Online Learning in Educational Research
Volume 6, Issue 1, 185-197.
e_ISSN: 2798-2351
https://www.journal.foundae.com/index.php/oler/index
DOI: 10.58524/oler.v6i1.1105

Role of ICT Self-Efficacy and TPACK in Linking AI Literacy to Digital Transformation

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Article Info

Article history:

Received: December 22, 2025
Revised: March 9, 2026
Accepted: March 26, 2026

Keywords:

Artificial intelligence;
Digital transformation;
ICT self-efficacy;
Mediating effect;
TPACK.

Abstract

Rapid technological advancements have positioned digital transformation (DT) as a critical requirement in higher education. However, the mechanisms through which teachers' artificial intelligence literacy (AIL) contributes to DT remain underexplored, particularly in relation to psychological and pedagogical competencies. This study aims to examine the relationship between AIL and DT among college teachers, with a focus on the mediating roles of ICT self-efficacy (ICTSE) and Technological Pedagogical Content Knowledge (TPACK). A quantitative cross-sectional design was employed using data from 400 college and university teachers across four states in India. Data were analyzed using mediation analysis to test both parallel and serial mediation effects. The findings revealed that AIL is positively associated with DT, both directly and indirectly through ICTSE and TPACK. Both mediators were found to play significant roles, with TPACK demonstrating a stronger mediating effect. Additionally, a significant sequential pathway (AIL → ICTSE → TPACK → DT) was identified, indicating a developmental mechanism linking AI literacy to digital transformation. These findings highlight the importance of enhancing both technological confidence and pedagogical competence to effectively translate AI literacy into transformative educational practices. The study offers important implications for policy and capacity-building initiatives in higher education.

To cite this article: Choudhury, S., Biswas, S., Deb, J. P., Chattopadhyay, A., Devi, A., & Boruah, A. S. (2026). Role of ICT self-efficacy and TPACK in linking AI literacy to digital transformation. *Online Learning in Educational Research, 6*(1), 185-197. https://doi.org/10.58524/oler.v6i1.1105

INTRODUCTION

India is now the world's most populated nation, and it boasts the third-largest higher education system globally behind the US and China. However, according to the QS World University Rankings 2025, only four Indian Universities are ranked within the top 400 worldwide (QS World University Rankings, 2025), disclosing that higher education in India has not improved to the same standards as its international counterparts. A crucial loophole is found in the widespread dearth of digital transformation (DT) in the context of higher education. Furthermore, according to a recent survey, 87% of enterprises expect DT in their sectors, yet just 50% think they are ready to handle these changes (World Economic Forum, 2024). This discrepancy emphasises how urgently organisations, especially Higher Education Institutions (HEIs), must reconsider their operational frameworks in order to be competitive and relevant in the face of rapidly advancing technology (Rodríguez-Abitia & Bribiesca-Correa, 2021). Significant policy-level initiatives toward DT are

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evident in India, particularly through the National Education Policy, which promotes digital integration in teaching, learning, and governance. However, many educators still struggle to meet the demands of digital literacy and AI-powered tools due to inadequate infrastructure, institutional support, and training (Karroum & Elshaiekh, 2023).

Artificial Intelligence (AI) has become increasingly prominent in education and plays a critical role in digital transformation (Baker et al., 2019; Chen et al., 2020; Holmes et al., 2019; Hwang et al., 2020; Ouyang & Jiao, 2021; Rowe, 2012; Starčič, 2019; Zainuddin et al., 2025). Thus, the holistic AI calibre of the educator plays a crucial role (Joshi & Khatiwada, 2025). Nevertheless, studies show that many college instructors still lack sufficient AI literacy, which prevents them from using AI tools for teaching. AI-literate teachers are better able to integrate AI-based feedback systems, AI-graded assessment systems, and personalised learning systems into their teaching plans (Zhang & Zhang, 2024). However, having AI literacy alone may not ensure successful technological integration, but instructors' confidence and proficiency with ICT, and pedagogical soundness via Technological Pedagogical Content Knowledge (TPACK) also play a critical role. ICT integration enhances student-centered learning and improves educational quality (Aydin et al., 2016; Guntara et al., 2021; UNESCO, 2017). Teachers with high ICT self-efficacy (ICTSE) may be competent to use various teaching methods with digital content to hold student-centered teaching approaches (Anderson & Maninger, 2007; Bull, 2009; Tondeur et al., 2017; Yonezawa & Nakai, 2024). while TPACK enables them to effectively combine technology, pedagogy, and content knowledge (Celik, 2023; Koehler & Mishra, 2009; Kurniawati et al., 2023). Thus, ICTSE reflects psychological readiness, and TPACK represents pedagogical competence, both of which are essential for translating AI literacy into meaningful practice.

