INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 14, Issue 4, (2025) E-ISSN: 2226-6348

TVET 4.0: Integrating Digital Pedagogy and Industry 4.0 Skills into Malaysian Community College Programmes

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DOI Link: http://dx.doi.org/10.6007/IJARPED/v14-i4/27068

Published Online: 25 November 2025

Abstract

The purpose of this research is to explore the embedding-specific strategies of digital pedagogy alongside competencies such as the Internet of Things (IoT), automation, artificial intelligence (AI), and big data into Community College Malaysia's Technical and Vocational Education and Training (TVET) programs. This study employed a quantitative method in the form of a survey with a sample size of 300 lecturers from 12 Community Colleges. The results show moderate application of digital teaching tools, limited adoption of IR 4.0 technologies at advanced levels, inconsistent readiness across institutions, uneven integration at various levels within the college and higher gap between colleges over technological readiness. Important gaps related to Greater Teaching Experience, Regional Diversity, Program Specific Diversity emerged from Explanatory Analysis. The framework is constructed illustrates elements driven by educators' digital competencies for industry engagement embracing modularized curricula, infrastructural inclusion, active learning spaces and advanced frameworks supporting collaborative environments paradigm shift through actionable insights focused on policy makers within curriculum design methodologies up for institutional leaders seeking advancement toward achieving TVET 4.0.

Keywords: TVET 4.0, Digital Pedagogy, Industry 4.0, Community College, Automation, Curriculum Reform

Introduction

The accelerating Technological Change of the Fourth Industrial Revolution (IR 4.0) has transformed the global economic environment and triggered a shift in educational systems that goes far beyond incremental changes. With respect to TVET, there is an urgent need for the workforce to be digitally literate, capable of sophisticated analytical tasks, and to possess the ability to adapt in a swiftly changing environment (Mohd Hani et al., 2023; UNESCO, 2022).

In this regard, Malaysia embracing the National TVET Action Plan alongside the DPTVN Policy demonstrates strategic efforts aimed at incorporating Digital Technology and Industry 4.0 frameworks within these policies as imperatives towards overcoming existing gaps within the TVET system. As first responders in training provision at community level, Community Colleges fulfil an important regional function towards achieving this goal.

Nevertheless, the process of integrating digital technology, innovative teaching methods, and Industry 4.0 skills like the IoT, automation, AI, and big data into TVET 4.0 is not fully developed in most Community Colleges (Hasan et al., 2021; Yunos et al., 2020). Insufficient training frameworks for educators and wide-spread gaps in infrastructure are some of the most pertinent issues (Abdul Razak et al., 2022). Instead of enabling the creation of a proficient workforce to propel local economic growth, these challenges stifle it.

The shift toward digital pedagogy has only intensified following the pandemic. To boost engagement with students in TVETs, educators have started using hybrid classes, MOOCs, gamified materials as well as VR/AR immersion technologies (Aziz et al., 2022; UNESCO-UNEVOC, 2020). Although those digitally-enabled instructional methods have great potential to facilitate learning interaction within TVETs on a new level, some concerns are still observed regarding the teaching staff's ICT proficiency as well as learners' readiness to engage in such classes (Ramli & Kassim, 2023).

Therefore, it is required to fully evaluate the educational practices within Community Colleges, paying particular attention on how digital pedagogy and Industry 4.0 have been interwoven in their framework. Particular focus should be devoted towards sensing issues facilitated by this system alongside providing information that would strategically aid advanced national goals of modernisation.

Thus, integrated assessment aims to strengthen teaching and learning activities with the digital pedagogies that appear expected role within community colleges in Malaysia. Establishing a model aimed at easing implementation of digital pedagogies requires defining response parameters, contextual hinges, systemic interactive components constituting critical interfaces with Malaysian Community Colleges' socio-educational infrastructure.

The results of this study are expected to have significance for guiding curriculum policy changes, specialized staff training initiatives and the overall improvements in the governance structure of TVET institutions. In the end, it is desired that this work will strengthen the ability of Community Colleges to equip graduates with a high level of technical skills, as well as competencies required in the context of the Fourth Industrial Revolution which include agility in technological shifts.

