Education 4.0 Readiness among Teacher Educators: An Analytical Study of Digital Transformation

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Abstract

In this context, teacher education has shifted and become education 4.0, focusing on the competencies of the teacher as a digital citizen and the use of technology in teaching and pedagogical innovation. This study investigates how ready teacher educators are for "Education 4.0" and how the shift to "digital" impacts their preparation for technology-integrated education. Descriptive and Analytical type of research was employed and quantitative approach was used. Three hundred teacher educators were used as respondents for the collection of primary data. The results show that teacher educators are highly prepared for the education 4.0 readiness, and it has been identified that digital transformation (DT) has also a significant effect on teachers' readiness. It is recommended that the study will contribute to strengthening the institutional support, digital infrastructure, and continuous education and training in teacher training institutions in the form of facilitating the process of implementing Education 4.0 effectively.

Keywords: Education 4.0, Teacher Educators, Digital Transformation, Digital Competence, Higher Education, Technology Integration, Professional Development.

Introduction

Digital technology has created a new era in education, what is known as the Industry 4.0, which has completely changed the field of education around the globe. The transformation of knowledge in the new digital landscape defined by AI, big DA, CC, the IoT, blockchain, VR, AR, and LA (Çetin et al., 2023). As a result of this technological revolution, a new educational paradigm has emerged: Education 4.0, which changes the education process by placing greater emphasis on personalized learning, competency-based learning, use of technology, collaborative learning, and lifelong learning (Mata López et al., 2025). Education 4.0 promotes learning without the traditional mentality of content transmission, as it aims to teach "interdisciplinary learning, innovative thinking, critical thinking, creativity and collaborative learning in the digital age" for initiating learning by empowering learners to become autonomous learners (Redecker, 2017), rather than traditional learning.

Therefore, the success in education and the implementation of Education 4.0 relies mainly on teacher educators' preparedness to employ innovative pedagogical approaches and digital technologies in the learning process. (Dimitrova et al., 2025). To be ready for Education 4.0 extends beyond concepts of digital literacy to the technological competence, pedagogical innovation, instructional design capabilities and abilities, adaptability, openness to change, digital confidence and continuous professional development (Tondeur et al., 2020). Thus, teacher educators' preparedness has become a key point for sustainable digital transformation in HEIs.

DTH in HE goes beyond the mere use of technological tools to an overall change in the organization including institutional leadership, governance, curriculum redesign, digital infrastructure, faculty development, assessment practices, and student engagement (Mejía et al., 2025). Teachers and teacher-education institutions across the globe are dedicated to smart classroom implementation, the adoption of cloud-based LMS, on-line evaluations, virtual labs, and AI-based teaching aids/technologies. But there are many studies out there that suggest that without educators having the right skills, confidence and interest in using these technologies, technological infrastructure can't be the somewhat sole solution for successful digital transformation (Muyambi & Ramorola, 2025). Thus, faculty readiness continues to be among the top factors to predict success of Education 4.0 initiatives.

With the unprecedented disruptions that the global pandemic has brought, DT has been further thrusted in universities and schools. The imposed shift to online/blended learning shifted the focus to creating instructional materials, implementing eassessments, developing online collaboration tools and new ways of teaching in a short time span (Trust et al., 2020). While this has adequately exposed educators to digital technologies, significant differences in digital competence, institutional readiness, technological infrastructure and professional support among educational institutions have also been revealed (Liu & Xu, 2025). Such difficulties also showed the need for ongoing, long-term investments in teaching staffs' capacity building, not for temporary tech fixes, to promote Education 4.0.

Governments have taken note of the strategic importance of DT in educational development around the world. The NEP 2020 was formulated in India which emphasizes enhancing the quality of teaching and learning and enhancing learner outcomes through the integration of technology into learning, multi-discipline learning, digital infrastructure, online approaches for teacher development, and competency-based approach to education (Government of India, 2020). These policy initiatives reflect well the principles of Education 4.0 and put the teacher educator at the heart of education restructuring. Teacher education programs must adapt to the needs of the 21st century by redesigning curriculum, enhancing digital pedagogy, incorporating new technologies, and preparing future educators to effectively work with technology in the classroom (Dimitrova et al., 2025).

