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MAPPING TEACHER DIGITAL COMPETENCE & LEVELS OF TECHNOLOGY IMPLEMENTATION: INSTRUMENT DESIGN

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Abstract: Understanding teacher capacity is crucial for optimizing technology integration within Indonesia's evolving digital education landscape. This paper details the foundational phase of a study mapping Teacher Digital Competence (TDC) and Levels of Technology Implementation (LoTI) among Indonesian teachers. Systematically mapping these variables (encompassing pedagogical skills, technical proficiency, and actual classroom technology use) provides vital baseline data essential for designing evidence-based curricula and online training materials truly tailored to diverse needs and contexts. Concentrating on this critical preliminary stage, we present the design process for initial survey and interview instruments. Instrument items and protocols were meticulously developed through synthesis of relevant literature and adaptation of established TDC and LoTI frameworks, aiming to capture key competence dimensions quantitatively (survey) and explore influencing contextual factors qualitatively (interview). This paper contributes a systematic, context-aware design methodology for these essential diagnostic tools. Importantly, the described survey and interview instruments are initial designs awaiting rigorous validation, which constitutes the next research step before the main mapping study proceeds to ensure reliable data collection.

Keywords: instrument design; teacher digital competence; Levels of Technology Implementation; needs analysis.

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INTRODUCTION

The imperative to understand and enhance teacher capacity is paramount within Indonesia's dynamically evolving digital education landscape. Indonesian education is undergoing a significant transformation, with increasing emphasis on the integration of technology into teaching and learning processes (Nasrullah & Zainuddin, 2023; Sari et al., 2025). This national drive is underpinned by the expectation that technology will not only improve the overall quality of education but also play a crucial role in mitigating disparities in educational access across the vast and diverse archipelago (Nasrullah & Zainuddin, 2023). However, the journey towards effective technology integration is complex and fraught with substantial challenges. These include persistent infrastructural

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limitations, inconsistent and inequitable access to essential technological resources, and a frequently observed lack of professional development opportunities specifically tailored to equip educators with the skills needed to leverage innovative digital tools effectively (Nasrullah & Zainuddin, 2023; Sari et al., 2025). This complex interplay between the ambitious goals for digital education and the on-the-ground realities necessitates a deep and nuanced understanding of the current digital capabilities of the nation's teaching workforce. The success of Indonesia's digital education initiatives is not merely a matter of providing technological tools; it is fundamentally dependent on addressing these systemic issues and empowering educators to navigate this new terrain.

A significant impediment to optimizing technology integration in Indonesian education is the absence of comprehensive, evidence-based baseline data regarding current Teacher Digital Competence (TDC) and Levels of Technology Implementation (LoTI) among the nation's educators. This critical information gap severely constrains the ability of policymakers, educational institutions, and curriculum developers to design and implement truly effective and targeted interventions (Rahmadani et al., 2022). Without a clear understanding of teachers' existing digital skills, their confidence in using technology, and the extent to which they are actually incorporating digital tools into their pedagogical practices, efforts to develop professional training programs, create relevant curricula, and establish supportive ecosystems are likely to be inefficient, misaligned with actual needs, or based on assumptions rather than empirical evidence. As highlighted in the foundational premise of this research, systematically mapping these variables—encompassing pedagogical skills, technical proficiency, and actual classroom technology use—provides vital baseline data essential for designing evidence-based curricula and online training materials truly tailored to diverse needs and contexts (Abstract). Evidence from specific regions within Indonesia, such as West Sumatra, already indicates potential areas of concern, with studies suggesting that a notable percentage of elementary school teachers may possess low skills in designing digital learning experiences and that a significant portion of teachers may not yet be fully prepared to adapt to the demands of digital literacy (Rahmadani et al., 2022). This underscores the urgent need for a broader, more systematic assessment to inform strategic planning and resource allocation. The problem, therefore, is not merely a lack of data, but a lack of actionable, diagnostic information that can precisely guide interventions to enhance teacher capacity where it is most needed.

