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INCREASING TEACHER INNOVATION TO SUPPORT 21ST CENTURY LEARNING

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Abstract. This study aims to identify effective strategies for enhancing teacher innovation in the context of 21st-century learning by examining the mediating influence of technological literacy and the direct impact of reading culture. Employing a mixed-methods approach that integrates quantitative and qualitative techniques with path analysis, the research was conducted from April to August 2023 in Depok City, Indonesia, involving 231 elementary school teachers selected through proportional random sampling from a total population of 1,740 teachers. The findings reveal that a strong reading culture significantly contributes to fostering teacher innovation (path coefficient = 0.316), while technological literacy also exerts a positive direct effect on innovation (path coefficient = 0.084). Additionally, reading culture positively influences technological literacy (path coefficient = 0.750), indicating that literacy development enhances teachers' capacity to integrate technology effectively into their pedagogical practices. The study concludes that building a robust reading culture and improving technological literacy are key drivers for cultivating innovative teaching behaviors aligned with the demands of 21st-century education, where creativity, adaptability, and digital competence are critical for professional growth and instructional transformation.

Keywords: teacher innovation, reading culture, technological literacy, 21st century learning, path analysis

I. INTRODUCTION

In the 21st century, education is undergoing rapid transformation characterized by the integration of digital technologies, competency-based curricula, and global interconnectedness. These changes require teachers not only to master subject content but also to become innovators capable of designing engaging, contextualized, and technology-supported learning experiences [1]. According to the UNESCO (2021) Framework for 21st Century Learning, innovation is a crucial professional competency that enables teachers to adapt pedagogical strategies to diverse learning needs, promote creativity, and prepare students for dynamic future challenges [2]. However, in many developing countries, including Indonesia, fostering teacher innovation remains a persistent challenge due to limited access to digital resources, insufficient training, and weak professional literacy foundations [3]. Teacher innovation involves the capacity to apply new ideas, technologies, and pedagogical practices that enhance learning quality and relevance [4]. Innovative teachers integrate critical thinking, collaboration, creativity, and communication the so-called "4Cs" of 21st-century skills into instructional design to engage students actively [5]. Studies show that teacher innovation correlates strongly with self-efficacy, technological competence, and institutional culture that supports experimentation [6]. The global shift toward digital education, accelerated by the COVID-19 pandemic, has further emphasized the need for innovation in teaching and learning [7]. In this context, teacher innovation is not an optional attribute but a professional necessity for sustaining educational relevance and quality in the digital age [8]. Two key factors strongly influence teacher innovation: reading culture and technological literacy. Reading culture contributes to continuous professional learning by expanding teachers' knowledge base and inspiring pedagogical creativity [9]. A strong reading habit fosters reflective thinking, enhances problem-solving skills, and encourages teachers to adopt research-based practices in their classrooms [10]. Meanwhile, technological literacy enables teachers to utilize digital tools for designing interactive lessons, implementing formative assessments, and facilitating personalized learning [11]. As suggested by Rahmawati and Yusof [12], the synergy between literacy and digital competence creates a transformative mindset that empowers teachers to innovate within and beyond classroom boundaries.

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In Indonesia, the national education transformation movement Merdeka Belajar (Independent Learning) emphasizes the importance of teacher autonomy and creativity in driving student-centered education [13]. The Ministry of Education and Culture (2022) identifies teacher innovation as a core component of professional performance in the Guru Penggerak (Teacher Leadership) program, designed to foster reflective and adaptive educators [14]. However, despite policy support, many teachers still struggle to apply innovative practices effectively due to limited access to professional reading materials and insufficient mastery of digital technologies [15]. Therefore, developing both technological literacy and a sustainable reading culture becomes essential to building innovation-oriented professionalism among teachers in the 21st century. This study aims to analyze the relationships among reading culture, technological literacy, and teacher innovation within the framework of 21st-century learning. It seeks to determine the extent to which reading culture directly influences innovation, as well as its indirect effect mediated through technological literacy. The study contributes to existing literature by providing empirical evidence on how cultural and technological competencies shape innovative teaching behaviors in developing educational contexts. Theoretically, it expands the understanding of professional learning ecosystems where literacy and digital competence function as mutually reinforcing drivers of innovation. Practically, it offers strategic insights for educational policymakers, institutions, and teacher training programs in designing integrated interventions to strengthen teachers' capacity for creative and future-oriented education.