This exploration is grounded on the *Unified Theory of Acceptance and Use of Technology* (UTAUT) by Venkatesh et al. (2003) and the *Self-Efficacy Theory* (SET) by Bandura (1977). UTAUT explains how technological adoption is influenced by perceived usefulness and ease of use, while SET emphasizes the role of confidence in performing tasks. Together, these frameworks support the pathways through which AI literacy influences DT, both directly and indirectly via ICTSE and TPACK.

Digital transformation is emphasized as it enhances the educational experience for students and expedites teaching and administrative work (Hudha et al., 2025; Firdaus et al., 2025; Singun, 2025; Triyoga et al., 2025; Wulansari et al., 2025). Numerous studies have consistently documented the benefits of it in higher education, specifically in recent years. DT forums are proven to make day-to-day processes smoother and more effective (Benavides et al., 2020), while being affordable and cutting down expenses for the HEIs and the learners (Alenezi, 2021; Kopp et al., 2019; Mello et al., 2019). For instance, technology-enabled alteration catalyses pioneering pedagogical methodologies and aligns activities with higher-order learning results (Alenezi, 2021; Benavides et al., 2020). Subsequently, digital environments support a flexible, individualized, and learner-centred scenario that empowers them to access the learning materials anytime and anywhere (Alejandro et al., 2024; Alenezi, 2021; Drieschner et al., 2019; Ratten, 2020; Vindaca & Lubkina, 2020). These are linked with enhancements in the quality of learning as the alignment between teaching objectives and student functioning is strengthened (Drieschner et al., 2019; Mello et al., 2019). In the end, such exposures and advancements prepare the learners to face a future that demands technical competencies (Hatlevik & Bjarnø, 2021).

Research indicates that AI literacy can enhance ICT self-efficacy by increasing teachers' confidence in using digital tools and support TPACK by enabling more effective integration of technology into pedagogy (Celik et al., 2022; Ning et al., 2024; Vindaca et al., 2024; Walter, 2024). Nevertheless, inconsistencies remain in understanding how these variables interact, particularly within complex pathways involving both psychological and pedagogical mechanisms.

Existing studies primarily focus on direct relationships between variables, overlooking the mediating roles of ICTSE and TPACK. Moreover, prior research often examines these constructs independently, lacking an integrated framework that explains how AI literacy translates into DT. Specifically, neither the parallel mediation of ICTSE and TPACK nor their sequential mediation (AIL → ICTSE → TPACK → DT) has been sufficiently explored. It remains unclear whether these mediators operate independently or sequentially. Therefore, this study aims to address these gaps by proposing and testing a comprehensive model incorporating both parallel and serial mediation

pathways. Understanding these mechanisms is essential, as AI literacy alone does not ensure transformation without the necessary confidence (ICTSE) and pedagogical integration (TPACK).

If left unaddressed, this gap may result in ineffective technology adoption and missed opportunities for innovation. Thus, this study contributes to the literature by examining the dual mediating roles of ICTSE and TPACK and offering insights for enhancing digital transformation in higher education.