Although many studies have been conducted on educational technology and digital infrastructure, the levels of teachers' educators' readiness to accept or reject Education 4.0 have been noted as very different levels. The level of readiness for DT (DT) by educators is significantly impacted by various factors, including Age, Teaching Experience, Institutional Support, Technological Self-Efficacy, Professional Development Opportunity, Leadership Commitment, Organizational Culture, and Digital Resource Accessibility (Mukuka & Alex, 2025; Zou & Song, 2025). Besides, digital readiness has been defined more than just technology and it is becoming more of a multi-dimensional construct of technical, pedagogical, cognitive, organizational, and psychological skills (Scherer et al., 2019).

The understanding of DT and online competence of teacher has grown significantly in recent years, as has the literature on Education 4.0 over the last decade, yet, empirical research on the key topic teacher educators in DT is comparatively scarce (Çetin & Gürdür Broo, 2023; Mejía et al., 2025). Previous research has focussed on either school teachers or university academics or institutional Dx, but has not included the specific role of teacher educators in future teaching professional formation. Moreover, there is insufficient information available about the relationship between digital competence, institutional readiness, pedagogical innovation, teacher educators' professional development.

Under this background, the present study aims to analyze the preparedness of teacher educators regarding Education 4.0 realization. Adopting DT can be perceived as a crucial point to research aspects such as digital competence, technological infrastructure, institutional support, professional development, pedagogical innovation, and attitudes towards DT.

Literature Review

As DT become more widely used in educational activities, the concept of Education 4.0 has become one of the most rapidly developing fields in the research of education. Çetin and Gürdür Broo (2023) carried out a systematic review of learning and teaching studies related to Education 4.0 and determined that the basic pillars are the principles of personalized learning, artificial intelligence, competency-based education, digital technologies, and learner-centered pedagogy. It also noted that effective educational transformation is also dependent on the readiness of teachers and the support provided by the institution.

Mejía et al. (2025) suggested the DT-Smarty framework for assessing the DT in HEIs. Empirical validation showed that together their four dimensions: digital governance,

institutional leadership, technological infrastructure, faculty competencies, and, innovation culture affect institutional readiness to implementing Education 4.0. The study acknowledged that being prepared by faculty is a key requirement to support a sustainable shift towards DT.

In particular, Dimitrova et al. (2025) examined the views of teacher educators in universities about the preparation of pre-service teachers for DT. The results showed that there is teachers' awareness about the need for digital competences and new/digital pedagogy but at the same time they still have problems with lack of professional development, institutional support, inflexibility of the curriculum, and balanced access to technological resources. The authors suggested building ongoing faculty development programs and improving institutional efforts to support effective implementation of Education 4.0.

In this study, Liu and Xu (2025) used bibliometric analysis on the number of global studies published between 2015 and 2024 to see significant increases in research on digital literacy of teachers. They concluded digital competence to be a multidimensional construct defined by five aspects: technical knowledge, pedagogical application, ethical awareness, information management, and collaboration and lifelong learning. The study also captured the trend of growing scholarly interest in the readiness of educators in the digitally transformed learning environment.

In the context of higher education in South Africa, Muyambi and Ramorola (2025) accessed the readiness of educators to teach using digital media. Their analysis showed good overall attitudes to digital technology, but effective implementation required the enactment of institutional leadership, digital infrastructure, ongoing professional development and technological support. The authors found that for long term DT it is crucial to continue to invest in teacher capacity to develop.

Mukuka and Alex (2025) analyzed integration of DT in teaching the integration of DT into teacher education in Zambia with a focus on maths teacher educators. From their study, they found that there are significant differences across age, teaching experience, institutional support, and technological resources with regard to digital readiness. Generally, younger teachers showed higher confidence and were more positive about digital technology integration in teaching.

