead to long-term risks for graduates, including reduced career adaptability, limited upward mobility, and increased vulnerability to technological displacement in rapidly evolving industries.

These findings are highly consistent with a growing body of international and local scholarly research, which has widely confirmed that digital literacy has evolved from an optional additional skill into an indispensable core condition for sustainable employability in the rapidly developing digital economy. Empirical evidence further suggests that practical, scenario-based, and industry-linked digital skills training can significantly enhance graduates' employment outcomes, job adaptation speed, work efficiency, and long-term career stability (Van Laar et al., 2020; Nguyen & Bartlett, 2022). Theoretically, this study strongly supports the fundamental propositions of human capital theory, demonstrating that systematic investment in developing digital skills effectively improves individual productivity, employment competitiveness, and career sustainability in the digital era. At the same time, the findings suggest that human capital accumulation in the digital age is increasingly uneven, raising concerns about whether existing vocational education systems can equitably support all learners in achieving sustainable career trajectories.

First, this study enriches the empirical literature on digital literacy by focusing specifically on vocational college students rather than general university populations, thereby expanding context-specific understanding of digital skill formation in vocational education settings. Second, it verifies the applicability and explanatory power of the Triple Helix Model in vocational skill development, highlighting that high-quality digital talent training requires coordinated, collaborative, and sustained interactions among vocational colleges, industrial enterprises, and government authorities. Weaknesses or insufficient collaboration in any single party directly restrict the overall quality of digital skill cultivation. Third, this study reinforces the conceptual perspective that digital literacy should be understood as an integrated, cross-cutting, and industry-embedded competency rather than a fragmented, independent technical skill, providing a clear theoretical foundation for curriculum design and teaching reform in vocational education.

For vocational colleges, digital literacy modules must be systematically embedded into all professional courses rather than being taught as isolated basic computer courses. Practical training platforms and simulation environments should be upgraded to reflect real industrial scenarios, enterprise operational processes, and authentic business data. For vocational teachers, regular industrial attachments, enterprise internships, and targeted digital skill updating programs are essential to enhance their digital teaching capacity and professional relevance to workplace needs. For enterprises, deeper, long-term, and institutionalised participation in curriculum development, internship supervision, part-time instruction, and joint training is critical to narrowing the persistent skill gaps between education provision and industrial demand. For policymakers, establishing standardised digital skill monitoring systems, industry-education collaboration incentive mechanisms, and regional digital talent development platforms can further support sustainable and high-quality digital talent cultivation.

CONCLUSION

This study systematically examined the relationship between digital literacy competency and graduate employability among vocational college students in Qingdao. Based on a mixed-methods design integrating questionnaire surveys, semi-structured interviews, and document analysis, the empirical findings provide clear and consistent evidence that digital literacy, especially professional digital application ability in authentic workplace environments, has become a core determinant of employment success, job stability, and long-term career development for vocational graduates. In an era of continuous digital transformation and industrial upgrading, digital literacy is no longer a supplementary skill but a fundamental requirement for graduates to adapt to the modern labour market, meet enterprise talent demands, and achieve sustainable career growth.

However, the findings also reveal substantial and persistent gaps between current digital education provision in vocational colleges and the actual skill needs of the service and digital industries. The most prominent shortcomings are reflected in professional digital application, data processing and analysis, cross-platform operational capacity, and practical digital problem-solving abilities, which directly restrict graduates' employment competitiveness and career development potential.

Key barriers underlying these gaps include rigid and outdated curriculum structures that fail to keep pace with rapid technological updates, insufficient practical training platforms and real-scenario digital learning opportunities, relatively low digital teaching capacity and limited industrial experience among vocational teachers, and weak, short-term, or superficial industry-education collaboration. These institutional and practical constraints collectively hinder vocational education from effectively cultivating job-ready digital talents required by the market. To address these challenges and improve graduate employability, vocational colleges must reconstruct a systematic and industry-oriented digital literacy training framework, embed digital competency modules across all professional courses rather than treating digital education as an independent basic course, establish long-term and in-depth cooperation mechanisms with digital enterprises, and strengthen teachers' professional upgrading through regular industrial practice and digital skill training. Only through comprehensive, targeted, and sustained reforms can vocational education effectively reduce the digital skill mismatch and truly support enhanced employability for graduates.

Theoretically, this study enriches empirical literature on digital literacy in vocational education, validates the expanded framework of human capital theory by highlighting the integrated value of professional skills, digital competencies, and soft skills, and reinforces the application of the Triple Helix Model in explaining collaboration among educational institutions, industries, and government in skill formation. Practically, the findings provide clear, actionable, and context-specific guidance for vocational college administrators, curriculum designers, enterprise managers, and policymakers. By clarifying the current digital skill gaps and targeted improvement pathways, the research supports more effective policy formulation, curriculum optimisation, and school-enterprise cooperation practices. With the deepening of digital transformation worldwide, digital literacy will only grow in strategic importance for individual career development and regional industrial upgrading. Therefore, building a sustainable, industry-linked, and practice-centred digital skill training system is not only necessary for vocational education reform but also critical to promoting the high-quality development of the regional economy and enhancing the overall competitiveness of the labour force.

Despite its theoretical and practical contributions, this study has several limitations. First, the research sample is restricted to vocational colleges in Qingdao, which may limit the generalisability of findings to other regions with different levels of economic development, industrial structures, or educational contexts. Future research should extend the sample to multiple regions and adopt cross-regional comparative designs to better capture contextual heterogeneity and enhance external validity. Second, the study adopts a cross-sectional design, which can reveal correlational relationships but restricts strong causal interpretations between digital literacy and employability. Third, the research focuses on the direct relationship between the two core variables without examining potential mediating or moderating factors that may influence this linkage, such as learning motivation, practical experience, curriculum relevance, or organisational support. Moreover, the reliance on a single quantitative approach may not fully reflect nuanced experiential differences among students in diverse settings. Future studies may conduct multi-region comparative research to enhance the generalisability of findings across different geographical and educational contexts. In particular, future research is encouraged to employ cross-regional mixed-methods approaches (e.g., combining large-scale surveys with in-depth interviews or case studies) to capture nuanced experiential differences and contextual dynamics. Longitudinal tracking designs can be adopted to explore the long-term effects of digital literacy on graduate's career development, job mobility, and promotion prospects. In addition, emerging research topics including artificial intelligence literacy, digital ethics, data security capabilities, and intelligent vocational education deserve in-depth investigation to adapt to the continuous evolution of digital technologies and labour market demands. Such extended investigations will further advance theoretical understanding and practical applications of digital skill development in an increasingly technology-driven and digitalised global labour market.

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