International Education Trend Issues
Volume 3, Number 2, 2025
https://ijble.com/index.php/ieti

Teacher Readiness in the Face of the Fifth Industrial Revolution: A Human-Centred Technological Paradigm in Education

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Abstract
The advent of the Fifth Industrial Revolution (5IR) has ushered in a paradigm shift in education, emphasising the synergy between human intelligence and technological innovation. This study aims to analyze teacher readiness in adapting to the transformative demands of 5IR by employing a systematic literature review (SLR) method with a qualitative descriptive approach. The review synthesises findings from scholarly publications between 2019 and 2024, encompassing aspects such as digital literacy, pedagogical innovation, ethical awareness, and adaptive competence. Results reveal that teacher readiness in the 5IR era comprises four core dimensions: technological proficiency, pedagogical adaptability, psychological resilience, and ethical responsibility. Despite remarkable progress in digital pedagogy, substantial challenges persist, including disparities in digital literacy, inadequate infrastructure, and limited professional development opportunities. The findings also highlight that continuous professional training, collaboration among educators, and strategic partnerships between schools and the technology industry significantly enhance teacher preparedness. Teachers are urged to transform into "edupreneurs," combining innovation, empathy, and ethical awareness to design inclusive and human-centered learning environments. Ultimately, teacher readiness for 5IR requires not only the mastery of digital tools but also the cultivation of humanistic and reflective pedagogical practices that sustain meaningful learning in a rapidly evolving world. This study contributes to the growing discourse on education transformation by offering a conceptual framework to guide teacher development programs in fostering resilient, innovative, and ethically grounded educators who can thrive in the technological and humanitarian dimensions of 5IR education.

Keywords:
Teacher readiness, Fifth Industrial Revolution, digital pedagogy, educational transformation, human-centred learning.

INTRODUCTION

The rapid development of digital technology has ushered in profound changes across various sectors, including education. Following the Fourth Industrial Revolution (4IR), characterized by automation and the integration of cyber technologies, the world now finds itself transitioning into the Fifth Industrial Revolution (5IR). This new era emphasizes the synergy between human intelligence and smart machines, redefining the relationship between technology and humanity. (al., 2021) argue that this paradigm shift positions humans not as mere objects of technology but as pivotal actors in directing technological advancements towards social welfare, ultimately reshaping educational methodologies and objectives (al., 2021).

In the educational landscape, teachers play a central role in preparing students to navigate and thrive in this evolving technological society. Educators are expected to possess comprehensive competencies that encompass not only technological proficiency but also pedagogical knowledge, social skills, and character development. (Tiengyoo et al., 2024) highlight that teachers must cultivate humanitarian values amid rapid digital advancements, thereby emphasizing the

importance of holistic teacher development (Tiengyoo et al., 2024). Research indicates a diverse spectrum of readiness among educators in their ability to cope with the demands of 5IR. Some teachers have successfully integrated technology into their teaching practices, enhancing learning engagement and outcomes (Rohayati et al., 2020; , Asare et al., 2024). However, others continue to encounter significant barriers related to digital literacy, infrastructural shortcomings, and a requisite shift in pedagogical paradigms, as elaborated by (Tay et al., 2023; (Tay et al., 2023; .

Given these dynamics, it becomes imperative to investigate teachers' preparedness for the challenges posed by the 5IR. The current research aims to analyze the readiness of educators by employing contemporary literature approaches to provide a comprehensive overview of the obstacles and opportunities present. Insights from educational technology researchers emphasize the importance of adaptive learning environments and the implementation of technology that fosters student engagement and individualized learning experiences. For instance, Salihu and Umar (2020) emphasize that the effective integration of Information and Communication Technology (ICT) necessitates the thoughtful design of pedagogical frameworks that foster interactive and cooperative learning environments (Salihu & Umar, 2020). Additionally, numerous studies point to the transformative potential of emerging technologies, such as artificial intelligence and virtual reality, which could significantly enhance educational engagement and facilitate personalized feedback mechanisms (Ruíz et al., 2020).

