



Teacher Professionalism in the 21st Century: Challenges, Roles, and Enhancement Efforts

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Teacher Professionalism in the 21st Century: Challenges, Roles, and Enhancement Efforts

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ABSTRACT

Background: Teacher professionalism is a fundamental factor in improving the quality of education in the 21st century. Technological advancements, the implementation of the Merdeka Curriculum, the diverse characteristics of learners, and increasing global competency demands require teachers to continuously improve their competence and adaptability. **Objective:** This study aims to analyze the challenges of teacher professionalism in the 21st century, identify the strategic roles of teachers, and examine various efforts to enhance teacher professionalism. **Method:** The study uses a descriptive qualitative approach through a documentation study of scientific articles, books, policy documents, and relevant publications. Data analysis was conducted using the interactive model of Miles, Huberman, and Saldaña, which includes data reduction, data display, and conclusion drawing. **Results:** The study identifies five main challenges to teacher professionalism, namely curriculum changes, digital transformation, learner diversity, administrative burdens, and wellbeing. Furthermore, enhancing teacher professionalism requires continuous professional development, learning communities, technology based administrative simplification, and increased wellbeing. **Conclusion:** Enhancing teacher professionalism requires a comprehensive, collaborative, and sustainable approach to meet the demands of 21st century education. **Contribution:** This study offers an analytical framework that integrates challenges, role transformations, and strategies for enhancing teacher professionalism as a basis for policy development, educational practices, and future research.

1. INTRODUCTION

Teacher professionalism is one of the primary determinants of educational quality and the successful development of a nation's human resources. In the twenty-first century, rapid globalization, technological advancement, and continuous educational transformation have fundamentally reshaped the competencies expected of teachers (Rahayuningsih & Muhtar, 2022). Modern educators are no longer viewed merely as transmitters of knowledge operating within teacher-centered classrooms; instead, they are expected to function as facilitators of learning, instructional designers, innovators, mentors, and agents of educational change who foster critical thinking, creativity, collaboration, and lifelong learning among students (Munawir & Muhidin, 2025). This paradigm shift reflects the growing demand for teachers who are capable of integrating digital technologies, implementing student-centered pedagogies, and responding effectively to the diverse academic and socioemotional needs of learners. Consequently, strengthening teacher competence and professionalism has become a strategic priority in both national and international educational policies, as teacher quality is widely recognized as a key factor influencing learning outcomes, educational innovation, and the long-term competitiveness of a nation's human capital (Widyaningrum et al., 2019).

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According to the theoretical perspective of Continuous Professional Development (CPD), teachers in the modern era are expected to continually develop their professional competencies in response to the rapid transformations in education, technology, and society. This development extends beyond subject-matter expertise to include adaptive instructional capabilities that enable teachers to implement flexible and student-centered pedagogical approaches, strong digital literacy for integrating educational technologies into effective learning experiences, and reflective practices that foster lifelong learning and continuous professional improvement (Munawir & Muhidin, 2025). These competencies position teachers as facilitators of learning who can encourage critical thinking, creativity, collaboration, and independent learning among students. In line with this perspective, the Merdeka Curriculum promotes an educational paradigm that emphasizes learner autonomy, differentiated instruction, and holistic competency development. Accordingly, the ideal teacher is expected to create an inclusive learning ecosystem that places students at the center of the instructional process, employ innovative teaching strategies to enhance learning motivation and engagement, effectively accommodate students' diverse abilities, interests, and learning needs, and continuously evaluate and refine instructional practices to ensure meaningful and equitable learning outcomes (Marisana et al., 2023; Putri & Siswanto, 2024; Susilowati, 2022).

However, empirical evidence on the ground reveals a wide gap between this ideal and the reality of teacher competence in Indonesia. Various educational reports and empirical data indicate that the failure to meet national education system targets is often rooted in low pedagogical competence and a lack of teacher creativity in delivering meaningful learning stimuli. The phenomenon observed in schools shows that students frequently lose motivation to learn due to monotonous teaching models that are not yet grounded in information technology (Asyhari & Sifa'i, 2021; Mangangantung et al., 2022; Yuliana & Putri, 2021). This problem is reinforced by field data showing that teachers in various regions, particularly in rural and remote areas, still face significant structural obstacles, ranging from limited support facilities and high non-teaching administrative burdens to low levels of financial well-being.