H1: AI literacy among college teachers is significantly related to DT
H2: AI literacy is significantly related to ICT self-efficacy among college teachers
H3: AI literacy is significantly related to TPACK among college teachers
H4: ICT self-efficacy is significantly related to DT
H5: TPACK is significantly related to DT
H6: ICT self-efficacy is significantly related to TPACK
H7: TPACK and ICT self-efficacy among college teachers jointly mediate the relationship between AI literacy and DT.

METHOD

This study employed a quantitative research design using a cross-sectional survey approach to examine the relationships among artificial intelligence literacy (AIL), ICT self-efficacy (ICTSE), Technological Pedagogical Content Knowledge (TPACK), and digital transformation (DT) among college and university teachers in India. To test the proposed hypotheses, mediation analysis was conducted using Hayes' PROCESS macro (Model 6) in SPSS, which allows for the examination of both parallel and serial multiple mediation effects. This approach is appropriate for analysing complex causal pathways among variables.

Sample and Area

The sample collection was carried out in May and June, 2025, among 400 College and University teachers across four states in India, i.e., West Bengal (25%), Odissa (35%), Chhattisgarh (20%), and Jharkhand (20%) via a convenience sampling technique. According to Fritz & MacKinnon (2007), a sample size of 400+ offers suitable statistical power for sensing medium to small effect sizes for the majority of statistical studies, including mediation models. The two inclusion criteria for partaking were: a) they should be willing, and b) be able to utilise smartphones to effectively complete the online survey form. Before sharing the Google Forms link, a verbal explanation about the objective, its anonymous nature, and that the information they provided would only be utilised for scientific reasons was given to each of the respondents, and informed consent was received. With prior authorization from the relevant authorities, the questionnaire was also distributed through institutional networks in a number of institutions. Out of the 400 participants, 157 were males, and 243 were females, and the mean age of the participants was 37 years. With regards to teaching experience, 59% were having 1-5years and 41% had more than 5years.

Measurements

The following scales were adopted as a whole, and the contents were not altered. Nevertheless, construct validity was assessed using Confirmatory Factor Analysis (CFA) as recommended by the literature (Chakraborty et al., 2021; Gupta & Shifali, 2019). Also, the instruments' validation was carried out using both EFA and CFA, following established scale validation procedures. Before adaptation, the scales were retested using samples from India to ascertain reliability quotients.

Developed by Ning et al. (2025) the Artificial Intelligence Literacy Scale for Teachers (AILST) consists of 36 items across four subscales: AI perception (10 items), knowledge and skills (10 items), applications and innovation (8 items), and ethics (8 items). The responses were retrieved on a Likert scale of A to E, with A being Fully applicable, B being Applicable, C being Uncertain, D being Not applicable, and E being Completely not applicable. The internal consistency coefficient (α) of the scale was 0.889, which was re-examined in the Indian context before adaptation (α=0.961).

To measure digital transformation, Benavides et al. (2022) the Digital Transformation scale was devised in 2022 with 25 items across three dimensions - Organizational perspective (12 items), Social and cultural perspective (7 items), and Technological perspective (6 items). Each of the items has a 5-point Likert scale, with 1 denoting None grade to 5 denoting Very high grade. Aiken's V coefficient of the original scale was 0.91; here, the investigators re-examined it in the Indian context and obtained α= 0.882, proving its suitability.

The ICT Self-Efficacy Scale, developed and validated by, Musharraf et al. (2018) was employed. The scale consists of 18 items spread across three dimensions - Privacy and security (10 items), Communication (3 items), and Differentiation and learning (5 items). It is scored on the 5-point Likert scale ranging from "agree strongly" (5) through "uncertain" (3) to "disagree strongly" (1). The reliabilities ranged from 0.83 to 0.93, when assessed in the Indian context by the investigators, the Cronbach's coefficient α was 0.944.

Schmid et al. (2020) developed the Teachers' TPACK scale, which is well known for its validity and reliability in educational research, and has seven dimensions that consist of a total of 28 items. A 5-point Likert scale, with 1 denoting "strongly disagree" and 5 denoting "strongly agree," was used in the original version and retained here. All dimensions showed good internal consistency, ranging from 0.77 to 0.91, which was reassessed in the Indian context by the investigators and yielded a Cronbach's coefficient α of 0.941.

