

Coastal Regions of Papua Students and Teachers' Responses of Educational Challenges in Generative AI Era

A Case Study

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Abstract: *This research investigates the integration of generative AI in the education system of Papua's coastal regions, highlighting both opportunities and challenges. Papua's remote and isolated geography has led to limited access to quality education due to infrastructure and teacher shortages. AI presents a transformative potential to address these challenges by improving educational quality, accessibility, and resource availability. This study investigates how AI tools can improve students' personalized learning, critical thinking, and independence while also supporting teachers with AI-assisted content development. Through qualitative methods such as interviews and focus groups with university students and teachers, the study examines perceptions of AI's role in overcoming geographical, technological, and cultural barriers. The research identifies practical benefits, including AI-powered language tools, virtual labs for STEM education, and climate change simulation tools, as well as challenges such as ethical considerations, digital infrastructure limitations, and the need for region-specific curricula. This study suggests three key strategies for future education: sustainable teacher professional development, curriculum localization, and AI integration into local content. These initiatives ensure educational relevance and foster innovation in culturally and ecologically unique environments. The research also calls for further exploration of rural inland areas and policy development.*

Keywords: coastal region, AI-based local content, teacher professional, lifelong learning.

Resumen: *Esta investigación examina la integración de la inteligencia artificial generativa en el sistema educativo de las regiones costeras de Papúa, destacando tanto las oportunidades como los desafíos. La geografía remota y aislada de Papúa ha provocado un acceso limitado a una educación de calidad debido a deficiencias en la infraestructura y a la escasez de docentes. La IA presenta un potencial transformador para enfrentar estos desafíos al mejorar la calidad educativa, la accesibilidad y la disponibilidad de recursos. Este estudio*

analiza cómo las herramientas de IA pueden mejorar el aprendizaje personalizado de los estudiantes, el pensamiento crítico y la autonomía, al mismo tiempo que apoyan a los docentes mediante el desarrollo de contenidos asistido por IA. A través de métodos cualitativos como entrevistas y grupos focales con estudiantes universitarios y docentes, el estudio examina las percepciones sobre el papel de la IA para superar las barreras geográficas, tecnológicas y culturales. La investigación identifica beneficios prácticos, incluidos herramientas lingüísticas impulsadas por IA, laboratorios virtuales para la educación en STEM y herramientas de simulación del cambio climático, así como desafíos como las consideraciones éticas, las limitaciones de la infraestructura digital y la necesidad de planes de estudio específicos para cada región. Este estudio sugiere tres estrategias clave para la educación futura: el desarrollo profesional sostenible de los docentes, la localización del currículo y la integración de la IA en los contenidos locales. Estas iniciativas garantizan la pertinencia educativa y fomentan la innovación en entornos cultural y ecológicamente únicos. La investigación también plantea la necesidad de una mayor exploración de las zonas rurales del interior y del desarrollo de políticas públicas.

Palabras clave: Región costera, contenido local basado en IA, profesional docente, aprendizaje a lo largo de la vida.

1. Introduction

Education serves as a means to enhance quality of life and economic status. Consequently, numerous individuals pursue higher education at the most advanced degree levels (Altbach et al., 2019), particularly in the context of the rapidly evolving technological era. This era has significant implications for the educational sector in both urban and rural areas, including the coastal regions of Papua, Indonesia. For instance, Butarbutar et al. (2023) asserted that online collaborative learning represents a novel flexible pedagogy for teaching English as a foreign language to students in universities in the rural areas of Papua. Similarly, Hasyim et al. (2024) posited that teachers' online teachers' readiness influences urban and suburban student outcomes.

The coastal region of Papua encompasses both Indonesia's Papua Province and Papua New Guinea and is characterized by a diverse array of cultures, languages, and ecosystems (Aini et al., 2023; Putra et al., 2024). These areas frequently serve as habitats for fishing communities and are associated with a rich biodiversity (Andradi-Brown et al., 2021; Sambrook et al., 2020). However, this region faces substantial challenges in terms of education (Hubert, 2023; Marmoah et al., 2021), caused by communities residing in relatively remote and isolated geographical locations (Beneite-Martí, 2022; Fiharsono et al., 2024; Parker & Sudibyo, 2024). The limitations in accessibility, infrastructure (Fauzi et al., 2019), and teacher availability (Ardiningtyas et al. 2023; Butarbutar et al. 2023; Nizar et al., 2024) have impeded efforts to provide quality education.