Research Gap Statement

With increasing attention being paid nationally and internationally to the vocational education sector's digital transformation, there is still a conspicuous gap in empirical analyses that look into the integration of digital pedagogy as well as competencies of Industry 4.0 into Community Colleges in Malaysia. There have been attempts to analyze the phenomena of TVET 4.0 at the polytechnic and vocational school levels, but there remains a significant scholarly neglect toward understanding Community Colleges and their distinct challenges

such as rural broadband gaps, instructor digital competence, curriculum and industry alignment (Mohamad & Zain, 2022; Abdul Razak et al., 2022).

Moreover, literature has yet to be developed which formulates a comprehensive design that systematically synthesizes digital pedagogy with technological competencies alongside institutional frameworks for support within Community Colleges in Malaysia. Most existing models are too generic and therefore do not provide tangible steps for actual grassroots implementation.

Consequently, this study aims to fill this gap by gathering information on the integration of digital pedagogy and IR 4.0 within Community Colleges. The study will outline systemic enablers and constraints, then develop a strategic framework informed by local institutional contexts. This study aims to advance both scholarship and professional work by enhancing the implementation of national policies designed for transformative change in institutions within the scope of TVET 4.0.

It is expected that the findings from this research will be directly relevant to changes in curriculum policy, professionally targeted development initiatives, and systems-wide improvement across TVET colleges. It is expected that Community Colleges will have an enhanced ability to produce graduates with high competencies who are digitally agile and globally competitive within the context of the Fourth Industrial Revolution.

Literature Review

The Evolution of TVET and the Emergence of TVET 4.0

With increasing attention being paid nationally and internationally to the vocational education sector's digital transformation, there is still a conspicuous gap in empirical analyses that look into the integration of digital pedagogy as well as competencies of Industry 4.0 into Community Colleges in Malaysia. There have been attempts to analyze the phenomena of TVET 4.0 at the polytechnic and vocational school levels, but there remains a significant scholarly neglect toward understanding Community Colleges and their distinct challenges such as rural broadband gaps, instructor digital competence, curriculum and industry alignment (Mohamad & Zain, 2022; Abdul Razak et al., 2022).

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Digital Pedagogy in the Context of TVET

Digital pedagogy encompasses instructional approaches that actively leverage technology to enhance the effectiveness of teaching and learning (Siemens, 2020). Within the TVET context, digital pedagogy involves visual and interactive delivery of technical concepts through simulation software, virtual learning environments, gamification, and virtual reality (VR) technologies (Yunos et al., 2020). The use of platforms such as Learning Management Systems (LMS), blended learning modes, and augmented reality has been shown to improve students' achievement and engagement in vocational courses (Aziz et al., 2022).

Nevertheless, studies by Ramli and Kassim (2023) indicate that the implementation of digital pedagogy in Community Colleges remains fragmented. The absence of regular professional development, limited access to digital equipment, and a continued reliance on face-to-face instruction have been identified as significant barriers to meaningful technology integration. The transition to a fully digital teaching model demands sustained professional capacity-building, supported by institutional policies that promote digital transformation.

The literature reveals that while digital pedagogy offers significant potential to enhance technical education, its implementation in Community Colleges remains fragmented and inconsistent. The gap between technological availability and pedagogical application is exacerbated by insufficient professional development and infrastructural disparities. These findings underscore the necessity of embedding digital pedagogy within institutional strategies and training frameworks to ensure its meaningful adoption across the TVET ecosystem.

Industry 4.0 Skills and Curriculum Adaptation in TVET

The industry 4.0 landscape demands high-level technical and digital competencies in the workforce. According to the World Economic Forum (2020), the future skillset is no longer static but includes systems thinking, creativity, big data analytics, and automation programming. Abdul Razak et al. (2022) highlighted that many TVET curricula in Malaysia still fall short in comprehensively integrating IR 4.0 content, particularly within core technical fields such as industrial sewing, food preparation, and office automation.

