
Pathways to Student Success in the Digital Age: A Structural Equation Model of Digital Literacy, ICT Integration, and Digital Competence

Rahma B. Alawi

PhD Student, Capitol University

Abstract— This study examined the pathways through which digital literacy, ICT integration, and digital competence influence student performance among junior high school teachers in the digital age. Grounded in the Technology Acceptance Model (TAM) and Cognitive Learning Theory, the research employed a quantitative, descriptive-causal design using Structural Equation Modeling (SEM) to test both direct and indirect relationships among the study variables. A total of 200 junior high school teachers from selected public schools participated in the study using validated self-assessment instruments. The findings revealed that digital literacy significantly predicts both ICT integration and digital competence, which in turn positively influence student performance. Furthermore, both ICT integration and digital competence were found to mediate the relationship between digital literacy and student performance, highlighting the importance of fostering advanced digital capabilities beyond basic technical skills. The structural model showed excellent fit indices (CFI = 1.00; RMSEA = .000), supporting the robustness of the hypothesized framework. These results underscore the need for sustained, pedagogy-aligned professional development programs that strengthen digital literacy and foster meaningful ICT integration to improve teaching effectiveness and student achievement. The study offers significant implications for teacher education, digital policy development, and institutional capacity building in the context of 21st-century learning.

Keywords: Digital Literacy; Digital Competence; ICT Integration; Student Performance; SEM

I. INTRODUCTION

In the 21st-century educational landscape, the integration of digital technologies has become an indispensable component of effective teaching and learning. The rapid advancement of information and communication technology (ICT) has transformed not only how information is accessed but also how knowledge is created, shared, and applied in classroom settings. For educators, particularly at the junior high school level, the ability to navigate digital platforms and incorporate them meaningfully into pedagogy has emerged as a vital skill set. However, while digital tools are increasingly present in schools, the question remains: do they actually translate to improved student outcomes?

The COVID-19 pandemic accelerated the need for digital transformation in education, pushing educators to shift rapidly to online and blended modalities. This shift highlighted the central role of teachers' digital literacy, ICT integration, and digital competence in maintaining instructional continuity and effectiveness. As the educational system moves toward post-pandemic recovery, the need to examine the impact of these digital constructs on student performance becomes even more critical. Yet, despite widespread technology adoption, disparities in teacher preparedness and digital implementation remain. Hence, identifying the pathways through which digital literacy influences student performance—both directly and through mediators such as ICT integration and digital competence—can provide valuable insights for capacity-building and policy formulation.

Digital Literacy

Digital literacy has become an essential competency in the modern information age, increasingly recognized as vital across various sectors of society, including education. First conceptualized by Paul Gilster in 1997 as the ability to use and create content on digital platforms, digital literacy encompasses a range of skills necessary for navigating, evaluating, and utilizing information in digital formats (Aini, 2023). This multifaceted ability has evolved alongside

technological advancements, adapting to meet the demands of different contexts and societal changes.

The widening scope of digital literacy considers various skills, such as information literacy, media literacy, and the capability to critically assess and create content in a digital environment (Fakhrudin & Haryanto, 2023; Ding et al., 2023). As identified by Yang (2023), digital literacy integrates competencies like image literacy, information management, and socio-emotional literacy, which reflect the nexus of technical proficiency and cognitive skills required in contemporary learning and working environments. This broadening definition underscores that digital literacy is not merely about technical know-how but also includes critical thinking and ethical considerations when engaging with digital information (Julien et al., 2022).

In education, the efficacy of digital literacy programs significantly contributes to students' overall learning experiences. The benefits of digital literacy extend to developing critical skills that are essential for the 21st century, where students must confront and resolve complex challenges (Munisa et al., 2024) Sari et al., 2022). For instance, Munisa et al. advocate for incorporating local wisdom into digital literacy strategies to enhance inclusive education, presenting a context-sensitive approach to cultivating these essential skills (Munisa et al., 2024). Furthermore, digital literacy has been linked to better academic outcomes, as evidenced by research indicating that increased engagement with digital resources leads to improved educational quality and student performance (Fakhrudin & Haryanto, 2023; Mega et al., 2022).

Digital Competence

Digital competence has become an essential aspect of education in the digital era, influencing both teaching and learning processes across various fields. The importance of developing digital competence among educators is particularly significant, as it enhances their teaching methods and equips students with crucial skills necessary for navigating contemporary societal challenges.

According to Litiņa and Svētiņa (2023), the integration of digital tools in health professional education is vital for enhancing students' confidence in accessing relevant clinical

evidence, highlighting the necessity for educators to develop these competencies. Furthermore, Santos et al. (2021) emphasize that training programs aimed at improving teachers' digital competencies should align with current technological advancements and pedagogical methodologies to adequately prepare educators for a digitalized teaching landscape.

Research indicates that teacher training programs significantly contribute to the development of digital competence among educators. Institutions must create supportive infrastructures that enable staff to enhance their digital skills, endorsing the notion that a reflective practice can facilitate a deeper understanding among student teachers regarding the pedagogical implications of digital tools (Peters et al., 2022). Similarly, Momdjian et al. (2024) found that embedding digital tools within curricula and promoting hands-on experiences can foster a culture of collaborative learning that enhances digital fluency.

The impact of digital competence extends beyond individual educators; it has systemic implications for the educational sector as a whole. The pandemic underscored the necessity for effective digital competencies, with many institutions facing significant challenges in adapting to remote teaching environments. This scenario brought attention to discrepancies in digital competence levels among educators, as evidenced by the findings of Hossain et al. (2023), who pointed out a gender divide in digital competence among university students, necessitating tailored training and awareness programs. Additionally, Wang et al. (2021) illustrate how digital competence is associated with students' psychological well-being during periods of increased reliance on digital platforms, emphasizing that educators' digital skills can directly influence student outcomes in times of crisis.

Ongoing assessment of digital competency is crucial for maintaining effective educational practices. It involves not only curriculum evaluation but also employing tools that measure educators' self-assessed competencies, as discussed by Ovcharuk and Ivaniuk (2021), who suggest a need for continuous professional development to close the digital competence gap. This cycle of assessment and training ensures that educators remain proficient in digital literacy and can foster similar competencies among their students, paving the way for a digitally competent workforce (Moreira-Chóez et al., 2023).