This paper details the foundational phase of a larger research initiative aimed at addressing the aforementioned problem by systematically mapping TDC and LoTI among Indonesian teachers. The primary objective of this specific paper is to present and elucidate the meticulous design process undertaken for the initial survey and interview instruments that will be pivotal for the main mapping study (Abstract; Ryan & Power, 2024). These instruments have been carefully conceptualized to serve a dual purpose: the survey component is designed to quantitatively capture key dimensions of teachers'

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digital competence and their self-reported levels of technology implementation, while the interview component aims to qualitatively explore the multifaceted contextual factors that invariably influence these competencies and practices within the diverse classroom environments of Indonesia (Abstract). This approach recognizes that understanding teacher capacity requires not only measuring skills but also appreciating the complex interplay of environmental variables that enable or hinder the effective use of technology in education. The development of these robust diagnostic tools is a critical precursor to generating the kind of granular data needed for informed educational planning.

The significance of this study, even at this preliminary instrument design stage, lies in its contribution of a systematic, context-aware design methodology for these essential diagnostic tools (Abstract; Ruslin et al., 2022). By detailing the rigorous process of adapting established international frameworks and synthesizing relevant literature to create instruments tailored to the Indonesian context, this paper offers a valuable methodological blueprint. These instruments, once subjected to rigorous validation, will be indispensable for the subsequent main mapping study. The data gathered through such a comprehensive mapping effort will be crucial for informing evidence-based policy decisions, curriculum reforms, and the strategic planning of professional development opportunities for teachers across Indonesia (Ruslin et al., 2022). Furthermore, the focus on this critical preliminary stage of instrument design addresses an often underreported yet fundamentally important aspect of large-scale educational research. The careful articulation of this design process not only ensures transparency and rigor for the current project but also provides a potentially transferable model for other researchers or educational bodies in contexts with similar challenges, particularly within developing nations seeking to enhance their educational systems through technology.

METHOD

The development of the initial survey and interview instruments for mapping Teacher Digital Competence (TDC) and Levels of Technology Implementation (LoTI) among Indonesian teachers was a systematic, multi-stage process, meticulously grounded in established theoretical frameworks and oriented towards contextual relevance. This foundational phase commenced with an extensive synthesis of pertinent academic literature, focusing on recognized international TDC frameworks, notably the European Framework for the Digital Competence of Educators (DigCompEdu) (Punie & Redecker, 2017) and the UNESCO ICT Competency Framework for Teachers (UNESCO, 2018), alongside Dr. Christopher Moersch's Levels of Technology Implementation (LoTI) model (Moersch, 1995; Moersch, 2002). The core activity involved the careful adaptation of these frameworks' dimensions and levels to create items for a quantitative survey, designed to measure teachers' self-assessed digital competencies and their reported levels of technology use in pedagogical practice. Concurrently, a semi-structured interview protocol was developed, drawing themes from the literature on technology integration

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challenges and enablers within the Indonesian educational setting (Nasrullah & Zainuddin, 2023; Sari et al., 2025), to facilitate qualitative exploration of the contextual factors influencing TDC and LoTI. This dual quantitative-qualitative instrument design ensures a comprehensive approach to data collection (Abstract). The entire process underscored an iterative refinement approach, with the explicit understanding that these initial instrument designs represent a critical preliminary step, requiring subsequent rigorous validation—including pilot testing and expert review, mirroring established psychometric procedures (Ruslin et al., 2022; Seferoğlu & Akbiyik, 2022)—before their deployment in the main mapping study to ensure the collection of reliable and valid data (Abstract). The deliberate strategy of "adaptation" rather than mere wholesale adoption of international frameworks was central, reflecting a commitment to ensuring the instruments are not only theoretically sound but also culturally and contextually sensitive to the unique Indonesian educational environment, thereby enhancing the potential validity and utility of the data to be collected. This commitment to a subsequent, thorough validation phase further underscores the research's adherence to scientific best practices, acknowledging the complexities of measuring latent constructs and aiming to produce robust and trustworthy tools for a study with significant policy implications.