Moreover, the UNESCO-UNEVOC (2021) report emphasises that TVET curricula must be industry-driven, not only meeting current market needs but also maintaining a flexible and modular structure to accommodate rapid technological changes. In Malaysia, initiatives such as the Curriculum Review Exercise led by the Department of Polytechnic and Community College Education (JPPKK) reflect institutional awareness of these imperatives; however, implementation remains inconsistent and often lacks systematic coordination.

Existing research confirms that current TVET curricula in Malaysia are struggling to keep pace with rapidly evolving Industry 4.0 demands. Although some efforts have been

made to introduce automation and data analytics, the integration remains limited and uneven across fields. This highlights a critical gap between industrial expectations and educational delivery, necessitating comprehensive curriculum reforms that are modular, responsive, and co-developed with industry partners.

Challenges and Opportunities in Implementing TVET 4.0 in Community Colleges

Several studies have identified major challenges in the implementation of TVET 4.0 at the Community College level, including: (i) limitations in digital infrastructure; (ii) inadequate competencies among educators in digital pedagogy; (iii) misalignment between curriculum content and industrial needs; and (iv) the effectiveness of institutional-industry partnerships (Hasan et al., 2021; Mohamad & Zain, 2022).

A study by Ahmad et al. (2023) reported that only 38% of Community College lecturers had participated in training related to IR 4.0, while 65% admitted to lacking confidence in utilising technologies such as VR and IoT in teaching. Furthermore, many programmes continue to focus on conventional technical skills that have not been updated in line with current technological advancements, thereby reducing the competitiveness of graduates in the digital labour market.

Despite these challenges, Community Colleges possess strong potential to serve as grassroots pioneers in the TVET 4.0 transformation. Their strategic locations in rural areas, close ties with local communities, and flexible programme structures position them as ideal platforms for inclusive digital education. Continued research and the piloting of TVET 4.0 integration models within Community Colleges are expected to open pathways to more sustainable systemic reform (MOHE, 2022).

Conceptual Framework for Integrating TVET 4.0

The implementation of TVET 4.0 within Malaysian Community Colleges necessitates a comprehensive and context-responsive conceptual framework that unifies pedagogical transformation, curriculum innovation, and institutional support. Building upon the synthesis of previous literature, this study proposes a multidimensional model that reflects both global best practices and local realities. This framework is underpinned by three central pillars:

1. **Educator Competency Development**
   This pillar emphasises the continuous professional development of TVET educators, focusing on building digital competencies such as technological literacy, instructional design for digital delivery, use of immersive tools (AR/VR), and data-informed pedagogy. Training must be modular, practice-oriented, and linked to certification pathways. Without digitally competent educators, efforts to modernise curriculum or infrastructure will fail to produce systemic transformation.
2. **Curriculum Modernisation**
   Curriculum must evolve beyond traditional skill training to integrate Industry 4.0 technologies such as Internet of Things (IoT), automation, artificial intelligence (AI), big data analytics, and cloud computing. Modular design, micro-credentials, and project-based learning strategies are crucial. Curricula should be developed in collaboration with industry partners to ensure alignment with current and emerging job market demands.
3. **Inclusive Digital Infrastructure**

A foundational pillar of digital transformation is equitable access to digital tools and platforms. Many Community Colleges, particularly in rural and underserved regions, face significant challenges in terms of internet connectivity, smart devices, and digital platforms. Addressing these infrastructural barriers is critical to ensuring that TVET 4.0 is inclusive, scalable, and sustainable.

Supporting Structure: The Triple Helix Model

At the base of this framework lies the Triple Helix Model (Etzkowitz & Leydesdorff, 2000), which advocates for synergistic collaboration between:

- Academia (Community Colleges) – responsible for curriculum delivery and educator development.
- Industry – offers input on skills demand, provides training platforms, and co-develops learning modules.
- Government – plays a regulatory and funding role, establishing national policy and monitoring mechanisms.

This tri-sectoral approach ensures shared responsibility in driving TVET 4.0, with each sector contributing expertise, resources, and accountability.

