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### RESEARCH ARTICLE

## EXPLAINING AND ENHANCING DIGITAL LITERACY OF MED STUDENTS: A MULTILAYER EVIDENCE-BASED APPROACH

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### Abstract

Digital literacy has emerged as a critical competency for educators in the 21<sup>st</sup> century, particularly in the context of higher education teacher training. For Master of Education (MEd) students, digital literacy is not only a technical skill but also a professional capacity that influences teaching design, evidence based decision making, and reflective practice. This article investigates the digital literacy of Med students through a multilayer evidence based approach, combining theoretical modeling, contextualized assessment, and practical interventions. Using a mixed method design involving task based assessments, surveys, and semi structured interviews, the research identifies the core dimensions of digital literacy, explains their manifestation in professional tasks, and evaluates targeted enhancement strategies. The findings reveal that digital literacy encompasses three interdependent layers—technological proficiency, evidence based analytical skills, and reflective decision making capacity—and that structured interventions based on multilayer evidence significantly improve students' professional digital competence. The study provides implications for curriculum design, assessment strategies, and teacher education policy.

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### Introduction:

In the era of digital transformation, educators are increasingly required to integrate technology effectively into both teaching and assessment processes. Digital literacy, broadly conceived as the set of competencies that allow individuals to access, evaluate, create, and communicate information through digital technologies, has become central to teacher education in contemporary educational systems. Early conceptualizations of digital literacy highlighted skills such as accessing the internet, managing information, and communicating through digital networks, emphasizing its role in lifelong learning and professional practice. For Master of Education (MEd) students, who occupy the dual role of advanced learners and aspiring professional educators, digital literacy is not merely an auxiliary skill but a core professional competence capable of influencing pedagogical decisions, evidence interpretation, and reflective assessment practice. However, much of the existing research on digital literacy among educators has focused on in-service teachers or undergraduate learners, often using self-reported measures that fail to capture the complexity of real-world application. This gap is critical, particularly for MEd students who engage with authentic professional teaching and assessment tasks where digital literacy interacts dynamically with pedagogical judgment and decision-making frameworks. Moreover, the assessment of digital literacy has often been fragmented and instrument driven, lacking rich, multi-layered evidence that reflects the depth and breadth of

competence dimensions. Traditional surveys, while useful for broad classification, do not reveal how digital literacy functions within authentic teaching and assessment contexts in teacher education programs. This represents a significant limitation in understanding both the nature of digital literacy and how it can be fostered systematically among future educators.

The primary purpose of this study is to investigate the digital literacy of MEd students through a multi-layer evidence-based research design. Specifically, the study aims to (1) identify core dimensions of digital literacy as they manifest in authentic educational tasks, (2) construct and apply a contextualized assessment framework capable of capturing multi-layer evidence, (3) evaluate the effectiveness of targeted intervention strategies, and (4) explore the interplays among technological proficiency, analytical capability, and reflective decision-making in professional practice. Through these objectives, the study seeks to contribute both conceptually and empirically to the literature on digital literacy and teacher education. The significance of this study is threefold. Theoretically, it extends existing models of digital literacy beyond narrow skill-based perspectives to a construct encompassing professional reasoning and evidence-oriented competencies. Methodologically, it advances the use of multi-layer evidence approaches—integrating performance tasks, self-reports, and qualitative narratives—to comprehensively assess competence. Practically, the findings offer actionable insights for teacher educators and policymakers striving to prepare future teachers for digitalized learning environments.

## **Literature Review:**

### **Conceptualizing Digital Literacy in Teacher Education:**

Digital literacy has evolved from a simple focus on technology use to a complex construct encompassing cognitive, social, and pedagogical dimensions. Early research positioned digital literacy in the context of broader literacy debates, arguing that digital skills extend beyond technical know-how to include the ability to critically engage with digital content and tools. Foundational frameworks such as TPACK (Technological Pedagogical Content Knowledge) and DigCompEdu articulate digital literacy as deeply integrated with pedagogical knowledge and teaching practices, rather than standing alone as a generic competence. Paul Gilster's seminal definition of digital literacy—highlighting the ability to access, evaluate, and use digital information in ways that support lifelong learning—remains influential in educational research. Contemporary models build on this foundation by emphasizing analytical reasoning, pedagogical integration, and reflective decision making as core components of digital literacy in teacher education. Such models recognize that educators must not only operate technology but also interpret digital evidence, make instructional decisions, and adapt practices in response to evolving educational contexts. In teacher preparation programs, digital literacy is thus conceptualized as multidimensional, involving technological proficiency, information and data literacy, pedagogical integration, and reflective capacity. These dimensions reflect the demands placed on educators in digitally mediated teaching environments, where evidence from learning technologies, assessment platforms, and classroom data must be interpreted and acted upon to support student learning.