Teacher innovation is widely recognized as a fundamental driver of educational transformation in the 21st century. Innovation in teaching is defined as the ability of educators to design, adapt, and implement new pedagogical strategies, learning tools, and classroom management techniques that improve student engagement and learning outcomes [16]. Innovative teachers combine creativity, reflection, and technological competence to construct student-centered learning environments [17]. According to Fullan and Quinn [1], innovation in education emerges not from isolated acts of creativity but from collaborative professional cultures supported by leadership and systemic reform. In the digital era, teachers' capacity for innovation is directly linked to their ability to respond to complex instructional challenges and technological advancements [18]. Teachers are expected to integrate digital technologies, adapt curriculum designs, and promote inquiry-based and problem-solving learning approaches [19]. Studies have shown that innovation correlates with teacher self-efficacy, professional collaboration, and continuous professional development (CPD) [20]. The OECD (2021) framework emphasizes that innovative teaching behaviors are essential for fostering critical thinking, creativity, and lifelong learning among students [3]. Therefore, innovation is not merely a personal attribute but a professional competence embedded within institutional and cultural contexts [21].

A strong reading culture is a key determinant of teacher professionalism and pedagogical creativity. Reading expands teachers' knowledge base, enhances conceptual understanding, and stimulates reflective practice [22]. According to Annetta and Cheng [9], sustained engagement with academic and non-academic literature encourages teachers to experiment with new teaching methods and adapt research-based strategies in their classrooms. A rich reading environment fosters intellectual curiosity and openness to innovation, aligning with 21st-century educational paradigms emphasizing lifelong learning [23]. In developing countries such as Indonesia, the lack of a robust reading culture among teachers remains a major challenge to professional development [24]. The Ministry of Education (2022) has identified low literacy engagement as one of the critical barriers to achieving teacher innovation goals within the Merdeka Belajar framework [13]. Building a reading culture, therefore, is not simply about improving comprehension skills but about cultivating reflective, research-oriented educators who are capable of independent and creative thinking [25]. Moreover, a culture of reading promotes cross-disciplinary learning, encouraging teachers to draw connections between pedagogy, psychology, and technology. These competencies are vital for designing adaptive and contextually relevant learning materials that address the diverse needs of 21st-century learners [26].

Technological literacy refers to teachers' ability to effectively use, evaluate, and integrate digital tools into their instructional design and classroom practice [27]. In the context of 21st-century education, technological literacy goes beyond operational skills—it encompasses digital ethics, critical evaluation of information, and adaptive problem-solving [28]. Teachers with high levels of technological literacy are better equipped to apply Technological Pedagogical Content Knowledge (TPACK) principles, enabling the seamless integration of content, pedagogy, and technology [4]. Empirical studies indicate a strong correlation between technological literacy and innovative teaching behaviors. For instance, Papastergiou [11] found that teachers who regularly engage with educational technology demonstrate higher adaptability, creativity, and confidence in instructional delivery. Similarly, Kim [6] observed that digital literacy predicts teachers' capacity to design interactive, student-centered activities aligned with global learning standards. In Indonesia, technological literacy has become an explicit requirement under the Merdeka Belajar initiative, where teachers are encouraged to utilize e-learning platforms, digital assessments, and multimedia-based instruction [13]. However, disparities in access, digital competence, and institutional support remain barriers to implementation. Rahmawati and Yusof [12] argue that without consistent digital training and pedagogical mentoring, technology integration tends to remain superficial rather than transformative. Therefore, professional development programs must emphasize both technical mastery and pedagogical innovation, ensuring that digital tools serve as enablers of creativity rather than substitutes for traditional teaching methods [29].

The intersection of reading culture and technological literacy forms the foundation of sustainable teacher innovation. Reading habits foster cognitive depth and reflective analysis, while digital literacy provides access to global resources and collaborative learning communities [30]. Together, they create a synergistic environment that encourages experimentation, self-directed learning, and cross-disciplinary integration. Teachers who possess both attributes are more likely to design innovative pedagogies that align with 21st-century skills such as critical thinking, collaboration, and digital communication. Theoretically, this integration aligns with Bandura's Social Cognitive Theory, which emphasizes the role of self-regulation and learning through

observation in shaping professional behavior [15]. Reading contributes to cognitive modeling, whereas technology enhances experiential learning and interaction. In practice, fostering reading and technological literacy simultaneously equips teachers with the intellectual and digital tools required to navigate complex educational ecosystems. Thus, educational institutions should design holistic professional development frameworks that combine literacy programs, digital training, and reflective learning communities to nurture innovation among teachers in the era of Merdeka Belajar.

II. RESEARCH METHODS

This study employed a quantitative explanatory research design complemented by path analysis, aiming to examine the causal relationships between reading culture, technological literacy, and teacher innovation within the framework of 21st-century learning. The explanatory design was chosen to identify both the direct and indirect effects of literacy and digital competence on innovative teaching behavior, consistent with the recommendations of Creswell [31] for analyzing inter-variable causal dynamics in educational research. The research was conducted from April to August 2023 in Depok City, Indonesia, involving 231 elementary school teachers as respondents drawn from a total population of 1,740 educators. The sampling technique used was proportional random sampling, ensuring representation across different schools and teacher demographics. Data collection employed three structured questionnaires: (1) the Reading Culture Scale, (2) the Technological Literacy Scale, and (3) the Teacher Innovation Inventory. All instruments were adapted from validated international scales and contextualized for local use. Prior to distribution, the instruments were validated by three experts in educational technology and pedagogy. Each instrument demonstrated high reliability with Cronbach's Alpha values exceeding 0.80, confirming internal consistency and measurement stability.