ICT Integration

The integration of Information and Communication Technology (ICT) in education has emerged as a significant driver of pedagogical innovation and improvement in learning outcomes. Teachers' self-efficacy and their perceptions play a crucial role in this process. As highlighted by Akram et al. (Akram et al., 2022), teachers' confidence in using technology significantly influences their capacity to enhance students' learning outcomes. This claim is further supported by Nunes et al. (Nunes et al., 2022), who identified internal factors, such as a teacher's perceived value of ICT for students' education, as critical determinants of successful ICT implementation in classrooms. Furthermore, Badran et al. (Badran et al., 2021) argue that the introduction of ICT should be gradual rather than revolutionary, suggesting that a supportive and evolving framework for ICT integration is necessary for a successful transition.

To effectively integrate ICT into educational practices, comprehensive training for teachers is essential. Siminto et al. (Siminto et al., 2024) emphasize that sustainable, customized training programs are imperative to address the dynamic nature of technological advancements and teachers' varying levels of understanding regarding ICT. This viewpoint is echoed in the research by Luvanda et al. (Luvanda et al., 2021), who assert that leadership plays a vital role in providing the necessary infrastructure and support for teachers, further closing the gap in teachers' technological skills. The emphasis on continuous professional development aligns with the UNESCO ICT Competency Framework, which suggests a structured approach to teacher training that progresses from understanding technology to deepening knowledge and ultimately achieving high standards in ICT integration (Trinh et al., 2024).

The challenges educators face in the practical application of ICT are complex and multifaceted. Factors such as limited access to ICT facilities, inadequate training, and varying teacher competencies contribute to these challenges (Ngodu et al., 2024). Moreover, the experience during the COVID-19 pandemic has underscored the importance of robust ICT integration, as many institutions were forced to rapidly adopt online learning solutions, revealing both potential and pitfalls of digital education (Körtesi et al., 2022). For instance, the findings from Ercan Ercan (2021) indicate that while teachers may have positive attitudes towards ICT use, they often struggle with effective implementation due to various logistical and pedagogical constraints.

Equitable access to ICT and its effective use are fundamental for addressing educational disparities. The insights from Kumar Kumar (2023) highlight how ICT can enhance educational effectiveness and narrow gaps, especially in contexts of varying resource availability. Addressing issues related to infrastructure, teacher training, and ongoing support systems is crucial. According to Adarkwah (Adarkwah, 2020), government initiatives aimed at integrating ICT into education must confront existing barriers to ensure all students benefit from technological advancements, which is a critical aspect in realizing the Sustainable Development Goal Four (SDG 4) on ensuring inclusive and equitable quality education.

Theoretical Framework

This study is grounded in two complementary theories: the Technology Acceptance Model (TAM) by Davis (1989) and Cognitive Learning Theory by Bruner (1960). The TAM posits that the perceived usefulness and ease of use of technology influence an individual's decision to adopt it. In the context of education, this model helps explain how teachers' digital literacy affects their willingness and ability to integrate ICT into instruction.

Cognitive Learning Theory, on the other hand, emphasizes the active role of learners in constructing knowledge through meaningful experiences. The digital competence of teachers plays a crucial role in shaping these experiences, particularly in the design and implementation of technology-enhanced learning environments. When educators integrate digital tools with purpose and pedagogical alignment, they create cognitively engaging experiences that support student achievement.

By integrating these theoretical lenses, the study proposes a structural model wherein digital literacy serves as the exogenous variable, influencing ICT integration and digital competence as mediators, which in turn affect student performance as the endogenous outcome. This framework allows for a comprehensive understanding of both direct and indirect relationships among the variables, providing empirical evidence on how teacher-level digital capabilities translate into student success in the digital age.

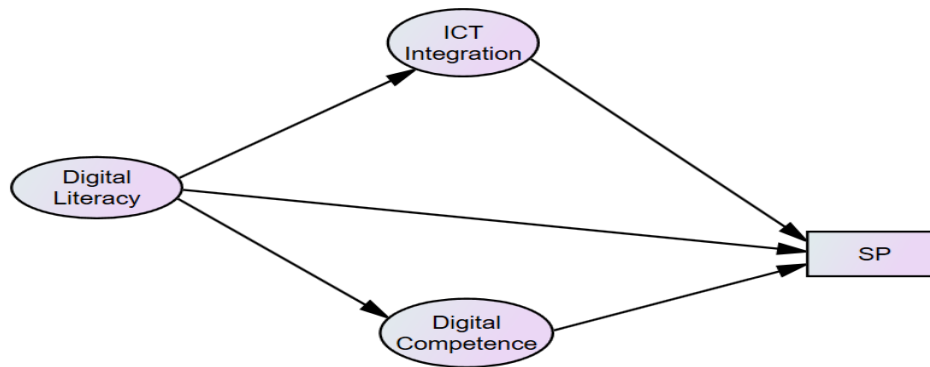


FIGURE 1. HYPOTHESIZED MODEL OF THE STUDY

Research Questions

This study seeks to examine the pathways through which digital literacy, ICT integration, and digital competence among junior high school teachers influence student performance. Specifically, it aims to address the following research questions:

1. What is the level of digital literacy, ICT integration, digital competence and student performance?
2. How does digital literacy influence ICT integration, digital competence and student outcomes?
3. How do ICT integration and digital competence influence student performance?
4. Does ICT integration mediate the relationship between digital literacy and student performance?
5. Does digital competence mediate the relationship between digital literacy and student performance?

Hypotheses

Based on the research questions and the conceptual framework of the study, the following hypotheses are proposed:

H1: Digital literacy significantly influences ICT integration among junior high school teachers.

H2: Digital literacy significantly influences digital competence among junior high school teachers.

H3: Digital literacy significantly influences student performance.

H4: ICT integration significantly influences student performance.

H5: Digital competence significantly influences student performance.

H6: ICT integration mediates the relationship between digital literacy and student performance.

H7: Digital competence mediates the relationship between digital literacy and student performance.

II. METHODOLOGY

Research Design

This study employed a quantitative, correlational research design using Structural Equation Modeling (SEM) to examine the pathways linking digital literacy, ICT integration, and digital competence to student performance. SEM was selected for its strength in analyzing complex relationships among latent variables and testing both direct and indirect effects in a single comprehensive model.