Statistical Analysis

The software used for statistical analysis was SPSS for Windows. As the scales were of recent origin, it is standard for the authors to have analysed the construct validity during development. Also, the scales have been revalidated in many contexts in India. Descriptive statistics were used to examine the demographic factors, as well as the scores of the four variables. Following that, model 6 of Dr. Andrew F. Hayes PROCESS macro v4.0 for SPSS was used to evaluate the multiple mediation model (Hayes, 2017). In this model, AIL was treated as the independent variable, DT as the dependent variable, and ICTSE and TPACK as the mediating variables. The majority of mediation analysis experts, including Hayes, have accepted the idea that a correlation between dependent and independent variables is no longer sufficient to determine causation but is a prerequisite for mediation analysis. Furthermore, Hayes stated that if the indirect effect is included in the confidence intervals, it is considered significant if there isn't a zero. Also, the Hayes technique has the maximum statistical power in comparison to multiple other confidence interval analyses (MacKinnon et al., 2004).

All relevant statistical assumptions were explicitly tested and found to be satisfactory. Analytical models are of three types: (1) Parallel mediation model, such as (a) AIL→ICTSE→DT, and (b) AIL→TPACK→DT, while controlling for the direct effect of AIL on DT. (2) Serial mediation model where ICT self-efficacy and TPACK mediate the AIL–DT relationship in a sequential causal chain, i.e., AIL→ICTSE→TPACK→DT. (3) A full conceptual model incorporating both parallel and serial pathways was tested to compare model fit and determine the relative contribution of each indirect effect. The visual representation is seen in Figure 1.

RESULTS AND DISCUSSION

The Baseline Demographic Statistics of AI Literacy, Digital Transformation, ICT Self-Efficacy, and Technological Pedagogical Content Knowledge across Gender

Table 1 presents the comparison of all four variables across gender using an independent samples t-test.

Table 1. Comparison of Demographic Characteristics of All Four Variables (M± SD) by T-test (N=400)

Variables	Male (n=157)	Female (n=243)	t	Cohen's d	Interpretation
AIL	88.28±28.50	80.49±27.13	2.749**	0.28	Small effect
ICTSE	49.33±14.31	50.67±15.27	0.881	0.09	Very small
TPACK	59.13±19.58	68.89±21.31	0.114	0.01	Negligible
DT	59.73±15.86	58.78±15.33	0.598	0.06	Very small

Table 1 compares the demographic characteristics across all four variables. For a result to be statistically significant, the t-value should be equal to or greater than 2.58 at the 0.01 level. The t-test result displayed a statistically significant gender difference in AI Literacy, with males (M = 88.28, SD = 28.50) scoring significantly higher than females (M = 80.49, SD = 27.13) with a t-value of 2.749 at $p < .01$. A small effect size ($d \approx 0.28$) was obtained, indicating that although the difference between the two groups is statistically significant, the practical magnitude of the difference is relatively small. With regards to the other variables such as ICT Self-Efficacy (ICTSE) ($t = 0.881$, $p > .05$), Technological Pedagogical Content Knowledge (TPACK) ($t = 0.114$, $p > .05$), and Digital Transformation (DT) ($t = 0.598$, $p > .05$), there were similar levels displayed in both the genders since the significance level yielded was non-significant as the obtained t-value's (0.881, 0.114, 0.598) are far below the critical value. Taken together, except for AIL, where there is a slight difference, it is safe to conclude that gender did not play a significant role in determining either of the other variables in the samples.

Correlation Analysis

Table 2 presents the correlation analysis among the study variables.

Table 2. Correlation Analysis among Study Variables (N = 400)

Variables	M±SD	AIL	ICTSE	TPACK
AIL	83.55±27.90	-		
ICTSE	50.15±14.90	0.443**	-	
TPACK	68.99±20.63	0.484**	0.427**	-
DT	59.16±15.52	0.671**	0.447**	0.643**

Note. **p < 0.01.