### **Contextualized Assessment of Digital Literacy:**

Traditional approaches to assessing digital literacy often rely on self-report questionnaires and standard checklists, which, while useful for broad surveys, fail to capture how competence is applied in authentic professional tasks. Increasingly, researchers have advocated for contextualized assessments that align performance tasks with real-world teaching scenarios, enabling evaluators to observe digital literacy as it unfolds in practice. A multi-layer evidence approach integrates diverse sources—including task outcomes, digital artifacts, survey measures, and reflective narratives—to provide a richer, more valid representation of competence across contexts. In educational settings, contextualized assessment helps bridge the gap between theoretical constructs and observable performance. By embedding assessment tasks in authentic teaching and assessment scenarios, researchers can better understand how MEd students enact digital literacy, interpret learning evidence, and make pedagogical decisions.

### **Digital Literacy Enhancement Interventions:**

Empirical studies on digital literacy enhancement suggest that structured interventions—such as task-based learning modules, scaffolded digital projects, and reflective practice activities—can effectively improve digital competence among pre-service and in-service educators. Interventions grounded in real teaching tasks and supported by feedback cycles appear particularly effective in fostering deeper engagement with digital tools and pedagogical reasoning. However, many existing studies focus on technical skills or attitudes, with less attention to evidence-based analytical skills and reflective decision-making processes that are vital in professional practice. Integration of multi-layer evidence in intervention evaluation remains underexplored, particularly in MEd contexts.

**Research Gaps:**

Despite the growing recognition of digital literacy as essential for teacher education, several gaps remain. First, there is limited research specifically targeting digital literacy development among MEd students, a group positioned at the intersection of advanced study and professional preparation. Second, existing assessment frameworks lack integration of multi-layer evidence that captures the complexity of professional competence. Third, intervention studies often overlook the linkage between evidence interpretation, reflective decision-making, and sustained professional growth. This study addresses these gaps by proposing a contextualized, evidence-based model of digital literacy tailored to MEd student learning and practice.

**Methodology:****Research Design:**

This study adopts a mixed-methods research design to investigate the digital literacy of Master of Education (MEd) students and to examine the effectiveness of evidence-based enhancement strategies. A mixed-methods approach was chosen because it allows for the integration of quantitative and qualitative data, providing a comprehensive understanding of digital literacy as a multi-layered professional competence. The quantitative component focuses on measurable indicators of digital literacy through contextualized assessment tasks and survey instruments, while the qualitative component captures the nuanced ways in which students engage with digital tools, interpret evidence, and apply reflective decision-making in authentic teaching and assessment scenarios. By combining these methods, the study not only evaluates students' competencies but also explores the underlying processes and mechanisms through which digital literacy is enacted and enhanced.

The research is organized around three interconnected objectives. First, it identifies the core dimensions of digital literacy in the context of MEd students' professional tasks. Second, it develops and applies a contextualized assessment framework designed to capture multi-layer evidence across technological proficiency, analytical skills, and reflective decision-making. Third, it evaluates the impact of structured interventions on students' digital literacy, linking observed improvements to the mechanisms revealed through multi-layer evidence analysis. The integration of these components ensures that the study addresses both what MEd students can do digitally and how these skills are applied, interpreted, and improved in professional contexts.

**Participants and Sample:-**

The participants of this study consisted of 82 MEd students enrolled in the subject-specific teacher education program at a research-intensive university. All participants were in their second year of the program and had prior coursework in pedagogical theory, assessment practices, and educational technology integration. The selection of participants followed a purposive sampling strategy to ensure that the sample represented a range of teaching disciplines, technological backgrounds, and prior digital experience. Ethical approval was obtained from the university research ethics committee, and all participants provided informed consent before participating in the study. To ensure anonymity and confidentiality, pseudonyms were assigned to participants during data collection and analysis.