RESULT AND DISCUSSION

The design of the survey and interview instruments was predicated on a careful selection and integration of conceptual foundations deemed critical for understanding teacher capacity in the digital age. The constructs of Teacher Digital Competence (TDC) and Levels of Technology Implementation (LoTI) were identified as pivotal variables (Abstract; Ryan & Power, 2024; Moersch, 2010). These frameworks are widely recognized in the educational technology literature for providing structured and empirically informed approaches to conceptualizing and measuring the diverse skills teachers need, as well as the extent and nature of their technology use in actual classroom settings (Ryan & Power, 2024). The importance of digital competence in teacher education has grown substantially, leading to the development of various frameworks aimed at guiding policy and practice (Ryan & Power, 2024). Similarly, the LoTI framework was initially conceived as a tool to help educational leaders quantify how teachers were using technology, thereby providing a basis for improvement (Moersch, 2010). The decision to incorporate both TDC and LoTI into the mapping study stems from an understanding that a comprehensive assessment of teacher readiness for technology integration requires looking at both their underlying competencies (their knowledge, skills, and attitudes towards technology) and their observable practices (how they actually implement technology in their teaching). A teacher might possess a high level of digital competence but face significant barriers to implementation, or conversely, might be using technology in a superficial manner without a deep pedagogical understanding. By assessing both dimensions, the study aims to provide a more holistic

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and diagnostically useful picture of teacher capacity, which can then inform more nuanced and effective interventions.

Design of the Teacher Digital Competence (TDC) Survey Component

The development of the TDC survey component involved a systematic operationalization of dimensions drawn from leading international frameworks, primarily the European Framework for the Digital Competence of Educators (DigCompEdu) (Punie & Redecker, 2017) and the UNESCO ICT Competency Framework for Teachers (UNESCO, 2018). These frameworks were selected due to their comprehensive scope, international recognition, and relevance to defining the multifaceted nature of digital competence for educators (Seferoğlu & Akbiyik, 2022; Ryan & Power, 2024).

The DigCompEdu framework, for instance, offers a robust structure comprising six distinct areas of competence: Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence (Punie & Redecker, 2017; Ryan & Power, 2024). These areas collectively address the professional environment, educators' pedagogical practices with technology, and their role in developing students' digital skills (Punie & Redecker, 2017). In designing the survey, these areas were translated into specific sections or clusters of items. For example, items related to "Professional Engagement" were formulated to assess teachers' use of digital tools for organizational communication, professional collaboration with colleagues, and engagement in reflective practices and continuous professional development. Similarly, the "Teaching and Learning" domain informed items probing how teachers utilize digital technologies in instructional design, delivery, and interaction, while the "Assessment" area guided questions about using digital tools for various assessment strategies. The TDiCoS scale development, which also drew upon DigCompEdu, similarly identified core areas such as the learning-teaching process, selecting and using digital resources, and assessment, indicating a common understanding of essential competence domains derived from this framework (Seferoğlu & Akbiyik, 2022).

The UNESCO ICT Competency Framework for Teachers (ICT CFT) Version 3 provided another critical layer to the survey design, emphasizing six key aspects of a teacher's professional life: Understanding ICT in Education, Curriculum and Assessment, Pedagogy, Application of Digital Skills, Organisation and Administration, and Teacher Professional Learning (UNESCO, 2018). This framework further delineates 18 specific competencies distributed across these aspects and articulates three progressive levels of proficiency: Knowledge Acquisition, Knowledge Deepening, and Knowledge Creation (UNESCO, 2018). This structure was influential in ensuring the survey captured not only the breadth of digital competencies but also the depth of their application, from foundational awareness to innovative and transformative uses of technology. For example, items pertaining to the "Application of Digital Skills" might assess proficiency

with various digital tools, while those related to "Pedagogy" could explore how teachers leverage ICT to foster collaborative learning environments or develop students' higher-order thinking skills, with response options designed to reflect varying degrees of sophistication. The continued relevance of the UNESCO ICT CFT is underscored by its role as a foundational document for newer frameworks, such as UNESCO's AI competency framework for teachers (UNESCO, 2024).