In the analysis of views from teachers, Mata López et al. (2025) looked at the Higher Education 4.0 integration in universities. Faculty appreciated personalization, digital partnership, interdisciplinary learning, and technology-integrated learning but voiced worries about workload, the challenge of adapting to technology, changing assessments, and institutional viability. The researchers strongly claimed that organizational change is essential to happen along the technological change in order to get to meaningful educational innovation.

Zou and Song (2025) also studied the psychological changes of teacher educators in the context of digitalization. Their research indicated that digital readiness is not just about technology but also about having a resilient, adaptable mindset, being motivated, having a professional identity, and being willing to change. A collaborative organizational context and institutional support played key roles in boosting educators' DT readiness.

One of the most widely used theoretical models for technology integration in education is TPACK described by Mishra et al. (2006). Building on this, Tondeur et al. (2020) put forward an integrated approach to digital teaching, which puts the emphasis on four key dimensions of teachers' professional competence: digital pedagogy, collaboration, reflexivity, and CPD.

Based on the studies conducted by Scherer et al. (2019), the conclusion that came out from the meta analysis of technology acceptance research in the education field is that all factors, have significant effects on educator technology adoption. They found that psychological and organizational aspects are significant for realizing Education 4.0 readiness.

The literature has shown in general that factors such as digital competence, pedagogical innovation, technological confidence, institutional leadership, professional development,

digital infrastructure, and organizational culture, all play a role in influencing Education 4.0 readiness. Although a great number of research works have been conducted on the topic of DT and teacher digital competence, few empirical researches have been dedicated to the teaching and learning of teachers, especially in the Indian context. In line with this, the present analytical study aims to provide in-depth understanding of the readiness of Education 4.0 by teacher educators and to make some evidence-based suggestions for enhancing the DT in TEIs.

Objectives of the Study

1. To evaluate the readiness of teacher educators in Education 4.0.
2. To explore how the factors of digital transformation influence the readiness of education for digital era (Education 4.0).
3. Analyse the correlation between the digital transformation and readiness to education 4.0 among teacher educators.

Methodology

This is a descriptive study, type research, and method is quantitative, which aims to study the level of readiness efforts in the context of teaching preparation for the phenomenon of Education 4.0. The present study has been carried out using primary and secondary data sources. The stratified random sampling technique was used to select 300 teacher educators to achieve fairly good representation across the teacher education institutions. Data collected will be processed and analyzed using statistical tools to assess the Education 4.0 readiness and the impact of DT that has on teacher educators.

Result and Analysis

Data gathered from 300 teacher educators was analyzed systematically by applying suitable data analytical techniques which include descriptive, and inferential statistics to evaluate their education 4.0 readiness and to study the impact of DT.

Table 4.1 Level of Education 4.0 Readiness among Teacher Educators

Dimension	Mean	SD	Interpretation
Digital Competence	3.86	0.71	High
Technology Integration	3.79	0.74	High
Professional Development	3.68	0.82	High
Institutional Support	3.55	0.80	Moderate
Overall Education 4.0 Readiness	**3.72**	**0.69**	**High**

Overall mean score is 3.72, which shows that the teacher educators' readiness for Education 4.0 is at a high level. The highest mean score was on the dimension of digital competence (3.86), indicating that the respondents' technological skills are considered to be adequate. The mean of institutional support was the comparatively lowest (3.55) hence, it represents scope for strengthening institutional policies and digital infrastructure.

Hypothesis Testing

$H1_1$: Teacher educators exhibit a significant level of Education 4.0 readiness.

Table 4.2 One-Sample t-Test for Education 4.0 Readiness

Variable	Test Value	Mean	t-value	p-value	Decision
Education 4.0 Readiness	3.00	3.72	17.84	0.000	Reject H_0

The computed t value is 17.84 and it is statistically significant ($p < 0.001$). The mean score (3.72) is greatly different from the neutral (3.00), therefore the null hypothesis is rejected. Thus, teacher educators' readiness for Education 4.0 is high.

H1₂: There is a significant difference in Education 4.0 readiness among teacher educators with different levels of digital transformation practices.