Guiding Philosophy: Outcome-Based Education (OBE)

Encircling the framework is the guiding principle of Outcome-Based Education (OBE). OBE ensures that every curriculum and training module is designed with specific learning outcomes in mind—outcomes that reflect the competencies needed in a digitised and automated workforce. This aligns with Malaysia's National TVET Action Plan and global benchmarks (e.g., UNESCO-UNEVOC, 2022).

Central Nexus: Digital Pedagogy + IR 4.0 Skills

At the centre of the framework lies the interaction between digital pedagogy and Industry 4.0 skills. Their integration ensures that learners not only gain technical expertise but also learn how to think, communicate, and solve problems using digital tools and platforms. This central nexus is where the transformation of TVET happens—through empowered educators, updated curriculum, and a well-supported learning environment.

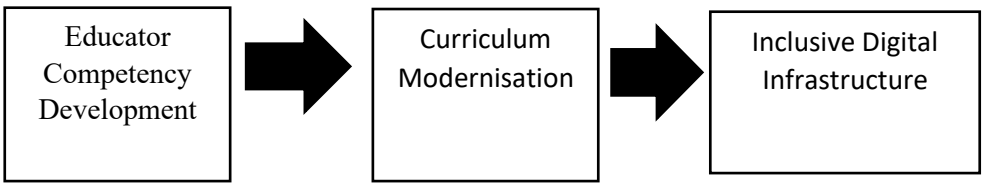


Figure 2.1: Conceptual Framework for TVET 4.0 Integration

This framework also integrates validated constructs from existing models (e.g., Md Hani et al., 2024; Salleh et al., 2022), incorporating educator digital competencies, curriculum-industry alignment, and institutional ecosystem readiness. It is designed to be scalable across diverse TVET domains, including Industrial Sewing, Food Technology, and Office Automation and is particularly responsive to the structural and socio-educational realities of Malaysian Community Colleges.

This framework serves as both a diagnostic and prescriptive model for institutional leaders, curriculum designers, and policymakers. It provides a pathway to align educational practices with industrial needs while ensuring inclusive and sustainable transformation.

Research Methodology

This chapter outlines the methodological framework adopted for the study aimed at investigating the integration of digital pedagogy and Industry 4.0 competencies within Malaysian Community College TVET programmes. The study employed a quantitative research design to systematically assess educators' readiness, institutional infrastructure, and curricular alignment with emerging technological trends. Details pertaining to the research design, population and sampling, instrument development, data collection procedures, data analysis techniques, and ethical considerations are elaborated to ensure transparency and reproducibility.

Research Design

A quantitative research design was employed using a cross-sectional survey method. This design was selected for its efficacy in capturing a snapshot of current practices and perceptions across a diverse population. The survey enabled the researcher to quantify the degree of digital pedagogy application and the extent of Industry 4.0 integration into curriculum delivery.

Population and Sampling

The target population for this study comprised lecturers teaching technical and vocational courses across Community Colleges in Malaysia. Stratified random sampling was used to ensure proportional representation from different geographical zones (i.e., North, South, East, Central, Sabah, and Sarawak). A total of 300 respondents were selected from 12 institutions, ensuring diversity across disciplines such as Industrial Sewing, Food Technology, Office Automation, and Fashion Design.

This sample size was determined using Krejcie and Morgan’s (1970) formula for determining representative sample sizes in educational research. The sampling strategy ensured sufficient variability to enable subgroup analyses based on teaching experience, programme specialisation, and geographical distribution.

Research Instrument

A structured questionnaire was developed, drawing upon established digital pedagogy and TVET 4.0 competency frameworks. The instrument was divided into five sections:

1. Demographics
2. Application of Digital Pedagogy
3. Integration of Industry 4.0 Competencies
4. Institutional Infrastructure and Support
5. Educator Training and Readiness

The questionnaire utilised a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The items were adapted from validated instruments such as the Digital Competence Framework (DigCompEdu) and aligned with policy guidelines issued by the Ministry of Higher Education (MOHE, 2021).

Validity and Reliability

Content validity was established through expert panel reviews involving three academics specialising in TVET and educational technology. Suggestions led to minor revisions in item phrasing and content alignment. A pilot study with 30 lecturers was conducted to assess reliability, resulting in a Cronbach's Alpha coefficient of 0.89, indicating high internal consistency. Item-total correlations were within acceptable limits, ensuring construct coherence.