In addition, educational institutions in these areas are often under-resourced, and numerous students face obstacles (Tracey, 2024) in pursuing studies beyond basic levels. However, steady progress has been observed as governmental and non-governmental organizations strive to improve literacy rates and the educational infrastructure (Smith et al., 2023). Zaw et al. (2021) increased educators' capacity to improve students' reading proficiency by developing lesson plans and providing reading materials. Consequently, this study investigates educators' and students'

perceptions of artificial intelligence in education in this region. This investigation aimed to enhance teacher development and quality, thereby addressing educational disparities in the coastal region of Papua.

In accordance with study's objective, generative AI presents a promising opportunity to transform education in Papua's coastal regions. However, its successful implementation will depend on addressing technological challenges (Aruleba & Jere, 2022; Mali et al., 2023)), building capacity within educational institutions (Suratni et al., 2022), and developing appropriate policies and regulations. As these technologies continue to evolve, it will be crucial to monitor their impact and ensure that they are used to enhance, rather than replace, human interaction and creativity in the educational process.

Unfortunately, there is a paucity of comprehensive research on the educational challenges (Fauzi et al., 2019; Tracey et al., 2024) encountered in the southern coastal region of Papua. Furthermore, concerns have arisen regarding the adequacy of reports or certificates in assessing students' preparedness for globalization and engagement with generative AI technologies. Consequently, principals, teachers, and educational practitioners are expected to demonstrate appropriate responses to AI technology, including adaptability to current technological advancements, enhanced commitment to their roles as educators, adherence to temporal discipline for teaching and lesson preparation, and proactivity in enriching teaching resources, such as facilitating self-directed learning based on internet resources (Butarbutar et al., 2023; Lalitha & Sreeja, 2020; Tsai, 2020). Furthermore, this study addresses the call for papers from the Vietnam International Conference Committee concerning issues pertinent to Papua coastal areas.

Research conducted in the coastal region of Papua has revealed that educators encounter significant challenges in their pedagogical process. These issues were categorized into four primary domains: (1) educational quality; (2) accessibility to education; (3) insufficient awareness of education and technology; and (4) technological obstacles. Given these substantial concerns, this study aims to conduct a comprehensive investigation of the responses of teachers and students in southern Papua's coastal area to the introduction of AI.

The implementation of artificial intelligence in southern Papua's coastal education system not only addresses practical challenges, but also offers significant theoretical insights into the transformative potential of technology in education, particularly in diverse and underserved regions. The practical significance encompasses (a) enhanced educational quality, (b) improved accessibility, (c) awareness and technology integration, and (d) overcoming technological obstacles. From a theoretical perspective, this study contributes to the following: (i) the impact on pedagogical practices, (ii) socio-cultural implications, and (iii) innovation in educational research. This research endeavour sought to address the following research questions:

How do educators respond to educational challenges in the generative AI era?

How do students respond to educational challenges in the generative AI era?

What kinds of AI tools are suitable for education in Papua's coastal regions?

What strategies can Papuan coastal regions implement for the future of education?

A concise overview of the educational history of the coastal region of Papua

Addressing education in Papua presents significant challenges, particularly in developing individuals with robust characteristics and future competitiveness. The educational landscape in Papua has been shaped by a complex interplay of factors, including colonial influences, cultural heterogeneity (Ananta et al., 2016; Sanjaya et al., 2023), political shifts, and societal transformations. While Papua (Indonesia) and Papua New Guinea have followed distinct educational trajectories (Nerenberg, 2022.), they share common historical threads. These include the impact of missionary work, indigenous knowledge systems, and contemporary government policies on regional education. This section presents a concise overview of the educational history in Papua, spanning from the pre-colonial period to the contemporary era of artificial intelligence-generated content.