Participants and Sampling

The participants in this study were junior high school teachers from selected public secondary schools. Using purposive sampling, the study targeted teachers with at least one year of teaching experience and exposure to digital tools in instructional settings. A total of 200 teachers participated in the survey, which ensured adequate statistical power for SEM (Kline (2016)).

Instruments

Digital Literacy Confidence Scale, adapted from the “Being Digital: Digital Literacy Checklist” by The Open University and modified by Yazon et al. (2019). The scale comprises items grouped into four subdomains: understanding digital practices, finding information, using information, and creating information. Respondents rate their confidence on a 4-point Likert scale ranging from 1 (Not Confident) to 4 (Very Confident), with higher scores indicating greater digital literacy confidence. The scale has demonstrated high internal consistency, with a reported Cronbach’s alpha of 0.89.

Digital Competence Scale, based on the Self-Assessment Tool from the European Digital Competence Framework for Educators (DigCompEdu) and adapted by Yazon et al. (2019). The scale includes items across six domains: professional engagement, digital resources, teaching and learning, assessment of learning, empowering learners, and facilitating learners’ digital competence. Participants respond using a 5-point Likert scale from 1 (Never) to 5 (Always), reflecting how frequently they engage in the described digital teaching practices. The scale has shown excellent internal consistency, with a Cronbach’s alpha of 0.92.

ICT Integration Scale, adapted from the work of Ghavifekr and Rosdy (2015) and revised by Tayaban (2022). This instrument measures teachers’ perceptions and experiences of ICT use in teaching and learning. It includes three subscales: teachers’ perception of ICT in teaching, effectiveness of ICT integration for student learning, and effective elements in ICT integration. Items are rated on a reverse-coded 4-point Likert scale ranging from 1 (Strongly Agree) to 4

(Strongly Disagree), with lower scores indicating stronger agreement with positive ICT-related statements. The scale has demonstrated good reliability, with a Cronbach's alpha of 0.88.

Student Performance was measured using teachers' self-reported evaluations of their students' academic progress and engagement in ICT-supported learning environments. This construct reflects perceptions of learning effectiveness, participation, and achievement in the context of technology-integrated instruction.

Data Collection Procedure

Prior to data collection, approval and formal permission to conduct the study was secured from the Department of Education Division Office of Lanao del sur II division and the respective school principals where the participants were teaching. Before answering the questionnaire, all participants were provided with a clear informed consent form detailing the purpose of the study, their rights as respondents, and the voluntary nature of their participation. They were assured that their responses would remain confidential and would be used strictly for academic purposes. Participants were also informed that they could withdraw from the study at any point without any negative consequences.

Survey questionnaires were distributed electronically through google forms and professional group chats to accommodate accessibility and ensure convenience for the participants. Regular follow-ups and reminders were sent to encourage participation and timely submission. Once completed, the responses were securely stored and prepared for data analysis.

Data Analysis

Data were analyzed using SPSS and AMOS version 24. Descriptive statistics (mean, standard deviation, skewness, and kurtosis) were used to assess the distribution and central tendencies of variables. The assumptions of multivariate normality and linearity were checked prior to SEM analysis.

The hypothesized model was tested using SEM with maximum likelihood estimation. Model fit was evaluated using multiple indices, including Chi-square (χ^2) and degrees of freedom (df), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Thresholds for good fit were based on the guidelines by Kline (2016).

Indirect effects were tested using bootstrapping (2,000 resamples) with 95% confidence intervals to determine the mediating roles of ICT Integration and Digital Competence in the relationship between Digital Literacy and Student Performance.

III. RESULTS AND DISCUSSION

This chapter presents the results and interpretation of the data gathered in accordance with the research questions of this study. The presentation and discussion of findings are organized based on the order of the research questions to provide a clear understanding of the relationships among the variables within the proposed structural equation model.

Problem 1. What is the level of digital literacy, ICT integration, and digital competence among junior high school teachers?

The descriptive statistics summarized in Table 1 offer critical insights into teachers' self-assessed levels of digital literacy, digital competence, and ICT integration, along with their perceptions of student performance (SP). These metrics help establish a foundational understanding of digital readiness among educators—an essential factor in today's technology-enhanced educational landscape.

TABLE 1
DESCRIPTIVE STATISTICS OF THE STUDY VARIABLES.

Variables	Mean	SD	Skewness	Kurtosis
CI	3.00	.553	-.325	-.242
UI	2.95	.502	.071	-.393
FI	2.97	.544	-.172	-.330
UD	3.01	.514	-.188	-.560
PE	3.02	.571	-.234	.126
DR	3.04	.583	-.091	-.210
TL	3.04	.553	-.079	-.093
AL	3.02	.573	-.037	.007
EL	3.01	.567	-.351	.238
FL	3.02	.582	-.157	-.006
TIT	3.01	.540	-.386	.036
EIS	3.01	.566	-.338	-.072
EIT	2.98	.574	-.271	-.273
SP	3.07	1.324	-.090	-1.06

Note: Standard Deviation (SD), Understanding Digital Practices (UD), Finding Information (FI), Using Information (UI), Creating Information (CI), Professional Engagement (PE), Digital Resources (DR), Teaching and Learning (TL), Assessment of Learning (AL), Empowering Learners (EL), Facilitating Learner’s Digital Competence (FL), Teacher’s perception of ICT in Teaching (TIT), Effectiveness of ICT integration for student’s learning (EIS), Effective elements in ICT integration in teaching and learning (EIT)

Overall, the mean values across all variables reflect moderate to moderately high digital competencies, with scores ranging between 2.95 and 3.07. Notably, Student Performance (SP) had the highest mean ($M = 3.07$), suggesting that educators perceive their students as achieving reasonably well in digital environments. This finding is consistent with prior literature, which links teachers’ positive self-perceptions to enhanced student achievement outcomes (Erstad et al., 2021).

Among the subscales, Digital Resources ($DR = 3.04$) and Teaching and Learning ($TL = 3.04$) emerged as strengths within the Digital Competence domain. These results align with Reixach et al. (2022), who emphasized the critical role of resource availability and effective instructional design in promoting digital competence in educational settings. On the other hand, the lowest mean was found in Using Information ($UI = 2.95$) under the Digital Literacy construct. This indicates a possible gap in teachers’ abilities to evaluate and apply digital content critically—a finding that supports Almenara et al. (2021), who advocate for targeted professional development to address deficits in information handling skills.