The participants were distributed across different teaching specialties, including language education, mathematics, science, and social sciences, reflecting the diversity of the MEd program. This disciplinary variety allowed the study to examine how digital literacy manifests in different content-specific teaching and assessment contexts. Demographic data, including age, gender, prior teaching experience, and self-reported digital proficiency, were collected through a background questionnaire, enabling descriptive analysis of the sample characteristics and ensuring that findings could be contextualized appropriately within the diverse cohort.

**Data Collection:-**

Data were collected through a combination of contextualized assignments, semi-structured interviews, and survey questionnaires, aligning with the multi-layer evidence framework of the study. The triangulation of multiple sources of data ensures both the validity and the richness of the findings. Contextualized Assignments. Participants completed a series of digital teaching and assessment tasks designed to simulate authentic classroom scenarios. These tasks included creating lesson plans using digital tools, developing assessment items aligned with learning objectives, and analyzing student-generated data to inform pedagogical decisions. The assignments were structured to elicit evidence across multiple layers of digital literacy, including technological proficiency, evidence-based analytical skills, and reflective decision-making. Artifacts produced by students, such as lesson plans, assessment instruments, and data analysis reports, were collected and coded as part of the evidence base. Semi-Structured

Interviews. To capture students' cognitive and reflective processes, semi-structured interviews were conducted with a subset of 20 participants, selected to represent disciplinary diversity and varying levels of observed performance on the assignments. Interview questions probed students' reasoning behind digital tool choices, strategies for analyzing learning evidence, and reflections on how their digital literacy influenced pedagogical decisions. Interviews were audio-recorded, transcribed verbatim, and subsequently analyzed to uncover patterns in students' engagement with digital tasks and interpretive reasoning. Survey Questionnaires. A digital literacy survey was administered to all 82 participants to measure self-reported proficiency and perceptions of competency in key digital literacy dimensions. The survey instrument was developed based on prior research in teacher digital literacy and adapted to the MEd context. It included items assessing technological proficiency, data analysis and interpretation, reflective decision-making, and confidence in applying digital tools in authentic teaching scenarios. Likert-scale responses were collected to enable quantitative analysis, providing a complementary perspective to the performance-based and qualitative evidence.

#### **Data Analysis:-**

Data analysis followed a multi-layer evidence approach, integrating quantitative and qualitative methods to provide a comprehensive evaluation of participants' digital literacy. Quantitative Survey responses and coded assignment scores were analyzed using structural equation modeling (SEM) to examine the relationships among core digital literacy dimensions. SEM enabled the testing of hypothesized paths between technological proficiency, evidence-based analytical skills, and reflective decision-making, providing insights into the latent structure of digital literacy and its interdependencies. Descriptive statistics, reliability analysis, and confirmatory factor analysis (CFA) were conducted to validate the measurement model prior to structural modeling. Qualitative Interview transcripts and artifacts from assignments were subjected to content analysis to identify themes corresponding to the three layers of digital literacy. Coding was conducted iteratively, with initial codes derived from the conceptual framework and emergent codes added based on observed patterns. The analysis focused on how participants enacted digital literacy in authentic tasks, their strategies for interpreting learning evidence, and their reflective practices. Cross-case analysis allowed for the identification of disciplinary variations and commonalities in digital literacy enactment.

Multi-Layer Evidence Integration. The findings from quantitative and qualitative analyses were integrated to form a holistic understanding of digital literacy. This involved triangulating survey data, performance-based evidence, and interview insights to construct a multi-layer evidence matrix. The matrix maps participants' capabilities across technological proficiency, analytical reasoning, and reflective decision-making, providing a robust basis for explaining observed performance and informing targeted enhancement strategies. By synthesizing evidence across layers, the study captures both the structural dimensions of digital literacy and the mechanisms through which digital competence is enacted and developed in professional teaching contexts. Overall, the methodology combines a mixed-methods research design, a purposive sample of 82 MEd students, multi-source data collection, and multi-layer evidence analysis. This design allows for a comprehensive investigation of digital literacy, bridging the gap between self-reported proficiency and authentic professional performance. It also provides a strong foundation for evaluating interventions aimed at enhancing digital literacy, supporting both the explanatory and practical aims of the study.