1. Pre-colonial Era: Indigenous Knowledge and Informal Education

Prior to Western influence, Papua's educational system was predominantly informal and embedded in community practices. Traditional Papuan societies disseminate knowledge through oral narratives, ceremonial events, and practical training in essential skills, such as hunting, fishing, agriculture, and artisanal crafts. Elderly people play a pivotal role as educators, imparting cultural principles, survival techniques, and indigenous wisdom. Each distinct ethnic group has developed its own methodologies for instructing vital life competencies, societal norms, and customary practices. For instance, in the coastal south of Papua, Merauke, the Marory tribe transmits its cultural heritage through traditional dances from the older generation to the younger generation. Moreover, for subsistence, parents accompany their sons to the forest for hunting and their daughters to the coast for fishing expeditions and to cultivate sago (Hastangka et al., 2024; Nggaruaka et al., 2019)

2. Colonial Era: Missionary Influence and Early Formal Education (19th - Early 20th Century)

Formal education in Papua commenced with the introduction of European missionaries in the 1800s. The Catholic Church and London Missionary Society (LMS) were pioneers in establishing educational institutions. Their primary objectives were to disseminate Christianity and impart fundamental literacy and practical skills. Schools founded by Christian missionaries are instrumental in establishing initial schools, particularly in the coastal regions (Derksen, 2020; Rizzo, 2004; Macdonald, 2023). The educational curriculum emphasizes religious instruction, elementary reading, writing, and mathematics (Matang, 2002), along with teachings on ethics and Western principles. Consequently, the education provided by missionaries often conflicts with local traditions and beliefs, resulting in a gradual decline in indigenous languages (Kik et al., 2021) and cultural practices. Nevertheless, it also provided Papuans with opportunities to acquire new knowledge and literacy.

3. Dutch Colonial Rule (Early to Mid-20th Century)

In Papua (Western New Guinea) under Dutch colonial administration, educational opportunities expanded but remained restricted and highly segregated (Beneite-Martí, 2022). The colonial authorities established educational institutions primarily

for urban and elite groups, while the vast majority of Papuans in rural areas had minimal or no access to formal schooling. The primary language of instruction was Dutch, creating a significant barrier for indigenous Papuans (Nakata, 2024). The curriculum was centered on Western concepts and aimed to cultivate a small group of elites for administrative positions within the colonial system (McNamee, 2020). Consequently, most Papuans were excluded from these educational opportunities, with only a select few students from privileged backgrounds or those associated with missionary families receiving formal education (Penders, 2021; Setiyawan & Maulida, 2024).

4. Post-Colonial Era: Integration with Indonesia and Educational Development (1960s-1990s)

Following Indonesia's incorporation of Western New Guinea (now known as Papua and West Papua provinces) in 1969, the government initiated efforts to integrate this area into its nationwide educational framework (Kluge, 2020). However, this method has several limitations. (1) Standardized curriculum: the adoption of Indonesian as the primary language of instruction created additional barriers for Papuans who spoke numerous indigenous languages (Warami, 2020). The centralized approach to education resulted in a uniform curriculum that often failed to consider local circumstances and requirements (Leba et al., 2021). (2) Logistical hurdles: Papua's mountainous terrain and the isolation of many communities present significant challenges in the construction of schools and the recruitment of educators. Despite these efforts, many areas have continued to lack adequate educational resources. (3) Subpar enrolment and literacy: Towards the end of the 20th century, Papua's educational participation and literacy rates were lower than in other Indonesian regions. Attempts to enhance accessibility have been impeded by practical, political, and economic challenges (Morin, 2018).

5. Contemporary Era: Decentralization, Challenges, and Progress (2000s-Present)

Over the past few decades, educational accessibility has improved in Papua provinces, although significant challenges remain. Indonesia implemented special autonomy legislation for Papua in the early 2000s, granting it increased local control over educational policies. The Indonesian government has augmented educational funding, established schools in remote areas, and initiated programs to address illiteracy. Nevertheless, the Papuan education system continues to face substantial issues including high dropout rates, inadequate infrastructure, teacher shortages, and linguistic barriers. A significant proportion of children, particularly in rural and highland regions, still lack access to quality education (Uspayanti et al., 2021).

6. Generative Era and Future Prospects

The advent of generative technology presents a significant transformative potential for education in Papua, particularly in isolated and underserved communities. The proliferation of digital infrastructure, including mobile devices and internet connectivity, has facilitated novel learning opportunities in remote areas (Butarbutar et al., 2021). Certain regions have already initiated the implementation of online educational programmes and digital resources, albeit encountering challenges related to infrastructure and connectivity (Butarbutar et al., 2024; Butarbutar, 2021; Butarbutar & Leba, 2023; Butarbutar et al., 2023). Simultaneously, there is increasing emphasis on the preservation of indigenous languages and knowledge systems, aligning with efforts to revitalize local cultures. Educational curricula are

progressively incorporating local cultural elements, historical content, and indigenous languages (Kik et al., 2021), to foster a more inclusive and culturally appropriate learning environment (Sokoy, 2022).

