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Coastal Regions of Papua Students and Teachers' Responses of Educational Challenges in Generative AI Era: A Case Study

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Abstract: This study 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 because of infrastructure and teacher shortages. AI presents 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, this 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 the local content. These initiatives ensure educational relevance, and foster innovation in culturally and ecologically unique environments. This research also calls for further exploration of rural inland areas and policy development.

Keywords: Coastal Region Papua; AI-based Local Content; Teacher Professional; Rural School

1. Introduction

Education serves as a means to enhance the quality of life and economic status. Consequently, numerous individuals pursue higher education at the most advanced degree level [1], particularly in the context of the rapidly evolving technological era. This era has significant implications for the education sector in both urban and rural areas, including the coastal regions of Papua, Indonesia. For instance, Butarbutar et al. asserted that online collaborative learning represents a novel flexible pedagogy for teaching English as a foreign language to students in universities in rural areas of Papua [2]. Similarly, Hasyim et al. posited that online teachers' readiness influences urban and suburban student outcomes [3].

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 [4,5]. These areas frequently serve as habitats for fishing communities and are associated with a rich biodiversity [6,7]. However, this region faces substantial challenges in terms of education [8,9], caused by communities residing in relatively remote and isolated geographical locations [10–12]. Limitations in accessibility, infrastructure, and teacher availability have impeded efforts to provide quality education [13–15]. In addition, educational institutions in these areas are

often under-resourced and numerous students face obstacles in pursuing studies beyond basic levels [16]. However, steady progress has been observed as governmental and non-governmental organizations strive to improve literacy rates and educational infrastructure to increase educators' capacity to improve students' reading proficiency by developing lesson plans and providing reading material [17,18].

Consequently, this study investigated educators' and students' perceptions of artificial intelligence in education in this region. This study aimed to enhance teacher development and quality, thereby addressing educational disparities in the coastal region of Papua. In accordance with this study's objective, generative AI presents a promising opportunity to transform education in Papua's coastal regions. However, its successful implementation depends on addressing technological challenges [19,20], building capacity within educational institutions [21], and developing appropriate policies and regulations. As these technologies continue to evolve, it is 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 encountered in the southern coastal region of Papua [13,16]. 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 [22,23].

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 aimed 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) impact on pedagogical practices, (ii) socio-cultural implications, and (iii) innovation in educational research. This study sought to address the following research questions:

(1) How do educators respond to educational challenges in the generative AI era?
(2) How do students respond to educational challenges in the generative AI era?
(3) What types of AI tools are suitable for education in Papua's coastal regions?
(4) What strategies can Papuan coastal regions implement for the future of education?

1.1. A Concise Overview of the Educational History of the Coastal Region of Papua

Addressing education in Papua presents significant challenges, particularly for 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 [1,24], political shifts, and societal transformations. While Papua (Indonesia) and Papua New Guinea have followed distinct educational trajectories [25], they share common historical threads. These include the impacts of missionary work, indigenous knowledge systems, and contemporary government policies on regional education. This section presents a concise overview of the educational history of Papua, spanning from the pre-colonial period to the contemporary era of artificial intelligence-generated content.

1.1.1. Pre-Colonial Era: Indigenous Knowledge and Informal Education

Prior to the 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 by 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 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 [25,26].

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

Formal education in Papua began 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 to impart fundamental literacy and practical skills. Schools founded by Christian missionaries are instrumental in establishing initial schools, particularly in coastal regions [27–29]. The educational curriculum emphasizes religious instruction, elementary reading, writing, and mathematics [30], along with teaching 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 and cultural practices [31]. Nevertheless, it also provides Papuans with opportunities to acquire new knowledge and literacy.

1.1.3. 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 [10]. 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, which created a significant barrier to indigenous Papuans [32]. The curriculum was centered on Western concepts and aimed to cultivate a small group of elites for administrative positions within the colonial system [33]. Consequently, most Papuans were excluded from these educational opportunities, with only a few students from privileged backgrounds or those associated with missionary families receiving formal education [34,35].

1.1.4. 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 [36]. 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 [37]. The centralized approach to education resulted in a uniform curriculum that often failed to consider local circumstances and requirements [38,39]. (2) Logistical hurdles: Papua's mountainous terrain and the isolation of many communities present significant challenges in the construction of schools and recruitment of educators. Despite these efforts, many areas continue 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 those in other Indonesian regions. Attempts to enhance accessibility have been impeded by practical, political, and economic challenges [40].