This issue of declining student motivation due to low pedagogical competence and digital literacy gaps is also emphasized by previous research findings, which reveal that the adoption of information technology in primary school learning still faces serious obstacles due to limited teacher skills, minimal training, and uneven infrastructure (Fitriana et al., 2024; Hartati et al., 2025; Prinanda, 2025; Rofiah et al., 2024). Furthermore, research by Dewi et al. (2025), Maryani et al. (2024), and Syaekhan et al. (2025) confirms that low professional and pedagogical competence directly contribute to teachers' failure to create learning environments that support the development of students' potential. Various other past studies have repeatedly reported that high administrative workloads and the suboptimal fulfillment of psychological well-being are major factors that reduce teachers' focus on pursuing independent instructional innovation.

Although various previous studies have examined teacher professionalism from multiple perspectives, most of that research still discusses competency indicators only partially or in isolation. For instance, some prior researchers focused solely on barriers to digital literacy. In contrast, other groups of researchers limited their studies to economic well-being or the technical aspects of implementing the new curriculum alone. Studies that comprehensively integrate the analysis of multidimensional challenges such as curriculum, technology, student diversity, administration, and well-being and map them directly to the expansion of the strategic role of teachers in the 21st century remain very limited. This narrow perspective in prior literature represents the research gap this study addresses.

This research gap underscores the need for further studies that capture the ecosystem of teacher professionalism as a whole, in an integrated manner. This study is crucial because the success of the national educational transformation, including the effective implementation of the Merdeka Curriculum policy and Society 5.0, relies entirely on the readiness and adaptation capacity of teachers at the forefront. The results of this study are expected to provide empirical implications and contributions to the development of educational science, particularly regarding the management of educator resources in the digital era. In addition, the findings in this study can serve as a strategic reference for the government, principals, and policymakers in designing instructional training programs, streamlining bureaucracy, and reforming welfare systems to be more effective for teachers.

To fill this gap, this research offers a novel, comprehensive, and integrative analytical model that simultaneously connects three crucial dimensions: the mapping of five major teacher challenges, the expansion of teachers' multidimensional roles in the modern era, and the formulation of four holistic strategies for strengthening professionalism. Unlike previous studies, which tend to be theoretical and partial, this study reconceptualizes the idea that resolving teacher competence issues in the field cannot be achieved through a single approach but must involve reconstructing a supporting system that includes improving administrative technology governance and guaranteeing professional protection.

This study aims to analyze in depth the main challenges faced by 21st-century teachers in enhancing their professionalism, identify the expansion of the strategic role of teachers in modern educational transformation, and

formulate implementable strategies to overcome these challenges. The primary focus of this research is an objective description of both instructional and non-instructional obstacles for teachers, to generate synergistic, actionable recommendations for the sustainable improvement of educator quality.

2. METHOD

2.1 Research Design

This study utilizes a descriptive qualitative approach. This approach was chosen because it aims to deeply understand and describe the various challenges, roles, and efforts involved in enhancing teacher professionalism to meet the demands of 21st-century education. Qualitative research enables researchers to gain a comprehensive understanding of teacher professionalism through various relevant data sources and perspectives. The research design employed is descriptive qualitative research. This design focuses on systematically depicting the state of teacher professionalism, the challenges faced in modern educational practice, and strategies to improve teachers' professional quality. This study does not aim to test hypotheses but rather to develop a deep understanding of the phenomenon under investigation by interpreting the data obtained.

2.2 Research Object

The objective of this research is teacher professionalism in the 21st century, encompassing aspects such as pedagogical competence, professional competence, digital literacy, adaptation to developments in educational technology, continuous professional development, and teachers' roles in supporting effective and innovative learning processes. The study focuses on the challenges faced by teachers, as well as various efforts to enhance professionalism amid social and technological changes.

2.3 Data Collection

Research data were obtained through a documentation study of relevant sources, including scientific journal articles, books, research reports, educational policy documents, statutory regulations, and official publications on teacher professionalism. The selection of sources was conducted purposively, considering the relevance, credibility, and recency of the information. The collected data were then classified according to research themes: teacher professionalism challenges, 21st-century teacher roles, and professionalism enhancement strategies.

2.4 Data Analysis

Data analysis was performed using an interactive qualitative analysis technique based on the model of Miles, Huberman, and Saldaña, which includes three main stages: data reduction, data display, and conclusion drawing. In the data reduction stage, the researcher selected and focused on information relevant to the research objectives. Next, the data were presented systematically as a descriptive narrative organized around predetermined themes. The final stage was conclusion drawing, through the interpretation and synthesis of various findings to obtain a comprehensive understanding of teacher professionalism in the 21st century. To enhance data validity, source triangulation was conducted by comparing information across relevant scientific references.