Table 2 presents the intercorrelations among the four variables under analysis. The results display numerous significant outcomes, specifically, that all four variables are significantly and positively correlated to each other at a $p < 0.01$ level. Looking at AI Literacy with a mean score of 83.55 (SD = 27.90), a positive correlation is noted with ICTSE ($r = 0.443$, $p < 0.01$), which indicates that higher levels of AI literacy are linked with higher levels of ICTSE. Likewise, AI literacy displays a positive correlation with TPACK ($r = 0.484$, $p < 0.01$) and also a positive and strong correlation with DT ($r = 0.671$, $p < 0.01$). This can be interpreted as participants with higher levels of AI literacy display higher levels of TPACK and bring about DT.

As for ICTSE (mean score of 50.15 (SD=14.90)), a positive correlation with TPACK ($r = 0.427$, $p < 0.01$) and with DT ($r = 0.447$, $p < 0.01$) was retrieved, implying that participants with higher ICTSE display a higher TPACK and DT level. Furthermore, TPACK (mean score of 68.99 (SD=20.63)) demonstrated a strong positive correlation with DT ($r = 0.643$, $p < 0.01$). This finding suggests that higher levels of TPACK are associated with greater involvement in bringing about DT. Overall, these findings indicate that all four variables are closely linked and tend to increase simultaneously. They also demonstrate that the technical antecedent AIL positively influences both the mediator and dependent variables.

Mediation Analysis Test

Mediation analysis decomposes the independent variables' total effect on the dependent variable into direct and indirect pathways via the mediating variables, while disclosing not just if but how the independent variable causes the outcome (Tönnies et al., 2023). First, regression analysis is recommended to be done before mediation analysis to determine baseline relationships between the variables, while it ensures consideration of all the possible confounders, which are most of the time more numerous than those under consideration for estimating overall effects (Baron & Kenny, 1986). There would be no effect to mediate if this path were not established, so testing for mediation subsequently would be pointless. Regression analysis also allows investigators to check for any multicollinearity, analyse the direction and intensity of associations, and ensure the data fulfils assumptions like homoscedasticity, normality, and linearity (Hayes, 2017). Table 3 presents the results of the regression analysis examining the relationships among variables in the proposed mediation model.

Table 3. Regression Analysis of Variable Relationships in the Mediation Model (N=400)

Variables	B	Std. Error	R	R^2	F	β	t	Sig.
Model 1								
AIL	.2364	.0240	.4430	.1962	97.1598	.4430	9.8570	.000
Dependent variable - ICTSE								
Model 2								
AIL	.2710	.0349	.5386	.2901	81.1050	.3666	7.7724	.000
ICTSE	.3659	.0653				.2643	5.6028	.000
Dependent variable- TPACK								
Model 3								
AIL	.2470	.0215	.7662	.5870	187.6077	.4440	11.4823	.000
ICTSE	.0863	.0390				.0828	2.2138	.027
TPACK	.2955	.0288				.3926	10.2420	.000
Dependent variable- DT								

Note. Before being incorporated into the equation, each of the four variables was standardised in the model.

Table 3 showcases the results of the regression analyses showing the mediation model among AIL, ICTSE, TPACK, and DT. In Model 1, the association between AIL and ICTSE was explored, and the results indicate that AIL significantly predicted ICTSE with a positive coefficient of standardized β .4430, with t = 9.8570 and p <.001. Further, an R - squared value of .1962 indicated that 19.62% of the variance in ICTSE was accounted for by AIL, i.e., the higher the AIL, the higher the level of ICTSE.

In Model 2, AIL and ICTSE were examined for their impact on TPACK. AIL significantly predicted TPACK with a positive coefficient of standardized β = .3666 with t = 7.7724 and p < .001. Likewise, ICTSE also significantly predicted TPACK at β = .2643 with t = 5.6028 and p < .001. The results show that AIL and ICTSE together explain 29.01% of the variance in TPACK (R^2 = .2901) and the model is statistically significant (p 0.000) for both.