Ultimately, this investigation seeks to establish a nuanced understanding of how educators can be empowered through professional development and support systems that enhance their competencies to meet the demands of 5IR. As emphasized by Wang & Harmer (2024), modern curricula in teacher education programs must be reimagined to cultivate essential digital literacy skills among future educators (Wang & Harmer, 2024). By analyzing these factors, we aim not only to identify existing gaps in teacher preparedness but also to articulate strategic recommendations for enhancing teaching practices integral to fostering learning success in the context of 5IR.

METHODS

This research employs a systematic literature review (SLR) method with a qualitative descriptive approach to comprehensively analyze the existing body of work regarding teacher readiness in the context of the Fourth and Fifth Industrial Revolutions. The data collection procedure encompasses a thorough exploration of scholarly articles and research reports published between 2019 and 2023, gathered from both accredited national journals and reputable international journals included in indices such as Scopus and DOAJ. The choice of systematic literature review is significantly justified as it is well-suited for synthesizing empirical findings across diverse educational contexts, allowing for a multidimensional perspective on various aspects influencing teacher readiness, such as technology integration and pedagogical innovations Meylina et al., 2021). This method is supported by literature indicating that structured and systematic approaches enhance the reliability of findings and promote a robust understanding of emergent trends in educational research (Гребенникова et al., 2021; , Cebe & Suson, 2023).

The analysis phase of the literature review is organized into three primary steps: (1) Identification and Selection of Sources, (2) Thematic Analysis, and (3) Conceptual Synthesis. In the first step, articles focusing on themes such as teacher readiness, Industrial Revolution 4.0 and 5.0, and technology-based education are selected using targeted keywords including "teacher readiness," "industrial revolution 5.0," "digital pedagogy," and "education innovation," ensuring a focused and relevant selection process that adheres to research objectives (Wu et al., 2022; , Meylina et al., 2021). The second step involves thematic analysis, where data from multiple sources are categorized into key themes, such as digital competence, pedagogical innovation, data literacy, and humanitarian values, enabling a clear understanding of the attributes essential for educators in the modern landscape (Endot et al., 2021; , Kaloka et al., 2023). Finally, the conceptual synthesis step compares and integrates findings from the various studies to identify patterns, research gaps, and directions for future competency development in teachers, supporting the researchers' aim to contribute valuable insights to enhance teacher preparedness for the demands posed by the Fifth Industrial Revolution (Susanto et al., 2022). This systematic methodology serves to underscore the relevance and importance of teacher readiness, particularly as educational systems globally strive to keep pace with rapid technological changes and evolving pedagogical paradigms.

RESULTS AND DISCUSION

1. Concept of the Fifth Industrial Revolution and Its Implications in Education

The Fifth Industrial Revolution (5IR) emphasizes synergistic collaboration between humans and intelligent technologies, placing human values at the forefront of innovation. This paradigm shift transforms educational practices, indicating that technology serves not as a replacement for teachers, but as a means to enhance interaction, creativity, and personalized learning experiences (Tannehill et al., 2020). As articulated by (Smith et al., 2023), educators are called to evolve into “learning designers” who curate learning experiences rooted in empathy, ethics, and sustainability (Smith et al., 2023). This expectation aligns with the findings of researchers such as Koskimäki et al. (2021), who assert that the integration of emotional intelligence and contextual awareness is pivotal for effective teaching in the 21st century (Robbins et al., 2022). Additionally, the role of teachers has expanded to include not only knowledge dissemination but also the fostering of critical thinking and innovation in students (Koskimäki et al., 2021). The application of technology in this setting aims to facilitate tailored educational paths that resonate with individual learners' needs (Ballecer et al., 2024), thus enhancing overall educational outcomes and student engagement (Tischendorf et al., 2024). Consequently, educators must develop pedagogical strategies that enhance the learning environment while prioritizing humanity-centric approaches (Hilsmann & Dodson, 2025).