1.1.5. Contemporary Era: Decentralization, Challenges, and Progress (2000s–Present)

Over the past few decades, educational accessibility has improved in Papua Province, although significant challenges remain. Indonesia implemented special autonomy legislation for Papua in the early 2000s, granting increased local control over educational policies. The Indonesian government has augmented educational funding, established schools in remote areas, and initiated programmes 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.

1.1.6. Generative Era and Future Prospects

The advent of generative technology presents 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 [41]. Certain regions have already initiated the implementation of online educational programs and digital resources, albeit encountering challenges related to infrastructure and connectivity [42–45]. 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 [31], to foster a more inclusive and culturally appropriate learning environment [32].

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 government initiatives have aimed to improve educational outcomes; however, significant disparities have persisted. In the contemporary era, technological advancements and innovative approaches have the potential to address a region's unique challenges and foster a more equitable education system.

2. Research Method

2.1. 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 Papua's coastal regions 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 that are not captured by broader research methodologies such as 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. Sokoy highlighted the particular advantage of this methodology in generating insights and theories for testing in subsequent studies [46]. 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 impacts and challenges faced by educators and students.

2.2. Participants' Demography

Purposive sampling was used to select participants with direct educational experience in an artificial-intelligence-driven environment. This study included five university students aged 18–25 years who were enrolled in the STEM Education Department. Among these students, three were female and two were male. It was assumed that these students possessed an understanding and experience of AI in an educational context. Additionally, ten teachers, aged approximately 30 to 40 years, were engaged in a more comprehensive investigation. These teachers also specialize in STEM education, with an average teaching experience ranging from five to ten years in coastal Papua. Among them, eight were female, while the remaining two were male. In this context, they understood the types of artificial intelligence technology suitable for this region in the future, considering students' sociocultural and environmental characteristics as well as the specific needs of English language education in the local setting.

2.3. 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 obtain 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, with a focus on learning outcomes, collaborative processes, and problem-solving strategies.

2.4. Data Analysis

In addition, we conducted thematic analysis to ensure rigorous and systematic examination of the data. The process began with open coding, during which we meticulously reviewed the data to identify initial patterns and recurring concepts. These codes were subsequently organized into emerging themes through axial coding, facilitating the categorization of patterns into broader categories such as the benefits of AI in education, challenges of AI, ethical concerns, and future implications. To enhance the validity and reliability, we employed peer debriefing and member checking. Peer debriefing involved engaging in discussions with fellow researchers to refine the theme construction and mitigate potential biases. Member checking was conducted by sharing preliminary findings with selected participants to confirm the accuracy and relevance of the identified themes.

Additionally, we used ATLAS.ti 9 software, a qualitative analysis tool, to facilitate data organization and coding and to ensure a comprehensive analytical process. Ethical considerations were prioritized throughout the study. Specifically, we focused on the following: Informed consent: Written consent was obtained from all participants after fully informing them about the study's purpose, procedures, and right to withdraw at any time. Confidentiality Participants' identities were anonymized in all data reports and publications to protect their privacy. Cultural sensitivity: respecting local customs, languages, and educational practices, considering the unique context of Papua. The institutional review board of Musamus University provided ethical approval to ensure compliance with research standards.

3. Results

To address this initial research question, this study examined educators' responses to pedagogical challenges in the generative artificial intelligence era. As shown in **Figure 1**, teachers identified several principal challenges. The most frequently cited obstacles included a shortage of qualified teachers (noted by eight out of ten educators), outdated curricula (reported by six educators), language barriers (mentioned by four educators), inconsistent teacher attendance (identified by five educators), and inadequate school infrastructure and facilities (highlighted by seven educators). These findings emphasize the pressing need for educational reform to facilitate an AI-driven learning environment, as illustrated in **Figure 1**.