Data Collection Procedure

Data were collected over a period of six weeks through a hybrid approach online distribution via Google Forms and face-to-face administration during regional workshops. Institutional permission was obtained through official channels. Participants were briefed about the study's aims and confidentiality protocols before consent was obtained. Response rates exceeded 85%, reflecting strong engagement from participating institutions.

Data Analysis Techniques

Quantitative data were analysed using SPSS Version 27.0. Descriptive statistics (mean, standard deviation, frequency, and percentage) were employed to profile educator practices and institutional readiness. To answer the research objectives and test hypotheses, the following inferential statistical tests were conducted:

- One-way ANOVA to assess differences across zones, teaching experience, and programme types.
- Independent-samples t-tests for binary group comparisons.
- Pearson correlation analysis to examine associations between educator training and TVET 4.0 implementation.
- Multiple regression analysis to identify predictors of successful integration (e.g., training, infrastructure, policy support).

These methods ensured both explanatory and predictive analysis, offering insights into the structural and pedagogical readiness of Community Colleges for IR 4.0.

Ethical Considerations

Ethical approval was obtained from the University Research Ethics Committee. All participants signed informed consent forms that clarified the study's purpose, voluntary participation, and confidentiality. Data were anonymised and stored securely, in compliance with institutional guidelines.

Summary

This chapter detailed the methodological underpinnings of the study, including a robust design that aligns with the study's objectives. The combination of validated instruments, rigorous sampling, and sophisticated statistical techniques ensures the credibility and reliability of findings. The next chapter presents the data analysis and discusses the results in relation to existing literature and national TVET policy directions.

Findings and Discussion

This chapter presents the empirical findings of the study and their implications in relation to the research objectives. It is organised by the three main objectives: (1) evaluating the extent of digital pedagogy application; (2) analysing the integration of Industry 4.0 competencies

into Community College curricula; and (3) proposing a framework responsive to institutional contexts. Quantitative findings are presented using descriptive and inferential statistics, supported by tables and critical discussion.

Objective 1: Evaluate the Extent of Digital Pedagogy Application

Descriptive Analysis

A total of 300 lecturers participated in the survey. The mean score for overall digital pedagogy application was 3.40 (SD = 0.79), interpreted as moderately high. Key practices are summarised in Table 4.1.

Item	Mean	SD	Interpretation
I use LMS platforms (e.g., Moodle, Google Classroom).	3.78	0.64	High
I conduct digital assessments (e.g., Quizizz, Google Forms).	3.62	0.72	Moderately High
I produce digital teaching materials (e.g., videos, infographics).	3.44	0.81	Moderate
I have received training in digital pedagogy.	3.20	0.88	Moderate
My college has adequate digital infrastructure.	2.94	0.91	Moderately Low

These results indicate that while digital teaching tools are adopted to some extent, institutional support and educator training remain underdeveloped.

Inferential Analysis

Analysis Type	Test Result	Findings	Implications
One-way ANOVA (Teaching Experience)	F (2,207) = 5.12, p = 0.007	Significant differences by experience; senior lecturers reported higher usage.	Experienced educators benefit from earlier exposure and support.
Independent Samples t-test (Urban vs Rural)	t (298) = 3.21, p = 0.001	Urban colleges had significantly higher digital pedagogy scores.	Reflects digital divide in infrastructure and training access.
Pearson Correlation (Training & Application)	r = 0.48, p < 0.01	Positive correlation between training and application of digital pedagogy.	Training strongly influences adoption.

Objective 2: Analyse the Integration of Industry 4.0 Competencies

Descriptive Analysis

Integration levels of IR 4.0 components were uneven across disciplines. The overall mean score was 3.00 (SD = 0.78), suggesting moderate integration. Results are shown in Table 4.2.