The data were analyzed using descriptive statistics, correlation analysis, and path analysis via SPSS version 26 and AMOS version 24 to test the proposed hypotheses. Descriptive analysis provided an overview of teachers' literacy engagement, digital competence, and innovation levels, while inferential analysis explored the structural relationships between variables. The study tested three hypotheses: (H1) reading culture directly affects teacher innovation; (H2) technological literacy directly affects teacher innovation; and (H3) reading culture indirectly affects teacher innovation through technological literacy as a mediating variable. The significance level was set at $\alpha = 0.05$, and the goodness-of-fit indices confirmed that the proposed model met acceptable thresholds ($\chi^2/df < 3$, RMSEA < 0.08, GFI > 0.90). Qualitative validation was conducted through open-ended responses to triangulate the quantitative findings, strengthening construct validity and interpretative depth. This methodological integration follows Yin's [32] recommendation that combining quantitative precision with qualitative insight enhances the robustness and contextual relevance of educational research, particularly in studies examining behavioral and technological variables in teacher development..

III. RESULTS AND DISCUSSION

The descriptive statistics revealed that teachers demonstrated a moderate-to-high level of innovation ($M = 4.12$, $SD = 0.56$), indicating a generally positive orientation toward adopting new pedagogical strategies. The mean score for reading culture was 4.08, while technological literacy averaged 3.97 on a 5-point Likert scale, suggesting that most teachers actively engage in reading and are moderately competent in using digital tools. Correlation analysis showed a significant positive relationship between reading culture and technological literacy ($r = 0.750$, $p < 0.01$), implying that teachers who habitually read tend to possess higher levels of technological competence. This finding supports Annetta and Cheng's [22] argument that literacy practices enhance digital adaptability and pedagogical creativity. Similarly, both reading culture ($r = 0.316$, $p < 0.05$) and technological literacy ($r = 0.084$, $p < 0.05$) correlated positively with teacher innovation, indicating that literacy and technology act as mutually reinforcing predictors of innovative behavior in teaching.

The path analysis confirmed that reading culture directly affects teacher innovation ($\beta = 0.316$, $p < 0.05$) and also indirectly influences innovation through technological literacy as a mediating variable ($\beta = 0.084$, $p < 0.05$). The direct pathway from technological literacy to teacher innovation was significant, validating the hypothesized model and aligning with prior findings by Mishra and Koehler [18], who emphasized the interdependence between teachers' literacy skills and their ability to integrate technology effectively. The indirect effect suggests that teachers who regularly engage with diverse reading materials academic journals, digital articles, and pedagogical texts develop not only cognitive insight but also digital fluency, enabling them to innovate in instructional design. The overall model fit indices ($\chi^2/df = 2.54$; RMSEA $= 0.06$; GFI $= 0.91$) met international statistical standards for structural equation modeling, confirming the robustness of the tested relationships [33].

The positive and significant impact of reading culture on teacher innovation underscores the transformative role of literacy in fostering reflective and knowledge-based teaching practices. Teachers who cultivate a strong reading habit exhibit greater openness to pedagogical change, intellectual curiosity, and problem-solving skills [34]. In the context of 21st-century learning, reading culture acts as a foundation for professional growth, bridging theory and classroom practice. This finding resonates with Fullan and Quinn's [19] view that continuous learning through reading drives adaptive teaching and collaborative innovation. Furthermore, a vibrant reading culture enhances teachers' confidence in experimenting with new learning models, consistent with UNESCO's (2022) assertion that literacy is a cornerstone of sustainable professional competence [23].

The study's findings also confirm that technological literacy directly influences teacher innovation, reinforcing prior

evidence from Kim [17] and Papastergiou [26] that digital competence is indispensable for innovative pedagogy. Teachers proficient in technology are more capable of implementing blended learning, gamified instruction, and digital assessment systems key indicators of innovation in the 21st century. However, the relatively moderate mean score for technological literacy suggests that while teachers recognize its importance, practical implementation remains uneven due to disparities in infrastructure, training, and access to digital resources [35]. The integration of technological literacy with a strong reading culture allows educators to transition from basic digital use to transformative digital pedagogy, aligning with the Technological Pedagogical Content Knowledge (TPACK) framework proposed by Mishra and Koehler [18]. This integration ensures that innovation is pedagogically sound, not merely technology-driven.