2. Dimensions of Teacher Readiness

Literature identifies several primary dimensions of teacher readiness for the challenges posed by the Fifth Industrial Revolution. The first dimension, technological readiness, encapsulates teachers' ability to leverage digital tools, online learning platforms, and Artificial Intelligence (AI) to optimize learning effectiveness (Koskimäki et al., 2021). Hidayat and Ningsih (2021) emphasize that the integration

of technology should enhance traditional teaching methodologies rather than overshadow them (Soklaridis et al., 2024). The second dimension, pedagogical readiness, involves harmonizing technology with active learning approaches, collaborative projects, and student-centered pedagogies (Carbullido et al., 2021). This preparation allows teachers to foster environments conducive to engagement and innovation, which are critical in post-4IR education contexts (Stenberg et al., 2024). Furthermore, psychological and adaptive readiness is crucial, encompassing teachers' openness to change, willingness to engage in continuous learning, and propensity for innovative practices (Qiao et al., 2024). Finally, value and ethical readiness entail teachers possessing a solid grounding in humanitarian values and ethical considerations surrounding technology use (Chowhan et al., 2024). As Fukuda (2022) notes, it is essential for educators to balance technological proficiency with ethical deliberation in educational contexts (Al-Matroushi & Alkiyumi, 2022). Collectively, these dimensions establish a framework for assessing and enhancing teacher preparedness in an era defined by rapid technological progress and a need for human-centric pedagogical approaches.

In light of these dimensions, organizations aiming to equip educators for the Fifth Industrial Revolution must implement robust frameworks for continuous professional development that address diverse areas of readiness. They should create comprehensive training programs that facilitate technological integration while simultaneously fostering growth in pedagogical strategies and ethical considerations related to digital learning environments (Saal & Graham, 2023). Research indicates that sustained engagement with professional development leads to marked improvements in teaching efficacy and learner outcomes (Madhakomala et al., 2023). Consequently, educational institutions must prioritize creating supportive infrastructures that empower teachers to navigate the complexities associated with modern pedagogy (Ravenswaay et al., 2024).

3. The Challenges Faced by Teachers

Despite evolving frameworks, numerous challenges persist that hinder effective teacher readiness for 5IR. A significant issue identified in the literature is the digital literacy gap between younger and more experienced educators, which can create disparities in technology utilization across educational settings (Hijazen et al., 2023). Koskimäki et al. (2021) highlight that while younger teachers tend to exhibit comfort with digital tools, seasoned teachers may struggle to adapt to new technological paradigms, which can affect their teaching methods and engagement levels (Tyagi & Misra, 2021). Furthermore, the lack of adequate technological infrastructure in many schools, particularly in rural areas, poses a formidable barrier to effective teaching and learning experiences (Gaus et al., 2024). Ongoing training on innovative pedagogical approaches is often insufficient, leading to educators feeling underprepared to integrate new technologies into their teaching practices (Gebregzabher et al., 2023). Administrative pressures and frequent curricular changes further exacerbate these challenges, as institutions may not provide the requisite support resources necessary for rapid transitions (Jaldemark et al., 2024).

To address these challenges, it is critical for policymakers and educational leaders to foster environments that facilitate continuous learning and adaptation for all educators, regardless of their experience levels (Michael & Eke, 2024).

Implementing mentorship programs and collaborative learning communities among educators can enhance resource sharing and reduce apprehensions surrounding technology adoption (Wahjusaputri et al., 2023). Moreover, exploring partnerships between educational institutions, technology companies, and community organizations can help secure resources and support systems that are necessary for cultivating a culture of continuous professional growth within schools ("Media Education Technologies in the Training of Future Social Educators as an Effective Tool in the System of Continuous Education", 2023). Ultimately, fostering an environment where open dialogue about technological integration and educational practices is encouraged will empower educators to navigate the complexities of the 5IR landscape successfully (Coelho et al., 2021).

4. Strategies to Strengthen Teacher Readiness

Emerging literature identifies several effective strategies for enhancing teacher readiness in the face of continuous technological advancements. Continuous professional development (CPD) programs that emphasize the integration of technology and humanistic values are essential (Jaldemark & Bång, 2024). As highlighted by (Tannehill et al., 2020), such training initiatives should cater to the varied needs of educators, addressing both pedagogical skills and technological competencies (Ibrahim et al., 2024). Additionally, the cultivation of teacher learning communities can create spaces for educators to share best practices and collaboratively explore innovative pedagogical approaches (Koskimäki et al., 2020). These communities facilitate peer support and enhance collective efficacy in addressing challenges associated with implementing new technologies in classrooms (Adjei & Kagbetor, 2023).