In addition to pedagogical challenges, educators have identified several technology-related barriers that impede effective integration of AI into learning environments. As illustrated in **Figure 1**, a prominent issue is the lack of awareness and familiarity with AI tools, as reported by seven out of ten teachers. This indicates a significant gap in the knowledge regarding the potential applications of AI in education. Another major concern is the economic difficulty and high costs associated with technology, as noted by six educators. Many schools in coastal Papua face limited financial resources, which restrict access to AI-driven educational platforms. Relatedly, five respondents cited limited digital devices, highlighting how infrastructure constraints further complicate AI implementation. Furthermore, technological illiteracy was identified as a critical issue, with four educators expressing concerns about their ability to navigate AI-powered learning systems. This was compounded by the intermittent Internet connectivity noted by six respondents, which disrupts the stability of online AI-driven learning experiences. Finally, the lack of ICT training highlighted by eight educators underscores the urgent need for professional development programs to equip teachers with the skills necessary to effectively integrate AI tools into their teaching practices. These findings emphasize the importance of targeted interventions, such as digital literacy workshops and government-supported technology infrastructure improvements, to facilitate AI adoption in education.

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 also encounter novel responsibilities. These include ensuring ethical AI implementation and preserving creativity and autonomy.

Figure 1. Papuan coastal region educational challenges in generative AI.

3.1. 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 for engaging students in geographically isolated areas. The successful adaptation of these tools necessitates concentrated efforts to enhance accessibility, provide comprehensive training, and incorporate local context into AI solutions.

"Initially, the experience proved overwhelming owing to substantial differences in learning methodologies. Among the five students interviewed, four reported initial challenges in adapting to AI-based systems, reflecting their general sentiments regarding technological transition. The integration of AI tools, including virtual laboratories, AI-based tutoring systems, and AI-generated essays, was mentioned in 80% of student responses, indicating a strong perceived effectiveness compared to traditional pedagogical approaches. Over time, adaptation to these methods resulted in increased appreciation; specifically, three out of five students emphasized that AI-enabled learning allowed them to address individual difficulties more efficiently. This theme, termed 'AI facilitates individualized learning,' emerged frequently during the coding process, underscoring its significance in the study findings (Student 1)."

3.2. 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 has 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. However, 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)."

3.3. 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 require critical thinking. 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 AI is used 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 was more important than just memorizing facts" (Student 3).

3.4. 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 and mitigating barriers associated with geography, language, and infrastructure [34]. This approach fosters increased independence, promotes continuous learning, and equips local populations 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 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 independently engage in learning activities without external assistance. They affirmed that AI enhanced confidence in active and autonomous learning. Additionally, one student observed that the absence of bullying in AI-assisted learning environments fosters learning confidence. Students do not experience apprehension from their peers regarding potential ridicule 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 proposed 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 experiences in these areas.

3.5. 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 contribute significantly 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 designed and adapted contemporary educational tools to accommodate these varied learning styles, ensuring that all students could effectively engage with the materials (Teacher 1)".

3.6. 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 urgently required. For this purpose, AI can create virtual laboratories for subjects such as biology, chemistry, and physics, allowing students to conduct experiments safely without expensive equipment. Teachers and students require AI-assisted data analyses. 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 poses substantial challenges, particularly in terms of access to resources and infrastructure. As noted by Teacher 2, limited budgets and infrastructure constraints hinder opportunities for hands-on experimentation, thereby creating a gap in scientific education in coastal Papua. Virtual laboratories have emerged as viable solutions to this challenge. These virtual laboratories, powered by artificial intelligence, offer interactive simulations across various scientific disciplines including biology, chemistry, and physics.

According to Student 5, these AI-driven environments enable students to conduct experiments safely, obviating the need for costly physical equipment that may be unavailable in remote areas. Furthermore, virtual laboratories enhance accessibility by allowing students to engage with complex scientific concepts irrespective of their location. This technological intervention is particularly advantageous for regions with limited school facilities as it compensates for the absence of traditional laboratory infrastructure. Based on the coded responses, eight out of ten educators recognized the significance of AI-assisted virtual labs, underscoring the demand for technology-driven solutions in science education within isolated communities. These findings highlight the necessity for government and institutional support in developing AI-integrated learning tools to address geographical disparities and equip students with essential scientific skills."

3.7. 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.

Indeed, 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).

3.8. Teacher Support Assisted AI

Educators in the coastal region of Papua frequently encounter limitations in teaching resources. Furthermore, a deficiency in teachers' professional development, particularly their technological proficiency, is 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, I lack proficiency in technology. When preparing instructional materials prior to classroom sessions, I sought assistance from my children. Due to this significant limitation, I aspire to acquire knowledge of material-assisted AI (Teacher 10, rural senior teacher).