The standard deviation values for most variables remain low (between 0.502 and 0.583), indicating relative consistency among teacher responses. However, the higher standard deviation for SP ($SD = 1.324$) suggests more substantial variation in perceived student outcomes. This

discrepancy may stem from differing classroom environments, student capabilities, and varying degrees of ICT integration among teachers (Zhao et al., 2021; Wang et al., 2021).

All skewness values fall within the acceptable range of -0.5 to +0.5, indicating approximately symmetric distributions and suggesting the absence of extreme biases in teachers' self-ratings. The slightly negative skew observed in Professional Engagement (PE = -0.234) may reflect a tendency toward higher self-ratings in this area, which could point to an encouraging professional outlook among teachers (Zhao et al., 2021). Additionally, kurtosis values fall within the acceptable range (± 1), supporting the mesokurtic (normal) nature of distributions, which is favorable for parametric analyses such as Structural Equation Modeling (Bayraktar & Tomczyk, 2021; Salman et al., 2020).

These findings highlight a generally positive digital readiness among educators, with specific strengths in digital resource use and instructional practices. However, the relatively lower ratings in Using Information and the high variability in perceived student performance call for strategic interventions. Professional development programs should focus on enhancing teachers' digital literacy, especially in information evaluation, while simultaneously examining classroom-level factors influencing student performance disparities (Almenara et al., 2021; Wang et al., 2021). Such evidence-based interventions will ensure that both teacher capabilities and student outcomes are uplifted within digitally integrated learning environments.

Structural Model and Fit Indices

TABLE 2
THE RESULTS OF MODEL FIT INDICES.

Model Fit Indices	Suggested Threshold	Final Model	Interpretation
χ^2	-	59.096	-
df	-	73	-
χ^2/df	≤ 3.0	.810	Good fit
p-value	> 0.05	.880	Good fit
GFI	≥ 0.90	.961	Good fit
NFI	≥ 0.90	.984	Good fit
CFI	≥ 0.90	1.00	Good fit
IFI	≥ 0.90	1.00	Good fit
TLI	≥ 0.90	1.00	Good fit
RMSEA	≤ 0.05	.000	Good fit
SRMR	≤ 0.08	.022	Good fit

Source: Kline (2016)

Table 2 presents the model fit indices for the final Structural Equation Model (SEM), indicating an excellent overall model fit. The Chi-square value ($\chi^2 = 59.096$, $df = 73$) was not significant, as evidenced by a high p-value of .880, which supports the null hypothesis that the model fits the observed data well. The relative chi-square ratio ($\chi^2/df = 0.810$) falls well below the suggested threshold of 3.0, further affirming a strong fit. In terms of absolute fit indices, the Root Mean Square Error of Approximation (RMSEA) is reported at .000, signifying a perfect model fit, while the Standardized Root Mean Square Residual (SRMR) value of .022 also indicates a very good fit, being well below the cutoff of .08.

The incremental fit indices further reinforce the robustness of the model. The Goodness-of-Fit Index (GFI) was .961, and the Normed Fit Index (NFI) was .984, both exceeding the acceptable threshold of .90. Additionally, the Comparative Fit Index (CFI), Incremental Fit Index (IFI), and Tucker-Lewis Index (TLI) all reached the ideal value of 1.00, suggesting that the final model performs significantly better than the null model. Taken together, these results provide compelling evidence that the final structural model accurately represents the data, validating the hypothesized relationships among the study's variables.

The combined results from all model fit indices (χ^2/df , RMSEA, SRMR, GFI, NFI, CFI, IFI, and TLI) strongly support the validity of the final SEM. The fit values fall within the most stringent thresholds, suggesting that the proposed structural model provides a highly accurate representation of the observed data. These findings validate the theoretical relationships specified in the model, enabling meaningful interpretation of the paths and constructs examined in the study. Researchers and practitioners can be confident in using this model for further analysis or practical application, especially in understanding digital literacy, competence, ICT integration, and their impact on student performance.

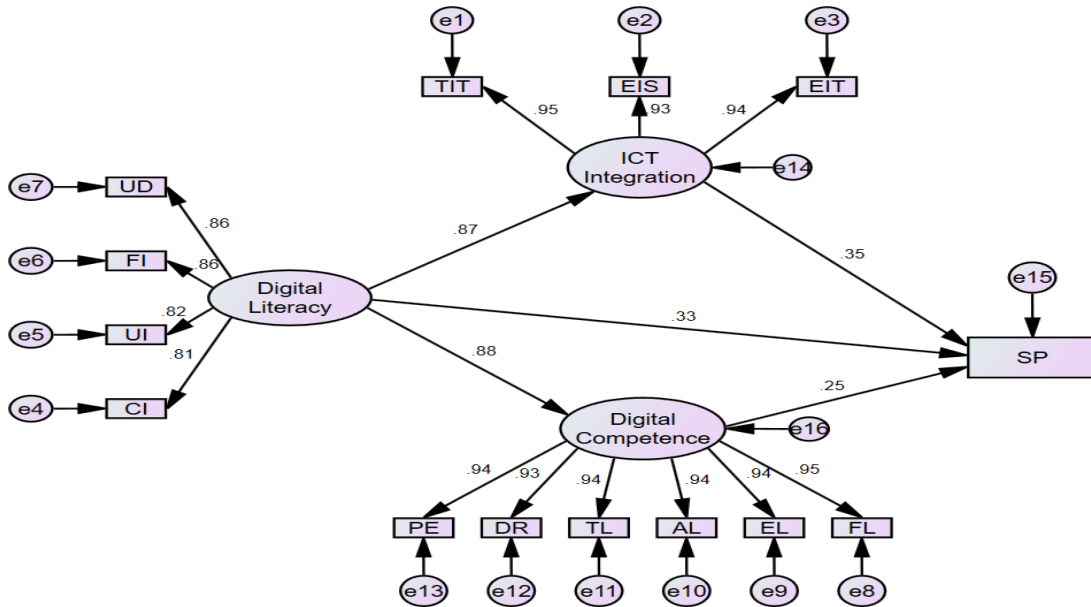


FIGURE 2. FINAL MODEL OF THE STUDY

Problem 2. How does digital literacy influence ICT integration, digital competence and student outcomes?