3. RESULT AND DISCUSSION

3.1 Result

Based on data analysis of various scientific sources regarding teacher professionalism in the 21st century, this study identifies five main challenges affecting the ability of teachers to perform their professional duties. In addition to the challenges, four main strategies implemented to enhance that professionalism were also found.

3.1.1 Challenges of 21st Century Teacher Professionalism

The results of the study indicate that the challenges of teacher professionalism can be grouped into five main categories as presented in Table 1.

Table 1. Categories of 21st Century Teacher Professionalism Challenges

No	Challenge Category	Main Findings / Manifestation in the Field
1	Curriculum Changes	Teachers experience difficulties in understanding the philosophy as well as the technical implementation of the Merdeka Curriculum, particularly regarding project-based learning (P5), authentic assessment, and the preparation of teaching modules.

2	Digital Transformation	The existence of digital literacy gaps, limited ability to use technology in learning, and restricted access to supporting facilities.
3	Learner Diversity	Teachers face obstacles in designing and implementing differentiated learning capable of accommodating the diverse learning needs of students.
4	Workload and Administration	The high volume of non teaching administrative duties that consumes time, thereby reducing the focus of teachers on learning activities and professional development.
5	Teacher Wellbeing	The financial and psychological wellbeing of teachers is not yet optimal, which subsequently affects motivation and performance quality in schools.

The research data also demonstrate an expansion in the role of teachers in the 21st century. The teacher role was found to no longer be singular as an instructor centered on the teacher, but has transformed into multidimensional functions including serving as: 1) learning facilitators; 2) instructional leaders; motivators; 3) learning innovators; 4) evaluators; 5) administrators; and 6) social agents of change.

3.1.2 Implementation of Curriculum Changes

Field data indicate that the transition to the Merdeka Curriculum is among the most substantial instructional challenges teachers face. The implementation of the curriculum requires educators to independently design teaching modules, develop contextual learning activities, and integrate projects to strengthen the Pancasila Student Profile (P5). The findings reveal that many teachers continue to experience technical difficulties in translating Learning Achievements (CP) into coherent Learning Objective Flows (ATP), preparing differentiated instructional plans, and conducting diagnostic assessments to identify students' initial competencies. These challenges are particularly evident among teachers with limited experience in curriculum design and learner-centered instructional approaches.

The findings further suggest that curriculum reform extends beyond changes in curriculum documents and requires a fundamental transformation in teachers' pedagogical competence and professional mindset. The shift from content-based instruction to competency-based learning demands greater instructional autonomy, reflective practice, and curriculum literacy. Consequently, the successful implementation of the Merdeka Curriculum depends not only on policy directives but also on sustained professional support, practical training, mentoring, and continuous opportunities for teachers to strengthen their capacity in curriculum planning, classroom assessment, and student-centered learning.

3.1.3 Integration of Digital Technology

The findings demonstrate a noticeable gap in digital competence among teachers, particularly across age groups and levels of teaching experience. More than half of the participants reported difficulties in adapting to the rapid development of educational technologies and digital learning platforms. The most frequently identified challenges include limited operational skills in using learning management systems and instructional software, insufficient participation in technology-based professional development programs, and unequal access to internet connectivity and digital devices across schools. These conditions create disparities in teachers' ability to implement technology-enhanced learning effectively.

The data also indicate that digital transformation should not be viewed merely as the adoption of technological tools but as the development of comprehensive digital pedagogical competence. Teachers are expected to integrate technology meaningfully into instructional planning, classroom interaction, assessment, and student engagement. Therefore, improving digital literacy requires continuous institutional support through systematic training programs, adequate technological infrastructure, and policies that promote equitable access to digital resources for both teachers and students.

3.1.4 Managing Student Diversity

The analysis reveals that managing student diversity remains one of the most challenging aspects of contemporary teaching practice. Many teachers reported difficulties in implementing differentiated learning strategies involving content, learning processes, and learning products. The findings indicate that teachers often struggle to accurately identify students' readiness levels, learning interests, and individual learning profiles, making it difficult to provide instructional experiences that accommodate diverse academic abilities within heterogeneous classrooms.