The process of adapting these international frameworks for the Indonesian context was a critical consideration. It was understood that a mere translation of items would be insufficient (Nasrullah & Zainuddin, 2023; Sari et al., 2025). Instead, a more profound adaptation was undertaken, involving the contextual rephrasing of items, the inclusion of examples relevant to Indonesian educational settings, and potentially the prioritization of certain competencies that are particularly salient given Indonesia's unique challenges, such as skills related to using digital resources in areas with limited internet connectivity or managing technology in large and diverse classrooms (Nasrullah & Zainuddin, 2023; Sari et al., 2025). This careful adaptation aimed to enhance the ecological validity and relevance of the survey for Indonesian teachers, ensuring that the instrument accurately reflects their experiences and the contexts in which they work. Table 1 provides a schematic overview of how key dimensions from these TDC frameworks were mapped to the survey domains.

Table 1: Mapping of Teacher Digital Competence (TDC) Framework Dimensions to Survey Domains

TDC Framework	Key Dimension/Area from Framework	Corresponding Survey Domain/Section Title	Example Item Focus
DigCompEdu	1. Professional Engagement	Professional Collaboration & Development	Using digital tools for communication with colleagues; engaging in online professional learning communities.
DigCompEdu	2. Digital Resources	Selection & Creation of Digital Content	Finding, evaluating, creating, and sharing digital educational resources; awareness of copyright.
DigCompEdu	3. Teaching and Learning	Digital Pedagogy & Instruction	Integrating digital technologies into lesson planning and delivery; facilitating student interaction with ICT.

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DigCompEdu	4. Assessment	Digital Assessment Strategies	Using digital tools for formative and summative assessment; providing digital feedback.
DigCompEdu	5.Empowering Learners	Learner Accessibility & Differentiation	Using ICT to cater to diverse learner needs; promoting student autonomy and active learning with technology.
DigCompEdu	6. Facilitating Learners' Digital Competence	Developing Student Digital Skills	Teaching students about digital citizenship, online safety, and information literacy.
UNESCO ICT CFT	Understanding ICT in Education	ICT Policy & Ethical Awareness	Understanding national ICT policies in education; awareness of ethical and safety issues in ICT use.
UNESCO ICT CFT	Curriculum and Assessment	ICT in Curriculum & Assessment	Aligning ICT use with curriculum goals; using ICT for varied assessment methods.
UNESCO ICT CFT	Pedagogy	Innovative Pedagogies with ICT	Using ICT to support collaborative learning, problem-solving, and creative student work.
UNESCO ICT CFT	Application of Digital Skills	Digital Tool Proficiency	Competence in using various hardware, software, and digital applications for educational purposes.
UNESCO ICT CFT	Organisation and Administration	Classroom & Admin Management with ICT	Using ICT for classroom organization, communication with stakeholders, and administrative tasks.
UNESCO ICT CFT	Teacher Professional Learning	ICT for Professional Growth	Using ICT to access professional development resources and networks; reflecting on practice using digital tools.

This mapping, as illustrated in Table 1, ensured that the survey instrument was comprehensively grounded in established theoretical conceptualizations of teacher digital

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competence, while simultaneously being tailored to capture data relevant to the study's objectives within the Indonesian context (Nasrullah & Zainuddin, 2023; Sari et al., 2025).