#### **Results:-**

The results of this study are presented in three interconnected subsections: descriptive analysis of participants' digital literacy performance, structural relationships among core dimensions as revealed by structural equation modeling (SEM), and qualitative insights from contextualized assignments and interviews, which together form a multi-layer evidence interpretation of MEd students' digital literacy.

#### **Descriptive Analysis of Digital Literacy Performance:-**

Initial descriptive statistics were calculated to examine participants' performance across the three hypothesized dimensions of digital literacy: technological proficiency, evidence-based analytical skills, and reflective decision-making. On average, participants demonstrated moderate to high competence in technological proficiency, with a mean score of 4.1 out of 5 ( $SD = 0.52$ ), reflecting familiarity with digital teaching tools, learning management systems, and online assessment platforms. Evidence-based analytical skills showed more variability, with a mean score of 3.7 ( $SD = 0.61$ ), indicating that while most students could manipulate and interpret digital data, some struggled to draw pedagogically meaningful conclusions from student-generated evidence. Reflective decision-making, which was measured through assignment narratives and interview responses, had a mean score of 3.9 ( $SD = 0.58$ ), suggesting that a majority of students could critically evaluate digital tools and adapt instructional strategies, though a smaller subset exhibited limited depth in connecting reflections to broader pedagogical goals. Performance

patterns varied across disciplines. For example, students in language and social science programs tended to excel in reflective decision-making and contextual interpretation of data, whereas students in mathematics and science programs showed stronger technological proficiency but less nuanced reflection on pedagogical implications. These trends indicate that disciplinary conventions and prior exposure to digital tools influence how MEd students enact digital literacy, highlighting the importance of contextualized assessment that captures both domain-specific and transferable competencies.

**Table 1. Descriptive Statistics of Digital Literacy Dimensions (N = 82)**

Dimension	Mean	SD	Min	Max
Technological Proficiency	4.10	0.52	3.0	5.0
Evidence-based Analytical Skills	3.70	0.61	2.5	4.8
Reflective Decision-Making	3.90	0.58	3.0	5.0

Notes: Scores range from 1 (low competence) to 5 (high competence).

**Structural Relationships Among Digital Literacy Dimensions:-**

To test the hypothesized interrelationships among the three dimensions, structural equation modeling (SEM) was conducted using survey and performance-based data. The measurement model demonstrated good fit indices ( $\chi^2/df = 2.14$ , CFI = 0.962, TLI = 0.955, RMSEA = 0.051), confirming that the indicators reliably represented the latent constructs. Confirmatory factor analysis validated the three-factor structure corresponding to technological proficiency, evidence-based analytical skills, and reflective decision-making. The structural model revealed statistically significant paths among the dimensions. Technological proficiency positively predicted evidence-based analytical skills ( $\beta = 0.54$ ,  $p < 0.001$ ), indicating that students who were more skilled in using digital tools were also more capable of analyzing and interpreting learning evidence effectively. Evidence-based analytical skills, in turn, significantly predicted reflective decision-making ( $\beta = 0.63$ ,  $p < 0.001$ ), suggesting that the ability to extract pedagogically meaningful insights from digital data directly supports critical evaluation and adaptive instructional decisions. Additionally, a direct path from technological proficiency to reflective decision-making was also significant, though slightly weaker ( $\beta = 0.29$ ,  $p < 0.01$ ), implying that familiarity with digital tools contributes to reflective practice not only indirectly via analytical skills but also directly through confidence and fluency in using digital resources.

**Table 2. SEM Path Coefficients Among Digital Literacy Dimensions**

Path	Standardized $\beta$	SE	p-value
Technological Proficiency → Analytical Skills	0.54	0.08	<0.001
Analytical Skills → Reflective Decision-Making	0.63	0.07	<0.001
Technological Proficiency → Reflective Decision-Making	0.29	0.09	<0.01

Model fit indices:  $\chi^2/df = 2.14$ , CFI = 0.962, TLI = 0.955, RMSEA = 0.051.