In Model 3, the relationship between AIL, ICTSE, and TPACK on DT was examined. AIL (positive coefficient of standardized β = .4440 with t = 11.4823 and p < .001), ICTSE (positive coefficient of standardized β = .0828 with t = 2.2138 and p = .027), and TPACK (positive coefficient of standardized β = .3926 with t = 10.2420 and p < .001) all significantly predicted DT, with a high R^2 value of .5870, signifying that the three predictor variables accounted for 58.70% of the variance on DT. This supports the idea that TPACK and ICT self-efficacy among college teachers jointly mediate the relationship between AI literacy and DT, which are significant explanatory routes. Because the effect of AIL on DT is still considerable even when the two mediators are added, Table 3 also shows a partial mediation rather than a complete mediation. Put differently, AIL has both a direct impact on DT and an indirect impact through ICTSE and TPACK. Table 4 presents the results of the mediation effect test, including the direct and indirect effects among the study variables.

Table 4. Mediation Effect Test Results (N=400)

Pathway	Effect Size	Bootstrap SE	Bootstrap (95% CI)
Total effect	.3730	.0207	[.3324, .4137]
Direct effect	.2470	.0215	[.2047, .2893]
Total indirect effect	.1260	.0172	[.0941, .1604]
Indirect effects1 (AIL →ICTSE→DT)	.0204	.0103	[.0007, .0407]
Indirect effects2 (AIL →TPACK→DT)	.0801	.0149	[.0524, .1102]
Indirect effects3 (AIL→ICTSE→TPACK→DT)	.0256	.0069	[.0037, .0404]

Table 4 showcases the PROCESS results on the mediation effect for the model reflecting the relationship among AIL, ICTSE, TPACK, and DT. The total effect of AIL on DT is .3730, and is significant with BootStrap 95% CI [.3324, .4137]. Similarly, the direct effect between the two variables also remained significant with an effect size of .2470 at BootStrap 95% CI [.2047, .2893],

indicating partial mediation even when taking into account the two mediators. The substantial residual direct effect indicates that AIL affects DT through mechanisms other than ICTSE and TPACK, most likely through more general characteristics like adaptability, openness to innovation, or access to institutional resources, etc. Further, the total indirect effect between the two variables was also significant with an effect size of .1260 and is significant with BootStrap 95% CI [.0941, .1604]. It suggested that one or more intervening variables (likely the mediators) have an impact on the link between the independent and dependent variables.

Specifically, we noticed the mediating effect to be caused through three mediating sequences. First, the indirect effect through ICTSE alone (i.e., AIL → ICTSE → DT) was small but significant with an effect size of .0204, and Bootstrap 95% CI [.0007, .0407]. Second, the indirect effect 2, which is through TPACK alone (i.e., AIL → TPACK→ DT), was stronger and significant with an effect size of .0801, and BootStrap 95% CI [.0524, .1102]). Thus, it is evident that TPACK has a stronger mediating effect than ICTSE. Third, the sequential mediation through both ICTSE and TPACK (i.e., AIL → ICTSE → TPACK → DT) was also significant with a small effect size of .0256, and BootStrap 95% CI [.0037, .0404]. These results lend credence to a partial multiple mediation model in which both parallel and serial mediation between AIL and DT is visible, mediated by both ICTSE and TPACK. These results imply that enhancing teachers' TPACK and ICTSE may increase the influence their AI literacy has on perceived DT, thus supporting Hypothesis 7. Figure 1 illustrates the proposed multiple mediation model, including both parallel and sequential pathways among the variables.