Design of the Levels of Technology Implementation (LoTI) Survey Component

The survey component designed to assess the Levels of Technology Implementation (LoTI) drew directly from the foundational work of Dr. Christopher Moersch (1995). The LoTI framework provides a valuable hierarchical model for quantifying how teachers are using technology in their classrooms, offering a progression through distinct levels of integration (Ruslin et al., 2022; Moersch, 2010; Moersch, 2002; Moersch, 1995).1 Originally, this framework delineated seven levels, starting from Level 0 (Non-Use), and progressing through Level 1 (Awareness), Level 2 (Exploration), Level 3 (Infusion), Level 4a (Integration: Mechanical), Level 4b (Integration: Routine), Level 5 (Expansion), and culminating in Level 6 (Refinement) (Moersch, 1995; Moersch, 2002). Each level is characterized by specific teacher behaviors, instructional strategies, and student roles concerning technology use. For instance, at lower levels like 'Awareness' (Level 1), technology might be used sporadically by the teacher for basic tasks such as information dissemination, with student use focused on lower cognitive skill development.1 As teachers progress to higher levels, such as 'Integration: Routine' (Level 4b), technology becomes an integral tool, with students actively engaged in exploring real-world issues and solving authentic problems using digital resources, and the teacher comfortably facilitating an inquiry-based, learner-centered approach.1 The survey items were carefully constructed to elicit responses that would allow for an estimation of a teacher's predominant LoTI level. These items probed aspects such as the types of software and digital tools used, the nature of student engagement with technology, the alignment of technology use with curriculum goals, and the extent to which technology is employed to foster higher-order thinking and authentic learning experiences.

It is also important to acknowledge the evolution of the LoTI framework towards the "Levels of Teaching Innovation" (Moersch, 2010; Moersch, 1995). This revised perspective places a stronger emphasis on powerful learning and teaching, advocating for a shift from teacher-centered to learner-centered pedagogical approaches, and from lower levels of student cognition to higher levels such as synthesis and evaluation (Moersch, 2010). This broader conceptualization influenced the design of the LoTI survey items, encouraging a focus not just on the presence or frequency of tool use, but on the pedagogical quality and transformative potential of the technology integration practices being reported. The aim was to capture data reflecting innovative teaching methods facilitated by technology, rather than simply cataloging technology use. This approach moves beyond a simple audit of technology tools to an evaluation of how technology is contributing to more effective and engaging teaching practices, which is a far more meaningful indicator of successful integration. Table 2 outlines the operationalization of these LoTI levels within the survey instrument, detailing key characteristics and example indicators for each stage.

Table 2: Operationalization of Levels of Technology Implementation (LoTI) in the Survey Instrument

LoTI Level	**Key Characteristics of the Level (Adapted from Moersch)**	**Example Survey Item Indicators (Focus of questions)**
Level 0: Non-Use	No use of digital tools and resources in the classroom due to various barriers (e.g., lack of access, competing priorities, perception of inappropriateness).[1] Traditional instructional focus.	Questions about access to technology, reasons for non-use, types of non-digital instructional tools predominantly used.
Level 1: Awareness	Teacher uses technology for information dissemination (e.g., lectures, multimedia presentations). Student use, if any, focuses on lower cognitive skills and reinforcing content (e.g., drill and practice).[1]	Questions about teacher use of presentation software, student use of computers for basic exercises, focus on knowledge/comprehension.
Level 2: Exploration	Students use digital tools for extension or enrichment activities, often reinforcing lower cognitive skills. Teacher experiments with technology for specific tasks. Multimedia products may be created.[1]	Questions about student projects involving multimedia, use of specific software for content reinforcement, teacher comfort with exploring new tools.
Level 3: Infusion	Technology is integrated into the curriculum to support higher-order thinking (e.g., problem-solving, decision-making). Teacher facilitates student use of technology for in-depth content treatment.[1]	Questions about technology use for problem-based learning, student research using digital tools, teacher's role in guiding technology-enhanced inquiry.
Level 4a: Integration (Mechanical)	Students use digital tools to explore real-world issues and solve authentic problems, but teacher may face classroom management or support challenges. Reliance on pre-packaged materials or external help.[1]	Questions about student engagement in authentic tasks using ICT, challenges faced during implementation (e.g., internet delays, discipline), need for external support or resources.
Level 4b:	Students fully engaged in authentic	Questions about student-led inquiry using