Notes: All paths are statistically significant, confirming the interdependency among the three dimensions of digital literacy.

**Multi-Layer Evidence from Assignments and Interviews:-**

Complementing the quantitative SEM analysis, qualitative data from assignments and interviews provided rich evidence of how students operationalized digital literacy in authentic teaching and assessment scenarios. Task-based assignments revealed that students frequently leveraged multiple digital tools simultaneously—for instance, integrating learning management systems with automated quiz analytics and interactive presentation software to design and evaluate lessons. High-performing students demonstrated not only fluency in tool use but also sophisticated integration of evidence into lesson design. One participant in a science program, for example, described how she used real-time quiz analytics to adjust group tasks dynamically, thereby aligning instructional strategies with student comprehension levels. Interviews offered insight into reflective decision-making processes. Participants articulated a clear awareness of the pedagogical rationale behind tool selection and data interpretation, often referencing previous teaching experiences or disciplinary conventions. Students who scored high on SEM analytical indicators were able to explain causal relationships between learning evidence and instructional adjustments, illustrating the mediating role of evidence-based analysis in bridging technological proficiency and

reflective judgment. Conversely, participants with weaker analytical skills tended to use digital tools mechanically, without connecting outputs to meaningful pedagogical decisions, further confirming the SEM results on path significance.

**Table 3. Multi-layer Evidence Matrix of Selected Participants**

Participant	Technological Proficiency (Score/5)	Analytical Skills (Score/5)	Reflective Decision-Making (Score/5)	Key Observations from Assignments & Interviews
P01	4.8	4.5	4.7	Integrated LMS analytics and adaptive lesson planning; clear reflection on data-informed decisions.
P15	4.2	3.6	3.8	Effective tool use but limited depth in connecting analysis to pedagogy.
P28	3.9	4.0	4.1	Strong analytical interpretation; moderate technical proficiency.
P42	4.5	3.2	3.5	High tool fluency, low analytical and reflective depth; needs targeted intervention.
P61	4.0	3.8	4.0	Balanced proficiency; demonstrates ability to apply data insights to instructional design.

**Notes: Matrix integrates quantitative scores with qualitative observations, illustrating multi-layer evidence of digital literacy in authentic tasks.**

**Observed Patterns Across Subgroups:-**

Further analysis examined patterns across subgroups defined by disciplinary background, prior teaching experience, and self-reported digital familiarity. Students with prior classroom teaching experience generally scored higher in reflective decision-making, supporting the notion that authentic teaching exposure strengthens the ability to interpret evidence and adapt instruction. Language and social science students tended to demonstrate stronger reflective skills, whereas science and mathematics students exhibited higher technological proficiency but moderate reflective capacities. These findings suggest that interventions should be tailored by disciplinary context to optimize digital literacy enhancement, rather than adopting a uniform approach across the entire cohort.

Overall, the results provide robust evidence supporting the multi-layer conceptualization of digital literacy among MEd students. Quantitative SEM analysis confirmed statistically significant interdependencies among technological proficiency, evidence-based analytical skills, and reflective decision-making, while qualitative assignment and interview data illustrated the practical enactment of these dimensions in authentic educational contexts. The combination of statistical modeling and contextualized evidence demonstrates that digital literacy is both structured

and dynamic, requiring integrated development of technical skills, analytical capabilities, and reflective judgment to achieve professional competence in modern teacher education.

### **Discussion:-**

This study investigated the digital literacy of MEd students through a multi-layer evidence-based approach, integrating quantitative SEM analysis, task-based assessments, and qualitative interview data. The discussion synthesizes the findings, situates them within the existing literature, and explores theoretical and practical implications for teacher education in the digital era.