In conclusion, the history of education in Papua has been characterized by both advancements and persistent challenges. While early missionary and colonial endeavors introduced formal schooling, access to education has remained limited throughout Papua's history. Recent governmental initiatives have aimed to improve educational outcomes; however, significant disparities have persisted. In the contemporary era, technological advancements and innovative approaches offer the potential to address a region's unique challenges and foster a more equitable education system.

2. Research Method

Research design

For this investigation, we chose a case study approach for three reasons: (1) In-depth Understanding: The case study methodology facilitates a comprehensive examination of students' and teachers' responses to the unique educational challenges in the coastal regions of Papua. It is particularly efficacious in elucidating complex issues, such as the influence of generative AI technologies on education within a specific social and geographic context. (2) Context-specific insights: Education in the coastal regions of Papua presents distinct challenges related to geography, infrastructure, and cultural factors. Researchers can investigate these challenges in their natural setting through a case study, which provides context-specific insights not captured by broader research methodologies like surveys or experiments. (3) Exploring new phenomena: Given that the utilization of generative AI in education is a relatively recent development, especially in remote regions such as Papua, a case study allows for exploratory investigation.

Yin (2018) highlights the particular advantage of this methodology in generating insights and theories for testing in subsequent studies. Yin argued that case studies are ideal for investigating contemporary phenomena within real-life contexts, especially when the boundaries between the phenomenon and context are not clearly evident. This is particularly relevant to the integration of generative AI into education, wherein the local context of Papua plays a crucial role in shaping the impact and challenges faced by educators and students.

Participants' demography

The study employed purposive sampling to select participants who had direct educational experience in an artificial intelligence-driven environment. The study included five university students, aged 18–25 years. We presumed these students had comprehension and experience with AI technology in an educational context. Furthermore, we engaged ten teachers, ranging in age from approximately 30 to 40, for a more comprehensive investigation. Their average teaching experience ranged from five to ten years in coastal Papua. In this context, they understood the types of artificial intelligence technology suitable for this region in the future, taking into account students' sociocultural and environmental characteristics.

Technique for collecting data

We used a variety of qualitative data collection methods, including semi-structured interviews, focus group discussions, non-participant observations, and document analysis, to get full, detailed information on how students and teachers deal with problems in the age of generative AI in the classroom. This study utilized multiple qualitative data collection methods to investigate students' and teachers' responses to educational challenges in the generative AI era. We will conduct semi-structured interviews to understand their perceptions and experiences with AI tools and focus group discussions to explore the influence of AI on learning, critical thinking, and ethical considerations. We conducted classroom observations to evaluate the integration of AI tools into educational practices, focusing on learning outcomes, collaborative processes, and problem-solving strategies.

Data analysis

Furthermore, we analyzed the data using thematic analysis. This process involved employing coding to identify emerging themes, followed by axial coding to organize them into categories (e.g., benefits of AI in education, challenges of AI, ethical concerns, and future implications). Additionally, we utilized the ATLAS.ti 9 software, a qualitative analysis tool, to facilitate data analysis.

We specifically focused on (1) informed consent, obtaining written consent from all participants after fully informing them about the study's purpose and their right to withdraw at any time, in accordance with ethical considerations. (2) Confidentiality: we anonymized the participants' identities in all data reports and publications. (3) Cultural sensitivity: we took care to respect local customs, languages, and educational practices, given the specific context of Papua. The institutional review board of Musamus University provided approval to address these considerations.