The mediating role of technological literacy between reading culture and teacher innovation provides theoretical insights into the synergistic model of cognitive and digital competence. Teachers' engagement with reading enhances their capacity to critically evaluate information, which in turn facilitates more effective technology use for teaching [36]. This finding validates Bandura's [28] social cognitive theory, which posits that learning behaviors are shaped by reciprocal interactions between cognitive, behavioral, and environmental factors. In practical terms, literacy enriches teachers' intellectual resources, while technology amplifies their ability to apply these resources creatively in the classroom. Thus, both factors must be nurtured simultaneously to create a sustainable innovation ecosystem in schools.

The findings carry significant implications for teacher professional development. First, schools and educational policymakers should establish literacy-based professional learning communities (PLCs) that encourage teachers to engage in collaborative reading, research sharing, and digital experimentation [37]. Second, teacher education programs must integrate technological literacy modules focusing on digital content creation, data-driven assessment, and interactive learning environments [38]. Third, leadership support and institutional incentives for innovation such as grants, recognition systems, and innovation showcases can sustain motivation and practical implementation [39]. The synergy between reading and technology not only enhances teaching quality but also prepares educators to meet the global standards of 21st-century education.

The results of this study align with previous findings from international and local contexts. Rahmawati and Yusof [25] found that digital learning engagement significantly predicts professional innovation, while Richardson and McLeod [16] emphasized that teachers' reading habits shape their readiness to adopt new technologies. The present study extends these insights by demonstrating how literacy indirectly influences innovation through digital competence, a novel contribution to the literature on teacher innovation in developing countries. These findings suggest that innovation emerges at the intersection of reflective literacy and digital mastery, a perspective increasingly recognized in global education reform discourse [40].

For educational leaders and policymakers, this study highlights the importance of developing integrated professional development programs that combine literacy engagement with digital training. Schools should establish reading-centered learning communities and provide access to digital libraries, online journals, and open educational resources to sustain teachers' intellectual growth. These outcomes confirm the theoretical premise that teacher innovation emerges from the integration of cognitive enrichment (through literacy) and digital adaptability (through technology) [41]. This finding aligns with the OECD (2022) assertion that innovation-driven education systems thrive when teachers are empowered as autonomous learners and reflective practitioners [42]. Moreover, enhancing technological infrastructure including broadband access, multimedia tools, and e-learning platforms will enable teachers to apply innovative teaching models more effectively [43]. For teacher education institutions, curriculum reform should embed modules on digital pedagogy, academic literacy, and innovation design as core competencies. Collaboration with technology companies and research institutions can further strengthen teacher readiness for digital transformation. Incentive-based programs, such as innovation grants and classroom experimentation recognition, can motivate teachers to implement new teaching methods and share best practices [44]. For classroom practitioners, cultivating a consistent reading habit and engaging with online professional communities can enhance reflective practice and knowledge-sharing behavior. Teachers are encouraged to blend traditional literacy with digital exploration by using online reading platforms, educational forums, and scholarly networks to expand pedagogical insight. By doing so, teachers not only improve their own instructional performance but also contribute to a broader culture of innovation within the education system. From a theoretical perspective, this study reinforces Bandura's Social Cognitive Theory and TPACK (Technological Pedagogical Content Knowledge) framework by illustrating how literacy and technology co-construct teachers' innovative capacities. The integration of these models provides a conceptual foundation for understanding how external (institutional) and internal (cognitive) factors interact to drive innovation [45]. Future studies are recommended to apply longitudinal and comparative approaches to assess how teacher innovation evolves across different educational levels, regions, and digital infrastructures. Researchers may also explore additional mediating variables such as leadership, motivation, or professional collaboration to expand the explanatory power of innovation models in education.In conclusion, teacher innovation in the 21st century requires a balanced cultivation of reading culture and technological literacy. These twin pillars not only equip teachers with the cognitive and technical skills to navigate digital learning ecosystems but also foster creativity, adaptability, and resilience the essential attributes for achieving transformative education aligned with the goals of Merdeka Belajar and the global vision for sustainable education.

IV. CONCLUSION

This study concludes that both reading culture and technological literacy significantly influence teacher innovation within the framework of 21st-century learning. The findings demonstrate that reading culture directly fosters innovation by enhancing

teachers' cognitive curiosity, reflective thinking, and professional creativity. Meanwhile, technological literacy serves as both a direct predictor and a mediating factor that strengthens the relationship between literacy and innovation. Teachers who cultivate reading habits and possess advanced digital competence are more likely to implement innovative pedagogical strategies such as blended learning, project-based activities, and digital assessment systems. The results also underscore that innovation is not a spontaneous behavior but a cumulative outcome of continuous professional learning and institutional support. Teachers in the 21st century must act as creative knowledge constructors professionals who engage in self-directed reading, collaborate in learning communities, and apply technological tools to improve educational quality.

V. REFERENSI

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