Integration (Routine)	problem-solving using digital tools. Teacher comfortably promotes inquiry-based, learner-centered strategies. Emphasis on personal goal setting and self-monitoring.[1]	technology, teacher's comfort with learner-centered approaches, use of ICT for self-directed learning and real-world application of knowledge.
Level 5: Expansion	Students use digital tools for projects that extend beyond the classroom, often involving collaboration with outside experts or audiences. Teacher acts as a facilitator of complex, student-driven projects.[1]	Questions about student projects with external audiences, use of collaborative online tools, student autonomy in defining project scope and process using technology.
Level 6: Refinement	Technology use is seamless and intuitive, supporting sophisticated, student-generated inquiry. Students use complex digital tools commensurate with their advanced thinking and creative expression.[1]	Questions about student-initiated use of advanced digital tools, technology as an invisible support for complex thinking and innovation, teacher's role in fostering a highly sophisticated digital learning environment.

This structured approach, as detailed in Table 2, aims to provide a nuanced assessment of how deeply and effectively technology is woven into the pedagogical fabric of Indonesian classrooms (Moersch, 1995).

Design of the Qualitative Interview Protocol

The qualitative component of this study, embodied in a semi-structured interview protocol, was designed to provide depth and context to the quantitative data gathered through the surveys. Its primary purpose is to explore the multifaceted contextual factors that influence teachers' digital competence and their levels of technology implementation within the Indonesian educational system (Abstract; Nasrullah & Zainuddin, 2023; Sari et al., 2025). The interviews are intended to capture rich, narrative accounts of teachers' lived experiences, their perceptions of technology's role in education, the specific challenges they encounter, and the enabling or disabling factors prevalent in their school environments and local communities (Nasrullah & Zainuddin, 2023; Sari et al., 2025). The development of the interview guide was directly informed by existing literature on technology integration in Indonesia, which highlights recurrent themes such as infrastructural limitations, adequacy and accessibility of teacher training, institutional support, policy clarity, and socio-cultural influences (Nasrullah & Zainuddin, 2023; Sari et al., 2025). Furthermore, the TDC and LoTI frameworks themselves prompted lines of inquiry aimed at understanding the reasons behind particular competency profiles or implementation patterns revealed by the survey data.

The choice of a semi-structured interview format is crucial.[2] This approach provides a framework of core questions and themes to be covered with each participant, ensuring

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consistency and comparability of data across interviews. Simultaneously, it offers the flexibility necessary for the interviewer to probe deeper into interesting or unexpected responses, explore emergent themes, and adapt questions to the specific context and experiences of each individual teacher.[2] This adaptability is key to uncovering nuanced insights that might be missed by more rigid data collection methods. Following established best practices for qualitative interviewing, the protocol emphasizes the use of open-ended questions, designed to encourage teachers to share their perspectives and experiences in their own words, thereby yielding rich and detailed narrative data.[3] The interviewer's role, guided by principles of being knowledgeable, clear, gentle, and adept at steering the conversation while remaining critical and reflective, is also a key consideration for the successful implementation of this protocol.[3] The insights gained from these interviews are expected not only to identify barriers but also to potentially uncover innovative local practices and coping strategies that teachers have developed, offering valuable lessons for broader policy and professional development initiatives (Ruslin et al., 2022).