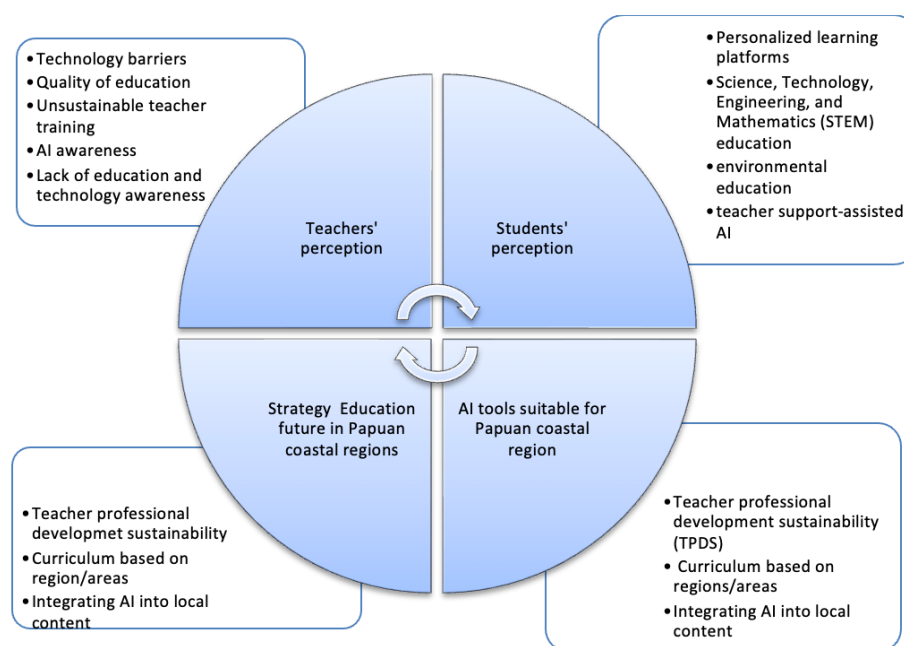


Figure 2.

In response to the second research question, students in the era of generative AI, specifically in the coastal region of Papua, addressed educational challenges by enhancing their adaptability, maintaining an equilibrium between AI tool utilization and individual effort, and refining their critical thinking skills. Although they benefit from AI personalization and accessibility, they encounter novel responsibilities. These include ensuring ethical AI implementation and preserving creativity and autonomy.

Adaptability to New Tools

“Adaptability to New Tools in the Coastal Regions of Papua” examines the distinctive challenges and opportunities that emerge from the implementation of artificial intelligence (AI) technologies in education. In these remote regions, limited access to digital infrastructure, linguistic barriers, and insufficient technological training impede the adoption of AI-driven tools. Nevertheless, with appropriate support, AI has the potential to transform learning by providing personalized educational resources, addressing deficiencies in teacher availability, and offering novel approaches to engaging students in geographically isolated areas. The successful adaptation of these tools necessitates concentrated efforts to enhance accessibility, provide comprehensive training, and incorporate local contexts into AI solutions.

Initially, the experience was overwhelming because of significant differences in learning methodologies. The integration of artificial intelligence (AI) tools, including virtual laboratories, AI-based tutoring systems, and AI-generated essays, suggests that technology-enhanced learning may be more effective than traditional pedagogical approaches. Over time, adaptations to these novel methods have led to an appreciation of how AI facilitates focused learning in areas of individual difficulty. (Student 1)

Access to Information and Resources

In the coastal region of Papua, students perceived the implementation of artificial intelligence as advantageous for accessing information and educational resources. The paucity of experienced educators in this area prompted learners to utilize artificial intelligence as a means of obtaining study materials. Moreover, the expeditious responses provided by artificial intelligence enhanced student engagement and facilitated a more effective learning experience.

One of the biggest challenges is not having enough resources or access to experts. But with generative AI, I can ask questions or get explanations whenever I need them, without having to wait for the teacher. AI even helps me practice language skills or perform virtual science experiments—things that would've been impossible without expensive equipment or native speakers around (Student 2)."

Critical Thinking and Problem Solving

Artificial intelligence (AI) has the potential to significantly enhance students' critical thinking skills through various mechanisms, serving as a tool for deeper engagement, analysis, and problem-solving. Project-based learning models can integrate AI to expose students to complex real-world scenarios that necessitate critical thinking for resolution. AI tools can provide prompts, suggest resources, or challenge assumptions, thereby assisting students in refining their problem-solving strategies as outlined below.

AI has made me think differently. Sometimes, AI provides answers, but it also encourages me to analyze and develop my solutions. For example, when I use AI to study environmental change data or write essays, it is up to us to interpret and make decisions based on the data. It helped me improve my critical thinking, which I think is more important than just memorizing facts (Student 3).

Increased Independence in Learning

In the coastal regions of Papua, artificial intelligence (AI) has the potential to enhance educational autonomy among students by facilitating access to personalized, adaptive learning tools (Swargiary, 2024) and mitigating barriers associated with geography, language, and infrastructure. This approach fosters increased independence, promotes continuous learning, and equips the local population with the requisite knowledge and skills to thrive in distinctive environments.