**TABLE 3
 DIRECT EFFECTS OF DIGITAL LITERACY.**

Path	β coefficient	SE	p-value	Decision
DL → ICT_I	.875	.073	<.001*	Accept H1
DL → DC	.876	.078	<.001*	Accept H2
DL → SP	.326	.404	.017*	Accept H3

Note: * significant at $p < .05$ level; Standard Error (SE), Digital Literacy (DL), ICT Integration (ICT_I), Digital Competence (DC), Student Performance (SP)

Table 3 presents the direct effects of Digital Literacy (DL) on ICT Integration (ICT_I), Digital Competence (DC), and Student Performance (SP), revealing statistically significant and positive relationships across all three pathways. The strongest direct effect was found between Digital Literacy and Digital Competence ($\beta = .876, p < .001$), followed closely by the relationship between Digital Literacy and ICT Integration ($\beta = .875, p < .001$). These results are well supported by prior research emphasizing the foundational role of digital literacy in enhancing teachers' professional capacities and their ability to integrate technology effectively into educational contexts. Grosseck et al. (2023) affirm that educators with higher digital literacy demonstrate

greater self-efficacy in using digital tools, thereby expanding their digital competence and teaching effectiveness. Similarly, Cahyono et al. (2020) highlight that digital literacy enables educators to integrate ICT tools more meaningfully into instructional practices, resulting in enriched learning environments and greater engagement.

Moreover, the direct effect of Digital Literacy on Student Performance, though smaller in magnitude ($\beta = .326, p = .017$), remains statistically significant. This suggests that digitally literate teachers are more capable of adopting innovative and student-centered pedagogies, which in turn enhance academic outcomes. Samani et al. (2020) support this interpretation, noting that improvements in digital competencies among educators contribute to the adoption of teaching strategies that promote better learning results. Although their focus was on students' digital literacy, the implication remains clear: educator competencies in digital environments play a key role in fostering improved student achievement.

Taken together, these findings underscore the centrality of digital literacy as a driver of both teacher and student success in the modern classroom. As such, the study reinforces the need to prioritize digital literacy development in teacher training programs and professional development initiatives. Doing so will not only strengthen ICT integration and digital competence but also translate into tangible improvements in student learning outcomes, thereby contributing to the overall quality of education in an increasingly digital age (Cahyono et al., 2020; Grossek et al., 2023; Samani et al., 2020).

Problem 3. How do ICT integration and digital competence influence student performance?

Table 4 reveals the significant direct effects of the mediators—ICT Integration (ICT_I) and Digital Competence (DC) on Student Performance (SP), supporting hypotheses H4 and H5.

TABLE 4
DIRECT EFFECTS OF MEDIATORS ON STUDENT PERFORMANCE.

Path	β coefficient	SE	p-value	Decision
ICT_I \rightarrow SP	.345	.234	<.001*	Accept H4
DC \rightarrow SP	.253	.213	.004*	Accept H5

Note: * significant at $p < .05$ level; Standard Error (SE), ICT Integration (ICT_I), Digital Competence (DC), Student Performance (SP)

The effect of ICT Integration on student performance ($\beta = .345, p < .001$) is notably strong, underscoring the transformative impact of embedding digital tools in classroom instruction. This result echoes the findings of Goldhaber (2021), who emphasized that effective ICT integration fosters active engagement and enhances the quality of educational delivery. Similarly, Romero et al. (2020) argue that ICT, when integrated into teaching practices, shifts instruction from passive learning to interactive and student-centered approaches, thereby improving learning outcomes.

In addition, Digital Competence was also found to have a significant positive influence on Student Performance ($\beta = .253, p = .004$), albeit to a slightly lesser extent. This finding is supported by Kwiatkowska and Wiśniewska-Nogaj (2022), who observed that educators with strong digital skills are better equipped to design inclusive and effective tech-supported lessons that respond to varied learner needs. These skills not only enable teachers to leverage educational technologies efficiently but also promote differentiated instruction, ultimately benefiting student achievement. Furthermore, Romero et al. (2020) emphasize that teacher competence in digital environments is crucial for curating meaningful and engaging learning experiences.

Collectively, the results affirm the critical mediating role of both ICT Integration and Digital Competence in driving improved student outcomes. As Morales et al. (2024) point out, educational institutions must recognize the importance of investing in both digital infrastructure and teacher development to support student success. They also highlight how demographic and contextual factors influence digital competence levels, suggesting the need for tailored professional development programs. In sum, the evidence strongly supports the view that enhancing teachers' capacity to integrate ICT and develop digital competence is essential for cultivating dynamic, learner-centered educational environments where students are more likely to thrive academically.

Problem 4. Does ICT integration mediate the relationship between digital literacy and student performance?

Table 5 presents the results of the mediation analysis using bootstrapping, which tested the indirect effect of Digital Literacy (DL) on Student Performance (SP) through ICT Integration (ICT_I).

TABLE 5
RESULTS OF MEDIATION ANALYSIS USING BOOTSTRAPPING.

Indirect Effects	Bootstrapping		95% Confidence Interval		p-value	Decision
	Estimate	Bootstrap SE	Lower	Upper		
DL → ICT_I → SP	.429	.097	.278	.668	.001*	Accept H6

Note: * Significant at $p < 0.05$ level; 2000 bootstrap resampling; Digital Literacy (DL), ICT Integration (ICT_I), Student Performance (SP)

The findings reveal a statistically significant indirect effect ($\beta = .429$, $SE = .097$, $p = .001$), with a 95% confidence interval ranging from .278 to .668, which does not include zero. This result confirms that ICT Integration significantly mediates the relationship between Digital Literacy and Student Performance, thereby supporting Hypothesis 6.

These findings align closely with prior studies emphasizing the critical mediating role of ICT Integration in translating teachers' digital competencies into improved student outcomes. Quraishi et al. (2024) and Akhyar et al. (2021) both assert that foundational digital literacy enhances educators' ability to meaningfully integrate ICT into pedagogy, thereby transforming instructional delivery. Mulyani et al. (2023) also demonstrated that the use of digital tools improves student learning outcomes, reinforcing the value of effective ICT usage as an educational catalyst. Additionally, research by Purnama et al. (2021) supports the claim that increased digital literacy—when coupled with structured ICT integration—can lead to better academic achievement across various subjects and learning contexts.