Table 3: Thematic Guide for Semi-Structured Interview Protocol

Key Theme	Link to TDC/LoTI	Example Probing Questions
1. Access to and Quality of Technological Infrastructure & Resources	Directly impacts LoTI (ability to implement) and opportunities to develop TDC (practice with tools).	- Could you describe the availability and reliability of computers, internet access, and software in your school/classroom? - What are the main challenges you face regarding access to or maintenance of digital technologies?
2. Professional Development & Support (Formal & Informal)	Crucial for developing all areas of TDC and progressing through LoTI levels.	- What kind of training or professional development have you received related to using technology in teaching? How effective was it? - What kind of support (technical, pedagogical) is available to you when you want to use technology or encounter problems?
3. Teachers' Pedagogical Beliefs, Attitudes, & Perceived Competence	Influences willingness to engage with TDC development and attempt higher LoTI levels. Self-efficacy is key.	- How do you see the role of technology in enhancing student learning in your subject area? - What are your biggest concerns or excitements about using more technology in your teaching? - How confident do you feel in your ability to integrate technology

		effectively?
4. Institutional Policies, Leadership, & School Culture	Can enable or constrain TDC development and LoTI through vision, resource allocation, and expectations.	- How does your school leadership encourage or support the use of technology in teaching? - Are there specific school policies or expectations regarding technology integration? - How would you describe the overall attitude towards technology use among your colleagues?
5. Curriculum & Assessment Demands	Influences the perceived need and opportunities for technology integration (LoTI) and the types of TDC prioritized.	- How do current curriculum requirements or assessment practices affect your ability or desire to use technology in your lessons? - Do you feel that using technology helps you meet curriculum goals more effectively?
6. Student Factors (e.g., digital literacy, access, engagement)	Can influence teacher choices regarding LoTI and the focus of TDC development (e.g., facilitating learners' digital competence).	- What are your students' general skill levels and access to technology outside of school? - How do students typically respond when you use technology in your lessons?
7. Challenges & Coping Strategies / Innovations	Provides insight into practical barriers and teacher agency in overcoming them, impacting both TDC and LoTI.	- What are the most significant challenges you've personally faced in trying to use technology in your teaching? - Can you share any successful strategies or innovations you've developed to overcome these challenges or integrate technology effectively?

This thematic guide, as shown in Table 3, is designed to ensure a comprehensive exploration of the contextual landscape influencing technology integration in Indonesian education (Ruslin et al., 2022).

A paramount consideration throughout the instrument design process was the imperative to ensure deep contextual relevance for the Indonesian educational setting. This commitment went significantly beyond simple linguistic translation of items derived from international frameworks (Nasrullah & Zainuddin, 2023; Sari et al., 2025; Rahmadani et al., 2022). It involved a nuanced adaptation of constructs, the careful selection of examples and scenarios that resonate with the daily realities of Indonesian

schools and teacher experiences, and the thoughtful phrasing of questions to align with local cultural nuances and pedagogical traditions. Recognizing the vast diversity within Indonesia—spanning urban and rural locales, schools with vastly different resource levels, and distinct regional characteristics—was central to this effort (Nasrullah & Zainuddin, 2023). The instruments were therefore designed with an inherent flexibility to capture these variations meaningfully, rather than imposing a uniform perspective. For instance, findings from specific regions like West Sumatra, which indicate particular challenges such as low teacher skills in designing digital learning materials (Rahmadani et al., 2022), highlight the need for instruments sensitive enough to detect such localized realities. The pervasive issues of "digital divides between regions" and "disparity in technology availability" (Nasrullah & Zainuddin, 2023) further underscore the necessity for tools that can function effectively and yield comparable data across these diverse conditions. This pursuit of contextual relevance is not a static achievement at the design stage but an ongoing commitment. The initial design has sought to build in this adaptability, which will be rigorously tested and refined during the subsequent pilot testing and validation phases, ensuring the instruments are truly fit for purpose across the Indonesian archipelago. The qualitative interview protocol, in particular, is structured to allow for the exploration of these diverse contexts in rich detail.