AI has helped me become more independent. I can study at my own pace, find solutions to problems without waiting for help, and explore the subjects that I am curious about. This is really empowering because it feels like I am more in control of my learning journey (Student 4).

The aforementioned excerpt suggests that students in the coastal region of Papua can engage in learning activities independently without external assistance. They affirmed that AI enhances confidence in active and autonomous learning. Additionally, one student observed that the absence of bullying in AI-assisted learning environments fostered learning confidence. Students do not experience apprehension regarding potential ridicule from their peers in response to their errors, a phenomenon commonly observed in traditional classroom settings.

In addressing the third research question, the investigation identified several artificial intelligence applications that are appropriate for students' needs in Papua's coastal region. This study proposes the following tools in response to the challenges identified by both educators and learners, as depicted in Figure 1.

The coastal regions of Papua present distinct educational challenges and opportunities that can be effectively addressed using specialized AI technologies. During structured interviews, educators and students identified several potential applications of these tailored AI tools to enhance their learning experience in these areas.

1. Personalized Learning Platforms

Each student exhibited distinct characteristics that facilitated the implementation of adaptive learning to support the students in the coastal regions of Papua. Artificial intelligence (AI) can tailor educational content and pedagogical approaches according to individual students' learning preferences and rates of progress, ensuring personalized education for all students. Furthermore, AI can significantly contribute to the language education of students in this region. AI-powered language learning tools can effectively impart instruction in Indonesian and other languages, particularly in remote areas where access to native speakers is limited. Technological innovation enhances the accessibility of language education and customizes it to meet the needs of diverse learners in Papua's coastal regions, as teacher perceptions follow.

I observed that individual students exhibited diverse learning preferences. Some demonstrate a propensity for auditory learning, whereas others favor visual or kinesthetic approaches. We have designed and adapted contemporary educational tools to accommodate these varied learning styles, ensuring that all students can effectively engage with the material (Teacher 1).

2. Science, Technology, Engineering, and Mathematics (STEM) Education

Geographically, the coastal region of Papua is a little far from a city or information-centered; it has limited infrastructure and budgets for schools. Therefore, the development of virtual laboratories is an urgent requirement. For this purpose, AI can create virtual laboratories for subjects such as biology, chemistry, and physics, allowing students to safely conduct experiments without expensive equipment. Teachers and students require AI-assisted data analysis. In this vein, AI can help students analyze environmental data related to coastal ecosystems, thereby promoting scientific literacy and critical thinking, as follows:

Geographical isolation from urban educational centers presents numerous challenges, particularly concerning resources. Limited infrastructure and budgets often pose significant obstacles. Consequently, the implementation of virtual laboratories is essential (Teacher 2).

In my opinion, virtual labs are relevant to the coastal region of Papua. Virtual laboratories are required for science students because artificial intelligence enables the creation of simulations for disciplines such as biology, chemistry, and physics. This technology allows students to conduct experiments in a safe environment without requiring costly physical equipment, which is often challenging to access (Student 5).

3. Environmental Education

The coastal region of Papua, which is in proximity to Australia, exhibited distinct weather patterns. Consequently, this region is highly susceptible to climate change. In response, educators and students engage in climate change simulation tools. These tools can model the effects of climate change on coastal ecosystems and facilitate students' understanding of the challenges and potential solutions. Furthermore, to enhance education in this region, the government, school leaders, educational training programs, and workshops require biodiversity monitoring applications. In this context, AI-powered tools can aid in monitoring biodiversity and identifying endangered species, thereby promoting environmental awareness and conservation efforts as outlined in the following excerpt.

Yeah owing to its geographical proximity to Australia, the coastal region of Papua experiences distinctive meteorological patterns that render it particularly susceptible to climate change. These patterns, in conjunction with sensitive ecosystems in the region, exacerbate the risk of adverse impacts, including sea-level rise, coastal erosion, and alterations in marine biodiversity. Therefore, the development of sophisticated climate change simulation tools is imperative. These tools provide a valuable methodology for modelling the effects of climate change on coastal ecosystems, facilitating students' comprehension of the potential consequences and exploration of viable solutions. Through the visualization of climate change impacts, students can cultivate a more profound understanding of the challenges confronting coastal communities (Teacher 5).