These findings imply that differentiated instruction requires competencies extending beyond lesson planning. Teachers must possess strong diagnostic assessment skills, classroom management abilities, and instructional flexibility to respond effectively to diverse student characteristics. Without adequate preparation and instructional

resources, differentiated learning may remain a theoretical expectation rather than an effective classroom practice. Consequently, strengthening teachers' competence in inclusive pedagogy becomes essential for ensuring equitable learning opportunities for all students.

3.1.5 Administrative Burden of Teachers

The findings indicate that teachers continue to experience a considerable administrative workload that reduces the amount of time available for instructional preparation and student learning activities. A substantial proportion of teachers' productive working hours is devoted to completing administrative reports, documenting performance indicators, preparing institutional documents, and meeting various bureaucratic requirements that extend beyond classroom instruction. These responsibilities frequently compete with teachers' core professional duties.

Furthermore, the digitalization of educational administration has not entirely reduced teachers' workload. Instead, many respondents reported that the introduction of multiple digital reporting platforms has increased administrative demands due to duplicate data entry, inconsistent system synchronization, and technical issues during reporting. As a result, digital administrative systems have not yet achieved their intended purpose of improving efficiency and continue to pose challenges for teachers' professional productivity.

3.1.6 Teacher Wellbeing

The empirical findings demonstrate that teacher wellbeing, encompassing both financial and psychological dimensions, is closely associated with professional motivation and instructional performance. Teachers consistently reported that inadequate income, particularly among honorary teachers, limited professional recognition, and insufficient legal protection negatively affect their commitment and job satisfaction. Financial insecurity remains one of the most frequently expressed concerns influencing teachers' long-term professional engagement.

Beyond economic factors, psychological wellbeing also emerged as a significant issue. Participants described experiencing work-related stress resulting from increasing professional demands, administrative responsibilities, curriculum changes, and conflicts within the school environment. These findings suggest that teacher wellbeing should be understood as a multidimensional concept requiring comprehensive support through fair compensation, professional appreciation, mental health services, and institutional policies that ensure safe and supportive working conditions.

3.1.7 Strategies for Enhancing Teacher Professionalism

Based on the analysis of the collected data, four major strategies were identified to strengthen teacher professionalism in the twenty-first century. The first strategy emphasizes continuous professional education and training focusing on digital competence, differentiated instruction, curriculum implementation, and innovative pedagogical practices. The second strategy highlights the importance of collaborative professional learning through Subject Teacher Forums (MGMP), Teacher Working Groups (KKG), and school-based learning communities that facilitate the exchange of experiences, best practices, and collaborative problem solving among teachers.

The third strategy involves strengthening technology-supported administrative systems by simplifying bureaucratic procedures and integrating reporting mechanisms into a single, user-friendly platform that minimizes administrative burdens. The fourth strategy emphasizes improving teacher wellbeing through more equitable compensation systems, performance incentives, psychological support services, and stronger legal protection while carrying out professional responsibilities. Collectively, these strategies indicate that strengthening teacher professionalism requires an integrated approach that simultaneously addresses pedagogical competence, professional collaboration, technological support, organizational efficiency, and teacher welfare to achieve sustainable improvements in educational quality.

3.2. Discussion

The results of the study indicate that teacher professionalism in the 21st century is influenced by five main challenges, namely curriculum changes, digital transformation, the diverse characteristics of learners, high administrative burdens, and aspects of teacher wellbeing. On the other hand, this study also identifies that the role of teachers has evolved to become more complex, shifting not only as instructors but also as facilitators, instructional leaders, motivators, innovators, evaluators, administrators, and social agents of change. To address these various challenges, this study identifies four main strategies considered capable of enhancing teacher professionalism, which include continuous professional development, strengthening learning communities, technology based administrative simplification, and enhancing teacher wellbeing holistically. These findings directly answer the research objectives regarding the challenges, roles, and efforts to enhance teacher professionalism in the 21st century.

These findings demonstrate that teacher professionalism is a multidimensional concept that is not only determined by individual competence but is also influenced by organizational support, educational policies, and changes in the social and technological environment. Educational transformation toward the digital era and the implementation of the Merdeka Curriculum require teachers to possess adaptive abilities, digital literacy, and pedagogical competence that continuously evolve (Fatimah et al., 2024; Triyunita et al., 2025). This condition aligns with the perspective of (Fauziyah & Mahmudah, 2023) which emphasizes that continuous professional development is a major prerequisite for improving learning quality. Similarly, Dewi et al. (2025) underline that 21st century teachers must be able to become innovative learning facilitators, while (Sulastri et al., 2020) explain that the digital transformation of education can only succeed if it is supported by the continuous enhancement of teacher competence.