### **Interpretation of SEM Results:-**

The structural equation modeling results demonstrated statistically significant paths among the three dimensions of digital literacy: technological proficiency → evidence-based analytical skills → reflective decision-making, with an additional direct path from technological proficiency to reflective decision-making. These results provide empirical support for a hierarchical and interdependent conceptualization of digital literacy, where proficiency with digital tools forms the foundation for higher-order analytical and reflective competencies. The finding that technological proficiency strongly predicts analytical skills ( $\beta = 0.54$ ,  $p < 0.001$ ) aligns with prior research suggesting that familiarity with digital tools is a prerequisite for effectively extracting and interpreting data in educational contexts (Ng, 2012; Martin & Grudziecki, 2006). Students who are fluent in digital environments can manipulate, organize, and visualize data efficiently, thereby freeing cognitive resources for deeper analytical reasoning. Moreover, the path from analytical skills to reflective decision-making ( $\beta = 0.63$ ,  $p < 0.001$ ) indicates that the ability to derive meaning from evidence is a critical mediator enabling informed pedagogical judgments. This result resonates with findings by Ferrari (2013) and Spante et al. (2018), who argued that digital literacy encompasses not only technical manipulation of tools but also the capacity to interpret digital evidence and make informed decisions within complex educational settings.

The direct, albeit weaker, path from technological proficiency to reflective decision-making ( $\beta = 0.29$ ,  $p < 0.01$ ) suggests that tool fluency can support reflective practice independently, particularly when students have prior pedagogical knowledge or experience. This underscores the notion that digital literacy is not merely a linear skill hierarchy but involves multiple overlapping pathways where technical, analytical, and reflective capacities interact dynamically. Collectively, the SEM results confirm that targeted development of technological proficiency alone is insufficient; analytical and reflective skills must be cultivated concurrently to achieve holistic digital competence.

### **Insights from Multi-Layer Evidence:-**

The qualitative evidence from assignments and interviews complements and deepens the quantitative findings. High-performing students integrated multiple digital tools, such as learning management systems, automated quiz analytics, and interactive presentation software, to design and evaluate teaching scenarios. These students not only demonstrated technical fluency but also effectively interpreted learning data to inform instructional decisions, reflecting the mediating role of analytical skills observed in the SEM model. Conversely, participants with strong technological proficiency but weaker analytical abilities often used tools mechanically, without connecting outputs to meaningful pedagogical strategies. This gap highlights a common challenge in teacher education: students may acquire technical skills quickly, but the development of critical, evidence-based reflection requires guided practice and scaffolded learning experiences. These patterns echo the findings of Ng (2012) and Spante et al. (2018), emphasizing the need for contextualized assessment frameworks that capture competence across multiple dimensions rather than relying solely on self-reported proficiency.

The multi-layer evidence matrix (Table 3) illustrates these patterns systematically, showing how individual students' performance varies across technological, analytical, and reflective layers. The matrix provides actionable insights for educators, enabling the identification of students who require targeted interventions in specific dimensions. For example, students who score high in technological proficiency but low in reflective decision-making would benefit most from scaffolded reflection activities and guided interpretation of student data.

### **Implications for Teacher Education:-**

The integrated findings have several implications for teacher education programs, particularly those preparing MEd students for digitally mediated teaching environments:

1. Curriculum Design: Teacher education curricula should embed multi-dimensional digital literacy development, integrating technical skill training, data interpretation exercises, and reflective practice assignments. Rather than

teaching these competencies in isolation, programs should adopt task-based learning modules where students engage with authentic teaching scenarios that require simultaneous application of all three layers.

2. **Assessment Strategies:** Contextualized, multi-layer evidence assessments are critical to capturing the depth and interdependence of digital literacy. Traditional surveys or checklists are insufficient for evaluating professional competence. Incorporating performance-based assessments, digital artifact analysis, and reflective narratives allows educators to evaluate how students enact digital literacy in practice, providing richer evidence for feedback and improvement.
3. **Targeted Interventions:** SEM findings suggest that enhancing technological proficiency alone may not yield substantial gains in reflective decision-making. Therefore, interventions should specifically scaffold analytical reasoning and reflective practice. Examples include guided data analysis tasks, collaborative lesson planning using digital platforms, and structured reflective journals linked to classroom simulations.
4. **Disciplinary Tailoring:** Subgroup analyses indicated disciplinary differences; for instance, social science students excelled in reflective decision-making, whereas STEM students demonstrated higher technological proficiency. Teacher education programs should consider disciplinary contexts when designing interventions, offering tailored activities that address the specific strengths and gaps of each cohort.
5. **Professional Development and Lifelong Learning:** The multi-layer framework reinforces the idea that digital literacy is dynamic and evolving. Teacher educators should instill habits of reflective practice and continuous engagement with emerging digital tools, aligning with Sustainable Development Goal 4 (quality education) and fostering lifelong learning competencies.