4. Teacher support assisted AI

Educators in the coastal region of Papua frequently encounter limitations in their teaching resources. Furthermore, a deficiency in teachers' professional development, particularly their technological proficiency, constitutes a critical prerequisite for the implementation of intelligent tutoring systems and curriculum development. By utilizing these tools, educators can enhance their technological capabilities to create more engaging and motivating content without relying on government intervention. Artificial intelligence has the potential to offer individualized instruction and feedback to students, thereby enabling teachers to concentrate on complex tasks. This technology can help create and customize curriculum materials tailored to the backgrounds and learning styles of coastal students.

As a rural primary school educator approaching retirement, I lacked proficiency in technology. When preparing instructional materials prior to the classroom sessions, I seek assistance from my children. Due to this significant limitation, I aspire to acquire knowledge of material-assisted AI (Teacher 10, a rural senior teacher).

To address the fourth research question, we analyzed three potential future-oriented educational programs: (1) teacher professional development that aligns with sustainability principles, (2) curriculum development specific to a region, and (3) the integration of artificial intelligence into local educational content.

Teacher professional development sustainability (TPDS)

Teacher professional development sustainability (TPDS) equips educators not only with current pedagogical methodologies but also with competencies to adapt to future educational technologies, including artificial intelligence. It facilitates continuous learning, peer collaboration, and the development of both pedagogical and technological proficiency. This strategy is essential for the credit system because of contextual challenges. Educators in the coastal regions of Papua frequently encounter geographical isolation, resource limitations, and a lack of consistent professional support. Ensuring continuous and sustainable professional development is crucial to overcoming these barriers.

Curriculum based on regions/areas

Coastal Papua exhibits distinctive cultural, ecological, and social characteristics that necessitate reflection on its educational framework. A region-specific curriculum can establish connections between students' learning and their life experiences, thereby enhancing the relevance and impact of education. Elders, local experts, and cultural custodians participate in curriculum development to ensure the preservation of indigenous knowledge and knowledge. These findings suggest that the most appropriate curriculum in this region is contextual project-based learning. This pedagogical approach encourages students to contextually address local challenges, such as sustainable fishing practices or the impacts of climate change on coastal areas, and has the potential to foster innovation and critical thinking skills. Artificial intelligence can facilitate this process by providing data analytics tools, simulations, and problem-solving platforms.

Integrating AI into local content

The integration of artificial intelligence (AI) into local content has become increasingly imperative in the Papuan coastal region because of its potential to facilitate the translation of educational materials into indigenous languages, customize learning experiences based on local requirements, and support the development of region-specific digital content. This approach would enable students to interact with culturally relevant materials in a contemporary interactive format. By utilizing AI to document traditional knowledge (e.g., maritime skills and local agriculture), students can acquire both traditional methodologies and modern techniques, ensuring their preparedness for future challenges while maintaining a connection to their cultural heritage. The incorporation of AI into local content will allow students to engage with cutting-edge technology while simultaneously interacting with traditional knowledge and localized learning resources. This integration will equip students to participate in the global workforce while concurrently ensuring the preservation and valorization of local cultures and practices.

4. Discussion

This research extensively examined the responses of students and teachers in Papua's coastal areas to educational challenges in the era of generative AI. Teachers

posit that the integration of AI into the educational system presents a significant potential for these regions, where factors such as geographical isolation (Yawan, 2022), inadequate infrastructure, and limited access to qualified instructors have hindered educational progress. In these locales, AI demonstrates the capacity to transform education by offering personalized, adaptable, and scalable learning methodologies.

Furthermore, our findings are pertinent to Serrano (2023), who posited that artificial intelligence enhances online learning modalities, which can be further augmented by adaptive learning and AI. He emphasized that both technologies facilitate personalized learning with respect to individual learning characteristics. Consequently, the students exhibited increased engagement in online educational pursuits. Regarding the educational challenges in the coastal region of Papua, our study strongly corroborates the findings of Al-Abdullah and Hassan's (2023) investigation, which demonstrated that introducing and implementing educational technology in the rural region has enhanced the quality of education. Their research confirms that the future adoption of digital technology in rural areas will promote educational advancement. Furthermore, digital technology serves to mitigate educational disparities in rural areas and constitutes a significant factor contributing to the success of educational technology initiatives in these regions.