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

3.9. Teacher Professional Development Sustainability (TPDS)

Teacher professional development sustainability (TPDS) equips educators with not only current pedagogical methodologies but also competencies to adapt to future educational technologies, including artificial intelligence. It facilitates continuous learning, peer collaboration, and the development of both pedagogical and technological proficiencies. This strategy is essential for credit systems because of the 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.

3.10. 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 student learning and life experiences, thereby enhancing the relevance and impact of education. Elderly people, local experts, and cultural custodians participate in curriculum development to ensure the preservation of indigenous knowledge and knowledge. These findings suggest that contextual project-based learning is the most appropriate curriculum for this region. 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.

3.11. 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 study 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 inadequate infrastructure, and limited access to qualified instructors have hindered educational progress [47]. In these

locales, AI demonstrates the capacity to transform education by offering personalized, adaptable, and scalable learning methodologies.

Furthermore, our findings are pertinent to those by Swargiary [48], who posited that artificial intelligence enhances online learning modalities that can be further augmented by adaptive learning and AI. He emphasizes that both technologies facilitate personalized learning with respect to individual learning characteristics. Consequently, 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 Tracey et al. [49], which demonstrated that introducing and implementing educational technology in rural regions has enhanced the quality of education. Their research confirmed 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 that contributes 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 Aruleba found about how family, social, and cultural economic problems affect the number of Indigenous Papuan students (OAP) who leave school early or drop out [12]. This investigation contrasted with the government's policy of approximately 12 years of compulsory education for children. Nevertheless, in Merauke, a coastal region of Papua, a significant number of students prematurely discontinued their education [12]. The integration of AI into coastal region education faces challenges, including inconsistent teacher presence in classrooms, high costs associated with technological devices, and the 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. [24], 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 in discerning factual information and fictional content. This lack of discernment contrasts with the findings of Tracey et al. [49], 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 and verified 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. Implementation of AI in this area has contributed to the development of students' critical thinking skills. His evidence aligns with the findings of Tsai [50], who asserted that AI substantially contributes to teacher education by facilitating lesson planning and fostering critical thinking.

Furthermore, this study concurs with van den Berg and du Plessis [51], who empirically demonstrated that AI promotes critical thinking among students [52], 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 environments. Consequently, not all information provided by this technology is accepted without scrutiny, necessitating a triangulation approach for validation [53]. In this vein, our findings align with those of Yawan [54], who posited that AI is 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 Yin and Zaw et al. [55,56], 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 education supports the concept of lifelong learning. Furthermore, this study corroborates the assertion by researchers that the integration of local cultural elements into the materials curriculum serves as an effective instructional approach for Papuan students [57,58].

5. Conclusions

This study identified five key components that characterize teachers' responses to educational challenges in the era of generative AI: (1) technological barriers, (2) quality of education, (3) unsustainable teacher training programs, (4) AI awareness, and (5) lack of education and technology awareness. This research substantiates the assertion that AI tools are advantageous for education, particularly in enhancing adaptability to new tools, access to information and resources, critical thinking and problem-solving, and fostering increased independence in learning. In response to these findings, educators and students in this region have advocated for the utilization of AI tools to augment their learning experiences in the following domains: (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 the challenges and opportunities for AI implementation in the coastal region of Papua, this study proposes three forward-looking educational strategies: teacher professional development sustainability (TPDS), a curriculum tailored to specific regions/areas, and integration of AI into the local context. The limitations of this study include the small sample size, comprising only five students and ten teachers. Although the findings provide valuable insights, the limited number of participants may not fully capture the broader experiences and perspectives of educators and students across the coastal regions of Papua.

Future research should incorporate a larger and more diverse sample to enhance the generalizability of the results. Additionally, the exclusive focus on Papua coastal areas may limit the applicability of these findings to other regions. The availability and implementation of AI tools in remote schools may vary significantly, necessitating further investigation to better understand the regional disparities. A comparison with inland or urban Papuan areas would offer a valuable contrast. Differences in technological accessibility, educational infrastructure, and sociocultural influences can reveal unique challenges and opportunities for AI integration across various regions. Future studies should adopt a comparative approach to examine variations in AI adoption, ensuring more contextualized and inclusive policy recommendations for AI-driven education.

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Conflicts of Interest

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