The significance of this mediation pathway is further emphasized by the work of Hidayanthi et al. (2024) and Azzahro et al. (2023), who highlight the role of digital integration in enhancing students' literacy and cognitive learning outcomes. These studies collectively validate the premise that digitally literate teachers who actively integrate ICT into their instruction contribute meaningfully to student achievement. Furthermore, Quraishi et al. (2024) emphasize that this relationship is best realized when teachers are provided with professional development that focuses not just on acquiring digital skills but on embedding them pedagogically in classroom practice.

The mediation analysis underscores the imperative for educational systems to invest in targeted teacher training programs that advance both digital literacy and practical ICT integration.

As noted by Goldhaber (2021), the real benefit of digital competence emerges when educators are empowered to use technology in student-centered, instructionally effective ways. These findings highlight that enhancing digital literacy alone is not enough—it must be coupled with meaningful ICT integration strategies to maximize student performance. The synthesis of results across multiple studies strongly supports the idea that such investments are critical for driving educational success in the digital era.

5. Does digital competence mediate the relationship between digital literacy and student performance?

TABLE 6
RESULTS OF MEDIATION ANALYSIS USING BOOTSTRAPPING.

Indirect Effects	Bootstrapping		95% Confidence Interval		p-value	Decision
	Estimate	Bootstrap SE	Lower	Upper		
DL → DC → SP	.425	.094	.269	.636	.001*	Accept H7

*Note: * Significant at $p < 0.05$ level; 2000 bootstrap resampling; Digital Literacy (DL), Digital Competence (DC), Student Performance (SP)*

The second mediation analysis detailed in Table 6 offers compelling evidence that Digital Competence (DC) significantly mediates the relationship between Digital Literacy (DL) and Student Performance (SP). The bootstrapped indirect effect was statistically significant, with an effect size of $\beta = .425$ ($SE = .094$, $p = .001$) and a 95% confidence interval ranging from .269 to .636, which does not include zero. This result confirms Hypothesis 7, indicating that teachers’ digital literacy translates into higher student performance indirectly through the development of digital competence. As emphasized in the literature, digital literacy not only enhances teachers’ conceptual understanding of digital tools but also fosters the ability to apply these tools effectively in pedagogical contexts (Akhyar et al., 2021; Rodafinos et al., 2024).

This finding is further supported by Grosbeck et al. (2023), who argue that a solid foundation in digital literacy empowers educators to develop more complex digital competencies, including the strategic use of digital resources, lesson design, and learner engagement. Sang et al. (2023) also found that instructors with strong digital competence exhibit greater work engagement and instructional effectiveness, which can positively influence learning outcomes. Moreover,

Rodafinos et al. (2024) emphasize that teachers with robust digital competence are more likely to implement meaningful, adaptive, and student-centered learning activities, reinforcing the pedagogical value of digital tools.

In addition, these results call attention to the critical role of professional development programs that go beyond basic digital skills. Hidayanthi et al. (2024) and Rodafinos et al. (2024) advocate for continuous training focused on higher-order competencies such as digital lesson planning, digital assessment strategies, and the promotion of digital citizenship. Such training not only enhances teacher preparedness but also directly supports students' cognitive and academic growth. When educators are confident and competent in navigating digital environments, they are better positioned to foster these same abilities in their students, thereby creating a ripple effect that enhances overall educational outcomes.

The mediation results reinforce a pivotal insight in digital education research while digital literacy is foundational, it is through the lens of digital competence that its full educational impact is realized. This underscores the need for educational institutions and policymakers to prioritize digital competence as a core component of teacher development frameworks. By strategically fostering both DL and DC, schools can create a digitally empowered teaching force capable of significantly improving student performance in the 21st-century classroom (Rodafinos et al., 2024; Sang et al., 2023; Grosseck et al., 2023).

IV. CONCLUSION

This study set out to investigate the pathways through which digital literacy, ICT integration, and digital competence influence student performance among junior high school teachers in the digital age. Utilizing a structural equation modeling approach, the research confirmed that digital literacy not only has a direct effect on student performance but also exerts a significant indirect influence through the mediating roles of ICT integration and digital competence.

The findings revealed that digital literacy serves as a foundational competency for modern educators. Teachers who possess high levels of digital literacy are more likely to integrate ICT meaningfully and develop advanced digital competencies—both of which significantly enhance student learning outcomes. The strong model fit indices support the robustness of the theoretical framework grounded in the Technology Acceptance Model (TAM) and Cognitive Learning Theory. These frameworks collectively affirm that perceived digital utility and cognitive engagement are crucial in shaping educational success in the 21st century.

Furthermore, the results emphasize that digital competence and ICT integration are not peripheral skills but central elements of effective teaching practice. Their mediating effects underscore the need for teacher training programs that go beyond basic digital skills to include pedagogically sound, student-centered applications of technology. In particular, professional development should aim to bridge gaps in information evaluation, instructional design, and technology-enabled assessment—skills that directly contribute to improved student performance.

V. RECOMMENDATIONS

Prioritize the Development of Teacher Digital Literacy and Competence through Structured, Pedagogically-Oriented Professional Development Programs

The study strongly supports that digital literacy is the foundational pathway through which ICT integration and digital competence influence student performance. Thus, the most urgent and impactful recommendation is for the Department of Education and teacher education institutions to invest in comprehensive, pedagogically grounded training programs that build teachers' digital capacities.

These programs should:

- Be aligned with the DigCompEdu framework to systematically develop core areas such as digital content creation, learner engagement, digital assessment, and online safety.
- Focus on practical classroom applications of ICT, not just technical skill-building.
- Include hands-on workshops, collaborative digital lesson planning, and peer mentoring.
- Be delivered continuously, rather than as one-time seminars, ensuring sustained development and reflection.

By focusing on this critical recommendation, schools can empower educators to become effective facilitators of 21st-century learning—ensuring that digital transformation in education leads to real, measurable improvements in student outcomes.