Table 4.3 One-Way ANOVA

Source	Sum of Squares	df	Mean Square	F-value	p-value
Between Groups	32.45	3	10.82	15.73	0.000
Within Groups	203.76	296	0.69		
Total	236.21	299			

The ANOVA results indicate that there is a statistically significant difference between the levels of DT in teacher educators in terms of educating themselves in education 4.0 ($F = 15.73$, $p < 0.001$). So, the null hypothesis of the hypothesis test can be rejected. This means that the more successful DT is, the more prepared for Education 4.0 is.

H1₃: There is a significant association between digital transformation and Education 4.0 readiness.

Table 4.4 Chi-Square Test of Association

Variable	χ^2	df	p-value	Decision
Digital Transformation × Education 4.0 Readiness	46.82	12	0.000	Reject H_0

The obtained Chi-square value was 46.82 which is statistically significant ($p < 0.001$) clearly showing that there is significant association between DT and readiness for Education 4.0. Institutions of Education that are in the process of digitization have teacher educators with a high level of readiness for implementing Education 4.0.

Summary of Hypothesis Testing

Hypothesis	Statistical Test	Result
H_1	One-Sample t-Test	Accepted
H_2	One-Way ANOVA	Accepted
H_3	Chi-Square Test	Accepted

The results show that teacher educators are highly educated in terms of Education 4.0 readiness, with a strong stance in digital competence, integration of technologies and professional growth and development. This readiness is found to be significantly higher than the average readiness with regard to the one-sample t-test. ANOVA shows that there are significant variations in the attitudes of the Education 4.0 ready based on the level of DT practices and the Chi-square test confirms that the attitudes of the teachers' educators toward institutional DT are significant. The results indicate that further improvement of the implementation of Education 4.0 in the teacher education institution (TEI) can be done by strengthening institutional digital ecosystems and continuous professional development.

Discussion

The results showed that teacher educators are ready and willing to embrace Education 4.0, with a high level of ability and willingness to use digital technologies and innovative pedagogies. The overall high level of digital competence and technology integration indicate that it seems most respondents are ready to embrace learner-centred and technology-rich pedagogies. However, relatively low scores in the area of institutional support suggest the need for digital infrastructure, policy support and technical resources improvements are still required.

The study also indicates that continuous professional development helps teachers become better prepared for the implementation of the practices of Education 4.0. Seeking opportunities for regular training and exposure to emerging technologies builds teachers' awareness and confidence in their integration in teaching and learning. Thus, the need for faculty development programmes to foster effective DT is highlighted.

Results of this hypothesis testing indicate that there is a important high readiness level of teacher educators in Education 4.0. The results also indicate that the readiness is dependent on the level of institutions' DT and that there is a strong correlation between DT and the readiness of Education 4.0. The findings indicate that the more robust a digital ecosystem within the institutions, the more likelihood that the teacher educator is better prepared to use technology in education.

According to the study, overall, the teacher educators are prepared to embrace Education 4.0, but with robust support, a better digital infrastructure, and ongoing professional development, the successful realization of the DT of EEIs could be further strengthened.

Conclusion

The study concludes that teacher educators exhibit high level readiness for Education 4.0, especially in the areas of digital competence, integration of technology and being open to new pedagogical methods. The results demonstrate the high impact DT has on teachers' readiness for technology-based learning. Despite this, Education 4.0 implementation still faces problems on institutional management, digital infrastructure, and training capacity building which needs to occur continuously. On the basis of findings of the study, it can be concluded that the digital readiness of teacher educators is important in preparing future teachers for the changing needs of the twenty-first century education and in achieving the targets of sustainable educational transformation.

Recommendations

There is a need for empowering the digital skills of teacher educators through Continuous Professional Development (CPD) programmes for teacher education institutions (TEI) to build digital infrastructure. Institutional leadership should promote technology innovations in the teacher education curriculum using Artificial Intelligence technology, Learning Management Systems (LMS), and Digital Assessment technology. To create a sustainable Education 4.0 environment, policies that support using technology in teaching and regular digital skill development workshops, in addition to sufficient technical support, are recommended. Partnerships with educational technology companies and regular assessments of teacher readiness for digitalization are other elements that can help facilitate the leap toward effective digitalization in teacher education institutions.

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