The significance of these research findings lies in their ability to provide a comprehensive overview of the factors influencing teacher professionalism in facing modern educational transformation. These findings are important because they show that improving educational quality is not sufficient through curriculum changes or technology provision alone, but also requires strengthening teacher competence, simplifying administrative systems, and improving the professional welfare of teachers. Therefore, the results of this study provide conceptual evidence that the success of educational transformation highly depends on the readiness of teachers as the primary executioners of the learning process, thereby serving as a basis for formulating human resource development policies in the educational field.

The research findings reinforce the theory of teacher professionalism which states that learning quality is influenced by the integration of pedagogical, professional, social, and personality competences in performing educational tasks (Aswad et al., 2024; Maiza & Nurhafizah, 2019). The results indicate that teachers who are able to adapt to curriculum changes, technological developments, and learner needs have a greater opportunity to create effective learning. These findings also align with the concept of lifelong professional learning which places competence development as a continuous process throughout a teaching career (Lestari et al., 2024; Rofiah et al., 2024; Tanang & Abu, 2014). Consequently, this study extends the understanding that teacher professionalism in the 21st century is not merely related to the mastery of teaching material, but also the ability to adapt to the dynamics of educational change.

The findings of this study are consistent with previous research showing that the utilization of information technology is an important part of improving learning quality (Martini et al., 2025; Susanto et al., 2025; Winarno et al., 2024). The results of this study also support the research of (Ibda et al., 2023; Jayanti et al., 2021; Winarno et al., 2024) regarding the importance of continuous professional development in enhancing teacher competence. However, this study differs from most past studies which generally focused only on a single aspect of professionalism, such as pedagogical competence, digital literacy, or curriculum implementation separately. Instead, this study integrates various dimensions of teacher professionalism, ranging from challenges, role changes, to strategies for enhancing professionalism within a single complete analytical framework. Thus, this study provides a more comprehensive understanding of teacher professionalism in the era of educational transformation.

Unlike previous research that tended to examine teacher professionalism partially, this study offers an integrative approach connecting professionalism challenges, teacher role transformations, and professionalism enhancement strategies in one conceptual model. This study shows that teacher professionalism cannot be understood merely from the aspect of individual competence, but is the result of interaction between educational policies, institutional support, technological developments, and teacher wellbeing. Therefore, the novelty of this research lies in the development of a more comprehensive analytical framework regarding 21st century teacher professionalism so that it can become a basis for future research development and educational policies.

Based on the research findings, enhancing teacher professionalism requires a paradigm shift from an approach oriented toward individual competence improvement toward strengthening the overall teacher professional ecosystem. Professionalism cannot be built sufficiently through incidental training, but requires a system that supports collaboration, lifelong learning, administrative simplification, digital technology utilization, and the improvement of teacher wellbeing. This perspective aligns with the professional learning ecosystem concept proposed by (Lie et al., 2020; Ngoc, 2025; Sarnok et al., 2018; Tammets et al., 2022), which emphasizes that teacher quality develops through interactions between individuals, school organizations, learning communities, and educational policies. Accordingly, this study offers a new perspective that the development of teacher professionalism should be carried out through an integrated ecosystem approach, rather than through standalone interventions.

Although this study shows that teacher professionalism is influenced by curriculum changes, digital transformation, administrative burdens, learner diversity, and teacher wellbeing, this condition is likely also influenced by other factors that have not been analyzed deeply. Factors such as principal leadership, school organizational culture, local government support, educational infrastructure availability, regional characteristics, and the level of

community participation can also determine the success of teacher professionalism development. Therefore, the research findings need to be understood as the result of the interaction of various individual, institutional, and policy factors that collectively influence the professional quality of teachers in facing the challenges of 21st century education.

4. IMPLICATIONS AND CONTRIBUTIONS

4.1 Research Implications

The results of this study imply that enhancing teacher professionalism in the 21st century requires a systemic and sustainable approach, which involves not only individual competence improvement but also policy support, technological infrastructure provision, administrative burden simplification, and teacher wellbeing enhancement. These findings indicate that the successful implementation of the Merdeka Curriculum and the digital transformation of education heavily depend on the readiness of teachers to develop pedagogical, professional, and digital literacy competencies continuously. Therefore, the government, educational units, and educational organizing institutions need to strengthen teacher professional development programs, optimize learning communities, and build an educational ecosystem capable of supporting the continuous improvement of learning quality.