REFERENCES

- [1.] Almenara, J., Osuna, J., Castillo, J., & Palacios-Rodríguez, A. (2021). The teaching digital competence of health sciences teachers. a study at andalusian universities (spain). *International Journal of Environmental Research and Public Health*, 18(5), 2552. <https://doi.org/10.3390/ijerph18052552>
- [2.] Bayraktar, F. and Tomczyk, Ł. (2021). Digital piracy among young adults: the role of values and time perspectives. *Sustainability*, 13(16), 9140. <https://doi.org/10.3390/su13169140>
- [3.] Erstad, O., Kjällander, S., & Järvelä, S. (2021). Facing the challenges of ‘digital competence’. *Nordic Journal of Digital Literacy*, 16(2), 77-87. <https://doi.org/10.18261/issn.1891-943x-2021-02-04>
- [4.] Reixach, E., Andrés, E., Ribes, J., Gea-Sánchez, M., López, A., Cruañas, B., ... & Saigí-Rubió, F. (2022). Measuring the digital skills of catalan health care professionals as a key step toward a strategic training plan: digital competence test validation study. *Journal of Medical Internet Research*, 24(11), e38347. <https://doi.org/10.2196/38347>
- [5.] Salman, M., Ganie, S., & Saleem, I. (2020). The concept of competence: a thematic review and discussion. *European Journal of Training and Development*, 44(6/7), 717-742. <https://doi.org/10.1108/ejtd-10-2019-0171>
- [6.] Wang, X., Wang, Z., Wang, Q., Chen, W., & Pi, Z. (2021). Supporting digitally enhanced learning through measurement in higher education: development and validation of a university students' digital competence scale. *Journal of Computer Assisted Learning*, 37(4), 1063-1076. <https://doi.org/10.1111/jcal.12546>
- [7.] Zhao, Y., Llorente, A., & Gómez, M. (2021). Digital competence in higher education research: a systematic literature review. *Computers & Education*, 168, 104212. <https://doi.org/10.1016/j.compedu.2021.104212>
- [8.] Cahyono, S., Drajatı, N., & Ngadiso, N. (2020). Am i a technophile? the narrative study of teachers' belief about digital literacy. *Lingua Didaktika Jurnal Bahasa Dan Pembelajaran Bahasa*, 14(1), 1. <https://doi.org/10.24036/ld.v14i1.106724>

-
- [9.] Grosseck, G., Bran, R., & Țîru, L. (2023). Digital assessment: a survey of romanian higher education teachers' practices and needs. *Education Sciences*, 14(1), 32. <https://doi.org/10.3390/educsci14010032>
- [10.] Samani, E., Bagheripour, R., & Noordin, N. (2020). Effect of a course on educational tools on students' attitude and digital literacy skills. *International Journal of Educational Technology and Learning*, 8(1), 38-46. <https://doi.org/10.20448/2003.81.38.46>
- [11.] Goldhaber, A. (2021). Impact of ict integration on quality of education among secondary schools in usa. *Journal of Education*, 4(6), 53-61. <https://doi.org/10.53819/81018102t5015>
- [12.] Kwiatkowska, W. and Wiśniewska-Nogaj, L. (2022). Digital skills and online collaborative learning: the study report. *The Electronic Journal of E-Learning*, 20(5), 510-522. <https://doi.org/10.34190/ejel.20.5.2412>
- [13.] Morales, L., Nieblas, C., & Sisto, M. (2024). Demographic and school factors associated with digital competences in higher education students. *Contemporary Educational Technology*, 16(2), ep498. <https://doi.org/10.30935/cedtech/14288>
- [14.] Romero, C., García, O., & Paz-Lugo, P. (2020). Improving future teachers' digital competence using active methodologies. *Sustainability*, 12(18), 7798. <https://doi.org/10.3390/su12187798>
- [15.] Akhyar, Y., Fitri, A., Zalisman, Z., Syarif, M., Niswah, N., Simbolon, P., ... & Abidin, Z. (2021). Contribution of digital literacy to students' science learning outcomes in online learning. *International Journal of Elementary Education*, 5(2), 284. <https://doi.org/10.23887/ijee.v5i2.34423>
- [16.] Azzahro, F., Norra, B., & Achmad, C. (2023). The relationship of digital literacy ability with students' cognitive learning outcomes. *Jurnal Bioeduin Program Studi Pendidikan Biologi*, 13(1), 28-35. <https://doi.org/10.15575/bioeduin.v13i1.24364>
- [17.] Hidayanthi, R., Siregar, N., Siregar, D., & Siregar, H. (2024). Implementation of steam-based digital learning for students' numeracy literacy in elementary schools. *Research and Development in Education (Raden)*, 4(1), 653-661. <https://doi.org/10.22219/raden.v4i1.32663>
- [18.] Mulyani, S., Nurdina, R., & Mahardiani, L. (2023). Improving students learning outcomes and digital literacy on acid-base titration using titration screen experiment media. *Ijpte*
-

- International Journal of Pedagogy and Teacher Education, 7(1), 22.
<https://doi.org/10.20961/ijpte.v0i0.72051>
- [19.] Purnama, S., Ulfah, M., Machali, I., Wibowo, A., & Narmaditya, B. (2021). Does digital literacy influence students' online risk? evidence from covid-19. *Heliyon*, 7(6), e07406.
<https://doi.org/10.1016/j.heliyon.2021.e07406>
- [20.] Quraishi, T., Ulusi, H., MUHID, A., Hakimi, M., & OLUSI, M. (2024). Empowering students through digital literacy: a case study of successful integration in a higher education curriculum. *Journal of Digital Learning and Distance Education*, 2(8), 667-681.
<https://doi.org/10.56778/jdlde.v2i8.208>
- [21.] Akhyar, Y., Fitri, A., Zalisman, Z., Syarif, M., Niswah, N., Simbolon, P., ... & Abidin, Z. (2021). Contribution of digital literacy to students' science learning outcomes in online learning. *International Journal of Elementary Education*, 5(2), 284.
<https://doi.org/10.23887/ijee.v5i2.34423>
- [22.] Rodafinos, A., Barkoukis, V., Tzafilkou, K., Ούρδα, Δ., Economides, A., & Perifanou, M. (2024). Exploring the impact of digital competence and technology acceptance on academic performance in physical education and sports science students. *Journal of Information Technology Education Research*, 23, 019. <https://doi.org/10.28945/5309>
- [23.] Sang, G., Wang, K., Li, S., Xi, J., & Yang, D. (2023). Effort expectancy mediate the relationship between instructors' digital competence and their work engagement: evidence from universities in china. *Educational Technology Research and Development*, 71(1), 99-115. <https://doi.org/10.1007/s11423-023-10205-4>
- [24.] Aini, D. (2023). Improving civic intelligence through citizenship education based on digital literature curriculum., 126-136. https://doi.org/10.2991/978-2-38476-096-1_15
- [25.] Boğa, E. and Yılmaz, K. (2024). The effect of emergency department history on health literacy level and role of digital literacy: an observational study. *Medicine*, 103(28), e38933.
<https://doi.org/10.1097/md.00000000000038933>
- [26.] Ding, J., Chen, T., & Lü, G. (2023). Analysis of the connotation of digital literacy and related literacy. *International Journal of New Developments in Education*, 5(23).
<https://doi.org/10.25236/ijnde.2023.052301>