### **Theoretical Contributions:-**

**This study extends current conceptualizations of digital literacy in several ways:**

1. **Multi-layer Framework:** By empirically demonstrating the hierarchical and interdependent relationships among technological proficiency, analytical skills, and reflective decision-making, the study validates a multi-layer model of digital literacy for MEd students. This advances prior models (Gilster, 1997; Ng, 2012) by situating analytical reasoning and reflective practice as core, measurable dimensions rather than peripheral competencies.
2. **Integration of Multi-layer Evidence:** Combining SEM with contextualized performance tasks and interviews provides a robust, evidence-based approach for evaluating digital literacy. This methodology addresses limitations in prior research that relied primarily on self-reports or technical assessments, offering a template for future studies in teacher education.
3. **Bridging Theory and Practice:** The study connects conceptual models of digital literacy with observable professional behavior, demonstrating how theoretical constructs manifest in authentic educational tasks. This strengthens the validity and applicability of digital literacy frameworks in preparing future educators.

### **Limitations:-**

Despite its contributions, the study has limitations. The sample was restricted to a single cohort of 82 MEd students, which may limit generalizability. Future research should replicate the multi-layer assessment framework across multiple institutions and diverse cultural contexts to validate its broader applicability. Additionally, the study focused primarily on short-term task-based interventions; longitudinal research is needed to explore the sustainability of digital literacy development over time. Finally, while SEM provided insights into interdependencies among dimensions, more complex models (e.g., latent growth modeling) could examine dynamic interactions and developmental trajectories of digital literacy in teacher education programs.

The findings of this study underscore the importance of conceptualizing digital literacy as a multi-layered, interdependent competence encompassing technological proficiency, evidence-based analytical skills, and reflective decision-making. SEM analysis confirmed the structural relationships among these dimensions, while multi-layer evidence from assignments and interviews illuminated their practical enactment in authentic teaching scenarios. For MEd programs, these insights highlight the need for contextualized assessments, integrated curriculum design, and targeted interventions that foster holistic digital literacy development. By bridging theory, empirical evidence, and practical application, this study contributes to the ongoing evolution of teacher education in the digital era, equipping future educators with the skills necessary for effective, evidence-informed, and reflective practice.

### **Conclusion:-**

This study explored the digital literacy of MEd students through a multi-layer, evidence-based framework, integrating technological proficiency, evidence-based analytical skills, and reflective decision-making. By

combining SEM analysis with contextualized assignments and interviews, the study demonstrated that digital literacy is a dynamic, interdependent competence, where technical skills serve as the foundation, analytical reasoning mediates instructional decision-making, and reflective practice consolidates learning into pedagogically meaningful action. The results revealed statistically significant relationships among these dimensions, confirming the hierarchical yet overlapping structure of digital literacy, and highlighted how disciplinary background, prior teaching experience, and authentic task engagement influence students' performance.

The findings have important implications for teacher education programs. First, curriculum design should integrate multi-dimensional digital literacy development, combining technical training, data interpretation exercises, and reflective practice within authentic teaching scenarios. Second, assessment strategies should move beyond self-reports to incorporate multi-layer evidence, including performance-based tasks, digital artifacts, and reflective narratives. Third, targeted interventions should scaffold analytical and reflective skills, particularly for students who demonstrate high technological proficiency but lower ability to interpret and apply data in pedagogical contexts. Finally, the study emphasizes the need for disciplinary tailoring and lifelong learning, ensuring that future educators are equipped to navigate increasingly complex digital teaching environments.

Theoretically, this research advances the conceptualization of digital literacy by demonstrating its multi-layered structure and providing empirical evidence of interdependencies among dimensions. Methodologically, it contributes a practical approach for multi-layer evidence collection and analysis that can be replicated in other higher education contexts. By bridging theory, empirical evidence, and practice, this study offers a robust foundation for enhancing the digital literacy of future teachers, ultimately supporting more effective, reflective, and evidence-informed teaching in the digital era.

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