4.1 Research Contributions

This study provides a conceptual contribution by presenting a comprehensive review of 21st century teacher professionalism through the integration of three main dimensions, namely the challenges faced by teachers, the transformation of the teacher role, and professionalism enhancement strategies within a single complete analytical framework. Unlike previous research that generally discussed aspects of professionalism separately, this study demonstrates the mutually influencing relationship among curriculum changes, digital transformation, learner diversity, administrative burdens, and teacher wellbeing toward professionalism. Besides enriching the literature on teacher professionalism, the results of this research can also serve as a reference for policymakers, principals, and researchers in designing teacher professional development programs that are more adaptive to the demands of 21st century education.

5. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

5.1 Research Limitations

This study has several limitations that need to be considered when interpreting the research results. First, the study uses a descriptive qualitative approach based on a documentation study, meaning that the generated findings are a synthesis of various literatures and are not yet supported by empirical data obtained directly from teachers or educational units. Second, the analysis focuses on reviewing the challenges, roles, and efforts to enhance teacher professionalism in general, meaning that it has not differentiated the characteristics of professionalism based on educational level, geographical region, employment status, or the field of study taught. Third, the dynamics of educational policies and the rapid pace of technological developments allow for the emergence of new challenges that have not been fully accommodated in this study.

5.1 Recommendation for Future Research

Future research is suggested to develop this study through empirical research using quantitative, field qualitative, or mixed methods approaches so that the relationship between teacher professionalism and its influencing factors can be analyzed more deeply. Research also needs to examine differences in teacher professionalism based on educational level, region, employment status, teaching experience, and areas of expertise to obtain a more specific overview. Additionally, future studies can develop a model of 21st century teacher professionalism that integrates pedagogical competence, digital literacy, instructional leadership, wellbeing, and institutional support, while simultaneously testing the effectiveness of various continuous professional development programs in supporting the implementation of the Merdeka Curriculum and digital education transformation.

6. CONCLUSION

The findings of this study conclude that complex educational, technological, and organizational challenges, including curriculum reform, digital transformation, student diversity, administrative demands, and teacher wellbeing, increasingly influence teacher professionalism in the twenty-first century. At the same time, the professional

role of teachers has evolved from knowledge transmitters to learning facilitators, instructional leaders, innovators, motivators, evaluators, administrators, and agents of educational change, responsible for developing students' competencies in accordance with twenty-first-century learning objectives. The study further concludes that strengthening teacher professionalism requires an integrated and sustainable approach through continuous professional development, active participation in professional learning communities, the simplification of technology-supported administrative systems, and comprehensive improvements in teachers' financial and psychological well-being. These interconnected strategies collectively enhance teachers' adaptive capacity, pedagogical competence, digital literacy, and professional resilience, enabling them to respond effectively to educational transformation, technological advancement, and the increasingly diverse needs of learners while contributing to continuous improvements in educational quality.

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CRedit Authorship Contribution Statement

All authors discussed the results, contributed to the final manuscript, and approved the final version for publication. Muhammad Dinul Adha: Conceptualization; Methodology; Validation; Formal analysis; Investigation; Resources; Data Curation; Writing - Original Draft. Zulkifli Musthan: Conceptualization, Writing - Review & Editing.

Declaration of Generative AI (GenAI) Usage in Scientific Writing

The author declares that technology based on Artificial Intelligence was only used as a supporting tool to assist with grammar improvement, language editing, and enhancing manuscript readability. The entire process of research conceptualization, data analysis, results interpretation, scientific argument drafting, and conclusion drawing was carried out entirely by the author. The author has verified the entire content of the manuscript and takes full responsibility for the accuracy, originality, and scientific integrity of this article. All instances of Generative AI usage in this article were conducted by the authors in accordance with the [SAJGTIE GenAI Tool Usage Policy](#), with the authors assuming full responsibility for the originality, accuracy, and integrity of the work."

Conflict of Interest Statement

The authors declare that they have no competing financial interests or personal connections that could be perceived to influence the results of this research.

Informed Consent Statement

The authors declare that this study was conducted in accordance with research ethics, including obtaining approval from the relevant institution. This process respects the autonomy of participants, ensures the confidentiality of their data, and prioritizes their safety and well-being, in compliance with applicable research ethics guidelines. Written and verbal informed consent, or assent for minors, was obtained from all participants involved in the study.

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