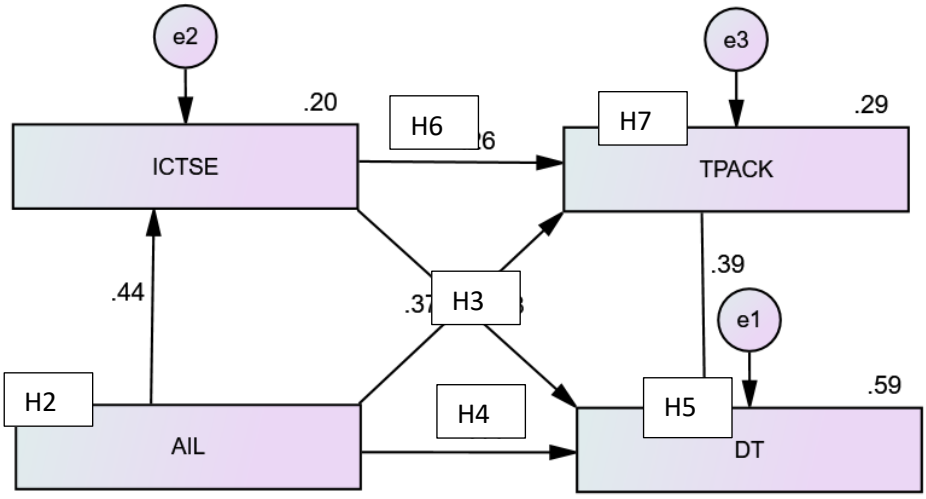

Figure 1. Diagram of a e Mediation Model

Discussion

The findings align with Hypothesis 1 that AI-literate college teachers significantly facilitate DT at the institutional level by enabling an effective integration of technology and pedagogical innovation. They are competent, confident, and prepared to engage in digital transformation initiatives within their institutions. The results support the findings of previous research, such as by Celik et al. (2022), Du et al. (2024), and Ning et al (2024). The existing literature points in the same direction as the current findings.

Hypotheses 2 and 3 are also proven by the results, which showed that a positive and significant relationship exists between AI literacy and ICTSE and TPACK. This reveals a cascading effect where AI competencies enhance their technological abilities (ICTSE) and confidence in effectively integrating technology (TPACK). These findings are aligned with previous investigations ,Celik (2023), Chen et al. (2020), Ning et al. (2024), Sun et al. (2023) and Zawacki-Richter et al. (2019). Though the same wordings are not used, the most common terms like digital competence and proficiency are used in a few of the studies, and similar results are noted.

Similarly, Hypotheses 4 and 5 are also supported through our findings. The teachers with higher ICTSE are often more open to experimenting with new technology and innovation, and can seamlessly use them in their pedagogical practice, thus bringing about DT. Further, those with strong TPACK can design and deliver meaningful learning experiences, again, bringing about DT. Similar findings are recorded in studies by Koehler & Mishra (2009), Koh et al. (2013), Teo (2011) and Tondeur et al. (2017). Contrary results were reported by Younas et al. (2026), who mentioned that technological self-efficacy had no significant effect on bringing about digital transformation. Likewise, Ning et al. (2024) also discovered in their investigation that traditional Pedagogical Content Knowledge (PCK) had no impact, while AI-Technological Content Knowledge (AI-TCK) had very poor direct effects on AI-TPACK. These variations may be due to contextual differences such as access to digital resources or institutional infrastructure.

Additionally, Hypothesis 6 was also validated. ICTSE is associated with TPACK since teachers' beliefs in using technology rightly influence their ability to combine it with pedagogy and content knowledge. Teachers with high ICTSE tend to consolidate their technological knowledge element of TPACK by investigating and choosing the appropriate ones (Koh & Chai, 2014). This is supported by investigations by Sang et al. (2010), Abbitt (2011) to name a few. Similar results reported by the existing literature may be due to an obvious effect and interconnectedness between the two variables.