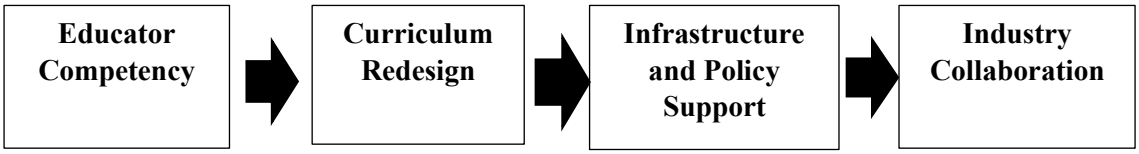
IR 4.0 Competency	Mean	SD	Integration Level	Programme Type
CAD/3D Design	3.54	0.68	Moderately High	Engineering, Fashion
Automation & Control	3.25	0.77	Moderate	Mechatronics
IoT Integration	2.96	0.86	Low	Select engineering
Big Data & Analytics	2.81	0.83	Low	Sporadic
Artificial Intelligence	2.40	0.75	Low	Rarely taught

Inferential Analysis

Analysis Type	Test Result	Findings	Implications
One-way ANOVA (Programme Specialisation)	$F(4,295) = 6.41$, $p < 0.001$	Engineering and Fashion Design reported higher IR 4.0 integration.	The programme focus influences readiness.
Regression Analysis	$R^2 = 0.42$, $F = 15.77$, $p < 0.001$	Training, policy support, and infrastructure predicted IR 4.0 integration.	Multi-factorial strategy is required.

Objective 3: Propose a Framework for Digital and IR 4.0 Integration

Drawing on the findings, a conceptual framework was developed to support integrated implementation. The framework consists of four pillars:



1. **Educator Competency** – Continuous professional training in digital tools, pedagogy, and emerging technologies.
2. **Curriculum Redesign** – Modular, industry-driven content with embedded micro-credentials and IR 4.0 elements.
3. **Infrastructure and Policy Support** – Adequate infrastructure, strategic investment, and policy alignment.
4. **Industry Collaboration** – Joint curriculum development, advisory boards, and certification schemes.

Summary

The findings show that while digital pedagogy is moderately adopted, significant disparities persist in infrastructure and training access, particularly in rural areas. Integration of IR 4.0 skills is nascent, with emphasis skewed toward traditional engineering disciplines. The inferential analyses confirmed that educator training, infrastructure, and policy direction are critical enablers. The proposed framework offers a pathway for strategic transformation toward a digitally resilient and industry-aligned TVET system.

Conclusion, Implications, and Recommendations

Conclusion

This study examined the integration of digital pedagogy and Industry 4.0 (IR 4.0) competencies in Malaysian Community College TVET programmes. Through quantitative analysis involving 300 lecturers across 12 Community Colleges, the research identified that while elements of digital teaching and IR 4.0 are present, their implementation is uneven and transitional.

Descriptive findings indicate moderately high usage of digital pedagogy tools, including LMS and digital assessments. However, integration of advanced IR 4.0 elements such as AI, big data, and IoT remains limited. Inferential analysis confirms significant disparities based on teaching experience, regional context, and programme type. Multiple regression further highlights institutional support, digital training, and infrastructure as key predictors of successful implementation.

To address these challenges and facilitate a transformative shift toward TVET 4.0, this study proposes a strategic framework involving three pillars: (1) educator digital competence, (2) modular curriculum design, and (3) inclusive infrastructure supported by industry partnerships. This framework aligns with national education policy goals and global TVET reform trends, offering an actionable roadmap for institutional and policy stakeholders.

Implications

Curriculum Development

Curricula should be restructured to include modular, competency-based formats that explicitly embed IR 4.0 skills such as automation, data analytics, and digital literacy. The use of micro-credentials and project-based learning modules should be scaled to reflect industry needs and future skill demands.

Educator Training

The role of educators as catalysts in the adoption of digital pedagogy is pivotal. This study reveals substantial training gaps, especially among less experienced staff. Structured, tiered professional development programmes must be institutionalised, integrating simulation-based instruction, blended delivery skills, and certification in AR/VR, IoT, and AI applications.

Institutional Policy and Infrastructure

Digital transformation requires a supportive policy environment and adequate infrastructure. Institutions must invest in stable internet access, smart labs, and maintenance systems, particularly in rural campuses. Policies should institutionalise innovation through clear strategies for digital integration, budget allocation, and leadership accountability.