-
- [27.] Fakhrudin, A. and Haryanto, H. (2023). Digital literacy analysis of primary school students. *Kne Social Sciences*. <https://doi.org/10.18502/kss.v8i8.13280>
- [28.] Ji, S. and Zhuang, J. (2023). The impact path of digital literacy on farmers' entrepreneurial performance: based on survey data in jiangsu province. *Sustainability*, 15(14), 11159. <https://doi.org/10.3390/su151411159>
- [29.] Julien, H., Gerstle, D., Detlor, B., Rose, T., & Serenko, A. (2022). Digital literacy training in canada, part 2: defining and measuring success. *The Library Quarterly*, 92(1), 87-100. <https://doi.org/10.1086/717233>
- [30.] Li, Z. and Wang, J. (2024). A study on the impact and cultivation of digital literacy and farmers' e-commerce participation behavior —analysis based on survey data of kiwifruit farmers in shaanxi province.. <https://doi.org/10.4108/eai.23-2-2024.2345906>
- [31.] Mega, I., Yuanita, Y., Arsisari, A., & Ulfah, W. (2022). Learners' digital literacy in the online learning during covid-19. *English Review Journal of English Education*, 10(2), 699-706. <https://doi.org/10.25134/erjee.v10i2.6314>
- [32.] Munisa, M., Putri, U., Sari, W., & Fitri, N. (2024). Digital literacy based on local wisdom in inclusive education. *Pionir Jurnal Pendidikan*, 13(1). <https://doi.org/10.22373/pjp.v13i1.22058>
- [33.] Sari, D., Prayitno, H., Rahmawati, L., & Prastiwi, Y. (2022). Culture of digital literacy in thematic learning at the basic education level. *Jurnal Ilmiah Sekolah Dasar*, 6(3), 467-475. <https://doi.org/10.23887/jisd.v6i3.46334>
- [34.] Wang, X. and Luan, W. (2022). Research progress on digital health literacy of older adults: a scoping review. *Frontiers in Public Health*, 10. <https://doi.org/10.3389/fpubh.2022.906089>
- [35.] Yang, C. (2023). Research on strategies for school-based training of digital literacy for university teachers. *Adult and Higher Education*, 5(20). <https://doi.org/10.23977/aduhe.2023.052021>
- [36.] Adarkwah, M. (2020). "i'm not against online teaching, but what about us?": ict in ghana post covid-19. *Education and Information Technologies*, 26(2), 1665-1685. <https://doi.org/10.1007/s10639-020-10331-z>
-

-
- [37.] Akram, H., Abdelrady, A., Al-Adwan, A., & Ramzan, M. (2022). Teachers' perceptions of technology integration in teaching-learning practices: a systematic review. *Frontiers in Psychology*, 13. <https://doi.org/10.3389/fpsyg.2022.920317>
- [38.] Badran, A., Eid, L., Abozaied, H., & Nagy, N. (2021). Egypt's ict reform: adoption decisions and perspectives of secondary school teachers during covid-19. *Aera Open*, 7. <https://doi.org/10.1177/23328584211042866>
- [39.] Ercan, B. (2021). Quality management concerning use of ict in higher education language learning environments: a case study in turkey., 901-915. <https://doi.org/10.22364/htqe.2021.71>
- [40.] Kumar, P. (2023). Transformative role of ict in 21st century learning: enhancing educational effectiveness and equitability. *International Journal for Research in Applied Science and Engineering Technology*, 11(12), 91-95. <https://doi.org/10.22214/ijraset.2023.57028>
- [41.] Körtesi, P., Simonka, Z., Szabó, Z., Gunčaga, J., & Neag, R. (2022). Challenging examples of the wise use of computer tools for the sustainability of knowledge and developing active and innovative methods in steam and mathematics education. *Sustainability*, 14(20), 12991. <https://doi.org/10.3390/su142012991>
- [42.] Luvanda, S., Ogoti, E., & Siamoo, P. (2021). Leadership strategies in enhancing integration of information and communication technology in teaching and learning in public teachers' colleges in moshi district, tanzania. *JEP*. <https://doi.org/10.7176/jep/12-32-11>
- [43.] Ngodu, A., Ndibalema, P., & William, F. (2024). Context-relevant strategies for ict integration in teaching and learning science subjects in tanzania secondary schools. *Educational Technology Quarterly*, 2024(1), 20-37. <https://doi.org/10.55056/etq.704>
- [44.] Nunes, A., Limpo, T., & Castro, S. (2022). Predictors of portuguese teachers' use of information and communication technologies in literacy classes. *Frontiers in Psychology*, 13. <https://doi.org/10.3389/fpsyg.2022.1006713>
- [45.] Siminto, S., Ausat, A., & Rijal, S. (2024). Education management strategies to maximize the effectiveness of information and communication technology integration in teaching and learning processes. *Indo-Mathedu Intellectuals Journal*, 5(2), 1630-1641. <https://doi.org/10.54373/imeij.v5i2.935>
-

- [46.] Trinh, T., Thi-Nga, H., Hằng, N., Thai, D., Linh, H., Nhung, N., ... & Dinh, N. (2024). The influence of gender and training sector on the ict competency of pre-service teachers in vietnam: using the unesco ict competency framework. *International Journal of Learning Teaching and Educational Research*, 23(3), 4