Lastly, Hypothesis 7 has also been accepted. ICTSE and TPACK are seen to be working synergistically to endorse DT in higher education settings. ICTSE provides teachers with confidence and faith in their capability to harness digital tools (Bandura, 1997), whereas TPACK offers the systematic template for deploying these inclinations in instruction. This interaction works through a developmental pathway, i.e., AI-literate teachers possess confidence in using technology (ICTSE), which subsequently empowers them in effectively integrating technology with pedagogical and content knowledge (TPACK), eventually facilitating DT in teaching practices. The latter one is the dominant mechanism (effect size 0.801), indicating TPACK contributes more to explaining the AIL-DT relationship than ICTSE among the teachers because digital transformation is fundamentally about redesigning instruction methods, not merely adopting tools. We notice a cumulative influence of both AIL and ICTSE before transmitting into DT. As for the former one, ICTSE lowers the barriers to using AI tools, but doesn't outline how to include it in instruction, which explains the smaller effect size.

By highlighting the crucial role of educators, the current study adds to the expanding corpus of work on AI literacy and the DT in higher education. The results show that teachers who are AI literate are vital for promoting DT at the institutional level by incorporating emerging AI technology into the classroom through their ICTSE and TPACK. This is in line with earlier studies that suggest educators play a key role in determining how well digital innovation takes place (Hatlevik & Bjarnø, 2021; Zawacki-Richter et al., 2019). Thus, it is becoming more and more imperative to ensure teacher readiness through AI literacy programs and proper resources as India and other countries prioritise DT in higher education (Andersdotter, 2023; Chou et al., 2023).

Implications

The findings of this research have significant theoretical and policy implications for higher education. The importance of enhancing teachers' AI-related competencies is highlighted by the strong positive correlation between AIL and DT, both directly and through the mediating roles of ICTSE and TPACK. From a policy standpoint, professional development programs that improve teachers' AI literacy should be given top priority by higher education institutions and legislators, along with ICT self-efficacy and TPACK, since these skills together enable successful DT in teaching and learning settings. Thus, it is possible to incorporate AI-based pedagogical techniques into higher education through curriculum revision, institution-level training programs, and focused capacity-building activities. By empirically establishing the parallel and serial mediating functions of ICTSE and TPACK in connecting AIL and DT, the study expands the theoretical knowledge of digital transformation in education. By elucidating the ways in which AI-related competences impact institutional DT in higher education contexts, this adds to the expanding corpus of work on technology integration.

LIMITATIONS

Complete reliance on self-reported data from one type of data collection method (quantitative) can introduce common method variance and social desirability bias. Future research could address this by employing mixed-method approaches where qualitative or observational methods are used to triangulate findings. As the respondents hailed from a single country, the results cannot be generalised universally and are limited to the specific geography and culture. Replication of the study can be done in different continents and nations to figure out the generalisability of the proposed mediating mechanisms. The cross-sectional design provides results only for the data collection period, and the study should be repeated over time to yield more generalisable results. Longitudinal research studies that examine the stability of the role of the two mediators are recommended over time. Other contextual variables that may influence digital transformation should not be explored. Future studies may explore additional mediating or moderating variables and extend the participant base to include school teachers and teacher educators to further validate and expand the findings.

CONCLUSION

This study establishes that the AIL–DT link is more complicated than previously thought by offering empirical evidence that AI literacy propels digital transformation among college instructors through both direct and indirect channels. This study shows that the translation of AI knowledge into transformative practice depends on two complementary mechanisms: the psychological confidence to use digital tools (ICTSE) and the pedagogical competence to embed them meaningfully into instruction (TPACK). It does this by combining AI literacy, ICT self-efficacy, TPACK, and digital transformation into a single mediation framework based on UTAUT and SET. The AIL→ICTSE→TPACK→DT sequence illustrates a developmental path from knowing, to trusting one can, to comprehending how to teach, and finally to truly changing. The finding that TPACK is the dominant mediator highlights the fact that digital transformation in education is ultimately a pedagogical challenge, i.e., knowing about AI is not enough without understanding how to use it in the classroom.

AUTHOR CONTRIBUTIONS

SC Conceptualization, study design, theoretical framework development, manuscript preparation. SB and JPD Literature review, instrument selection, data analysis, and critical revisions. AC, AD, and ASB Data collection and validation.

ACKNOWLEDGEMENT

We thank the teachers who voluntarily took part in this survey and helped in the efforts of the authors

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