Industry Engagement

Industry-driven curriculum alignment is essential. Advisory boards comprising industry experts should be formalised. Collaborative internships, dual-certification schemes, and industry-led training should be mandated to ensure that graduates meet current and future labour market expectations.

Inclusivity and Rural Empowerment

Given the decentralised nature of Community Colleges, the framework emphasises equity. Infrastructure and training must prioritize underserved regions to close the digital divide. Customized support for rural institutions is necessary to ensure inclusive digital transformation.

Recommendations

1. **National Framework**: Develop and enforce a national TVET 4.0 curriculum blueprint that integrates IR 4.0 across all programmes.
2. **Mandatory Digital Certification**: Require educators to attain certification in digital tools and pedagogies, including LMS, AR/VR, and data analytics.
3. **Digital Hubs**: Establish fully equipped Digital TVET Hubs within Community Colleges, especially in rural areas.
4. **Performance-Based Incentives**: Introduce KPIs and incentives for institutions and educators demonstrating excellence in digital implementation.
5. **Monitoring Mechanism**: Create a national dashboard to monitor digital integration progress, with annual benchmarking and compliance audits.

Limitations and Future Research

While this study provides valuable insights into the integration of digital pedagogy and Industry 4.0 competencies within Malaysian Community Colleges, several limitations must be acknowledged. First, the study employed a quantitative design, which, while effective in capturing trends and correlations, may not fully capture the nuanced perspectives of educators or administrators. Future research could benefit from incorporating qualitative methods such as interviews or case studies to provide a richer contextual understanding of the challenges and success factors involved in TVET 4.0 implementation.

Second, the sampling was confined to 12 Community Colleges within Malaysia. Although the sampling was stratified to ensure representation across regions and disciplines, the findings may not be generalisable to all institutions, particularly those in other countries or with different institutional structures. Comparative studies involving Community Colleges in other ASEAN or developing countries could provide deeper insights into regional best practices and challenges.

Third, this study focused primarily on educator readiness and curriculum integration. Other critical dimensions such as student digital competencies, administrative leadership, and policy enforcement mechanisms were not examined in depth. Future research should adopt a more holistic lens by including multiple stakeholder perspectives.

Lastly, the rapidly evolving nature of IR 4.0 technologies means that the competencies required today may not be sufficient tomorrow. Longitudinal studies are needed to track changes in integration levels and their long-term impact on graduate employability and institutional transformation.

Global Relevance and Comparative Perspectives

Although the study is situated within the Malaysian context, the findings have broader implications for global TVET reform. Many developing nations face similar challenges in terms of digital infrastructure disparities, educator capacity gaps, and curriculum misalignment with industry demands. This study contributes to the global literature by proposing a scalable framework that balances technological integration with pedagogical innovation and institutional readiness.

Compared to models in advanced economies where IR 4.0 skills are embedded systematically from early education stages, this study highlights the grassroots challenges encountered by mid-tier institutions in transitioning towards digital transformation. By situating Malaysia's experience within the broader global discourse on TVET reform, this research offers a context-sensitive yet transferable model that can inform policy and practice across the Global South. International collaboration through ASEAN TVET networks, UNESCO-UNEVOC initiatives, and bilateral partnerships can further accelerate the adoption of such models. Cross-country benchmarking and regional adaptation of this study's framework could catalyze more inclusive, resilient, and future-ready vocational education systems worldwide.

Summary

This study contributes significantly to the evolving discourse on TVET reform by offering empirical evidence from Malaysia's Community Colleges. The validated framework integrates institutional, pedagogical, and technological factors crucial to successful digital transformation. If implemented systematically, the framework can position Community Colleges as dynamic engines for Industry 4.0-aligned human capital development, fostering inclusive, innovation-driven economic growth.

The research underscores that TVET 4.0 is not simply a technological upgrade—it is a pedagogical and institutional reimagination. As such, reform efforts must be holistic, collaborative, and adaptive to Malaysia’s unique educational and socio-economic context.

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