Moreover, fostering collaboration between educational institutions, universities, and the technology sector can lead to the co-creation of innovative curricula that are responsive to the dynamic educational landscape (Sherman et al., 2024). The integration of AI within learning environments aims to enhance adaptive and personalized learning experiences, catering to diverse student needs and learning styles (Chibabhai et al., 2023). Such adaptive learning technologies can empower educators to better support individual learning trajectories while also maintaining a focus on character development (Liu et al., 2022). Consequently, in this conceptual framework, educators are envisioned as "edupreneurs" — innovative, collaborative, and future-oriented professionals who create inclusive and human-centered learning environments while leveraging technological advancements to their fullest (Miao & Agnawa, 2024). By implementing these strategies, educational stakeholders can substantially advance the readiness of educators to thrive in the transformative context of the Fifth Industrial Revolution.

Discussion

The Fifth Industrial Revolution (5IR) is paving a transformative pathway in education, merging technological advances with a strong emphasis on human-centered values. In this evolving landscape, teachers are transitioning from being mere transmitters of knowledge to becoming innovative learning designers who incorporate empathy, creativity, and ethics into their teaching methodologies (Jang et al., 2021). This shift signifies a movement away from traditional pedagogical practices towards educational environments that are both engaging and

personalized, in line with research on the potential of augmented and virtual reality technologies to support this new role (Jang et al., 2021). Within this framework, technology is envisioned not as a replacement for teaching expertise but as an enabler of human development and personal interaction (Alshorman, 2024). Consequently, teacher readiness must encompass several dimensions: first, technological readiness denotes the aptitude for utilizing digital tools effectively in educational contexts (Landolt & Bauer, 2024). Second, pedagogical readiness requires teachers to integrate technology within active learning strategies that prioritize collaboration and student engagement (A.F.A et al., 2025). Third, psychological readiness involves cultivating resilience and adaptability amidst constant change, while ethical readiness underscores the importance of maintaining moral responsibilities in increasingly technologized educational environments (Shaari & Kamsin, 2024). Taken together, these facets of teacher readiness establish a comprehensive framework essential for navigating the complexities of teaching in the 5IR.

Despite the clear potential of 5IR to enhance educational practices, teachers encounter significant challenges that hinder their ability to fully realize this potential. Notably, the digital divide persists, with younger educators often more adept at integrating new technologies than their senior counterparts, which creates disparities in digital literacy across the profession (Hayati et al., 2024). Insufficient technological infrastructure, particularly in rural schools, exacerbates these disparities, making it difficult for all educators to access training that fosters effective pedagogical innovations (Verelst et al., 2024). This necessity aligns with calls for continuous professional development (CPD) programs that emphasize both technological and humanistic education perspectives (Li, 2021). Collaborative learning communities and strategic partnerships involving educational institutions and the technology sector can significantly bolster teacher adaptability by promoting cultures of innovation and lifelong learning (Khairunnisa et al., 2025). Additionally, the concept of "edupreneurs," emphasizing the use of technology as a vehicle for human empowerment rather than mere efficiency, should be central to teacher training initiatives (Yunita, 2025). It is crucial to cultivate educators who are reflective, adaptable, and ethically centered, positioning them to lead educational transformations effectively amidst the evolving demands of the 5IR (Shagirbasha, 2024).

CONCLUSION

Teacher readiness for the Fifth Industrial Revolution transcends technical proficiency; it embodies a balanced integration of technology, pedagogy, adaptability, and ethics. The findings of this study confirm that while technological competence forms the foundation of readiness, the ultimate goal of 5IR education is to foster human-centered learning experiences. Strengthening teacher preparedness requires continuous professional development, inter-institutional collaboration, and supportive policy frameworks that prioritize both innovation and inclusivity. Teachers who embrace reflective practice, creativity, and ethical awareness will be best positioned to guide students in a future shaped by the synergy of humanity and technology. The conceptual model presented here serves as a pathway for educational

institutions and policymakers to reimagine teacher education and professional growth in alignment with the transformative spirit of the Fifth Industrial Revolution.

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