This study suggests that how teachers feel about the introduction of AI in the coastal region of Papua is similar to what Parker and Sudibyo (2024) found about how family, social, and cultural economic problems affect the number of Indigenous Papuan students (OAP) who leave school early or drop out. This investigation contrasted with the government's policy of approximately twelve years of compulsory education for children. Nevertheless, in Merauke, a coastal region of Papua, a significant number of students prematurely discontinued their education (Parker & Sudibyo, 2024). The integration of AI into coastal region education faces challenges, including inconsistent teacher presence in classrooms, high costs associated with technological devices (Butarbutar et al., 2023), and living conditions of rural inland students.

The research findings, in conjunction with student feedback, suggest that the integration of artificial intelligence (AI) into Papua's coastal areas offers potential benefits and solutions to the challenges encountered in traditional classroom instruction within this region. Specifically, AI-facilitated independent or self-directed learning necessitates students' adaptation to novel educational technologies, such as ChatGPT, which enables enhanced access to academic resources. Similarly, this finding aligns with those presented by Gill et al. (2024), who posited that the ChatGPT exerts a substantial influence on the reconfiguration of contemporary education. Correspondingly, we recognize the necessity for educational transformation in Papua's coastal regions during this era of generative artificial intelligence.

Despite the substantial autonomy afforded by artificial intelligence in learning, students acknowledged that it occasionally compromised their academic integrity and ethical standards. They frequently encountered difficulties discerning factual information and fictional content. This lack of discernment contrasts with the findings of Niloy et al. (2024), whose literature review indicated that AI reinforces academic integrity. Their study also emphasized the significance of educational institutions in fostering students' academic conscientiousness and ethical conduct. To achieve this objective, they proposed a three-pronged approach, verifying the results using three distinct sources to ensure accuracy.

In addition, students perceive AI as a potential solution to persistent educational challenges in Papua's coastal region in the contemporary era. Moreover, AI

implementation in this area has contributed to the development of students' critical thinking skills. This evidence aligns with the findings of van den Berg and du Plessis (2023), who assert that AI contributes substantively to teacher education by facilitating lesson planning and fostering critical thinking. Furthermore, this study concurs with Essien et al. (2024), who empirically demonstrated that AI promotes critical thinking among students (Butarbutar et al., 2021), encouraging them to evaluate and verify information obtained from AI text generators such as ChatGPT. Students in rural areas possess substantial empirical data and information about their local environment. Consequently, not all the information provided by this technology is accepted without scrutiny, necessitating a triangulation approach for validation (Niloy et al., 2024). Furthermore, our findings align with those of Aithal and Aithal (2023), who posited that AI represents a prospective learning tool specific to the educational context.

In alignment with the potential of AI in future-oriented educational programs, our findings corroborate those of Abulibdeh et al. (2024), who concluded that the integration of AI into education holds promise for sustainable development. They further emphasized that AI has propelled academicians forward, enabling them to continue their growth, transformation, and navigation of the advantages and disadvantages of AI in educational domains. Consequently, the incorporation of AI into educational fields supports the concept of lifelong learning. Furthermore, this study corroborates the assertion by Wibowo et al. (2024) that the integration of local cultural elements into the materials curriculum serves as an effective instructional approach for Papuan students.

5. Conclusion

This study concluded that teachers' responses to educational challenges in the generative AI era can be categorized into five components: (1) technology barriers, (2) quality of education, (3) unsustainable teacher training programs, (4) AI awareness, and (5) lack of education and technology awareness. Consequently, this research affirms that AI tools are beneficial for education, particularly in areas such as adaptability to new tools, access to information and resources, critical thinking and problem solving, and increased independence in learning. In light of these findings, teachers and students in this region have proposed leveraging AI tools to enhance their learning experiences in the following areas: (a) personalized learning platforms; (b) Science, Technology, Engineering, and Mathematics (STEM) education; (c) environmental education; and (d) teacher support-assisted AI. Based on an analysis of challenges and opportunities for AI implementation in the coastal region of Papua, this study proposes three futuristic education strategies: teacher professional development sustainability (TPDS), a curriculum based on regions/areas, and integrating AI into local content (Sokoy, 2022).

However, this study acknowledged certain geographic constraints as limitations. Focusing on Papua's coastal areas may limit the generalizability of the results to other regions. The differential availability of AI tools in remote schools may have influenced their implementation in this area. Further research is required to address this issue. Furthermore, this research concentrated on the Merauke regency of the coastal region. Further studies should investigate rural inland areas with distinct sociocultural backgrounds and identities. Therefore, this research will inform policy recommendations for integrating AI into education, ensuring equitable access to technology, and addressing the ethical challenges unique to AI use in educational settings.

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