It is crucial to reiterate that the survey and interview instruments detailed in this paper represent initial, albeit carefully constructed, designs. As explicitly stated from the outset, these tools are "awaiting rigorous validation, which constitutes the next research step before the main mapping study proceeds to ensure reliable data collection" (Abstract; Ruslin et al., 2022; Seferoğlu & Akbiyik, 2022). This validation phase is an indispensable component of the research methodology and will be undertaken with meticulous attention to psychometric principles and qualitative research integrity. For the quantitative survey, this will involve pilot testing with a representative sample of Indonesian teachers, followed by comprehensive statistical analyses. These analyses will include Exploratory Factor Analysis (EFA) to examine the underlying factor structure of the TDC and LoTI scales, Confirmatory Factor Analysis (CFA) to test the fit of the proposed models, and the calculation of internal consistency reliability coefficients, such as Cronbach's Alpha, for each subscale (Seferoğlu & Akbiyik, 2022). This process mirrors the rigorous validation undertaken for other established educational measurement tools (Ruslin et al., 2022; Seferoğlu & Akbiyik, 2022). Concurrently, the qualitative interview protocol will also undergo pilot testing. Feedback from participating teachers and analysis of the pilot interview data will be used to refine question wording, ensure clarity and cultural appropriateness, and confirm the relevance of the thematic areas. Only after these rigorous validation procedures are completed, and any necessary modifications made, will the instruments be deemed ready for deployment in the main mapping study. This phased approach, emphasizing thorough validation, is fundamental to ensuring the scientific integrity of the research and the trustworthiness of the data that will ultimately

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inform policy and practice in Indonesian education.

CONCLUSION

This paper has detailed the foundational phase of a significant research endeavor: the systematic design of survey and interview instruments intended to map Teacher Digital Competence (TDC) and Levels of Technology Implementation (LoTI) among Indonesian teachers. The design process was meticulously grounded in established international frameworks, including DigCompEdu and the UNESCO ICT Competency Framework for Teachers for TDC, and Moersch's LoTI model. A core principle throughout this process was the careful adaptation of these frameworks to ensure deep relevance and sensitivity to the unique and diverse educational context of Indonesia. The resulting instruments aim to provide a nuanced, dual perspective, quantitatively measuring key competence dimensions and implementation levels while qualitatively exploring the rich tapestry of contextual factors that shape teachers' engagement with technology.

The primary contribution of this preliminary phase is the articulation of a systematic, context-aware design methodology for these essential diagnostic tools. This detailed methodological account serves as a transparent foundation for the subsequent stages of the research and offers a potentially valuable model for similar endeavors in other national contexts. The development of such robust, theoretically grounded, and contextually adapted instruments is a critical first step towards generating the empirical evidence needed to inform effective educational policies and interventions.

The principal limitation of the current work, inherent in its focus on the initial design phase, is that the described survey and interview instruments are, at this stage, unvalidated. They represent carefully constructed blueprints that now require rigorous empirical testing. Therefore, the immediate and crucial future direction is the comprehensive validation of these instruments. This will involve extensive pilot testing with Indonesian teachers, followed by appropriate statistical analyses for the survey component to establish its psychometric properties (reliability and validity), and thorough qualitative analysis of pilot interview data to refine the interview protocol.

Ultimately, the successful validation and subsequent deployment of these instruments in a national mapping study hold considerable promise for Indonesian education. The rich, granular data generated will be vital for informing the development of targeted teacher professional development programs, shaping evidence-based educational policies, and guiding the strategic allocation of resources. By fostering a deeper understanding of teachers' current digital capacities and the contexts in which they operate, this research aims to contribute significantly to empowering Indonesian educators to effectively leverage technology, thereby enhancing the quality of teaching and learning and supporting the nation's goals of educational improvement and equitable access for all students.

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