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Readiness of the Public Junior High Schools in the Province of Albay Offering Robotics: An Assessment

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Abstract

This study assessed the readiness of public junior high schools in the Province of Albay to offer robotics education, focusing on institutional capacity, challenges, and opportunities within STEM implementation. Anchored on the Triangular Theory of Creativity (Sternberg, 2024), Multidimensional Digital Pedagogy Readiness Theory (Fatma, Fahmi, & Darmawan, 2025), Unified Theory of AI Adoption, and the ROBO GEAR UP framework (Llabore, 2026), the study employed a mixed method research design integrating quantitative and qualitative approaches. Data were collected through structured survey questionnaires and interviews from fifty-six (56) department heads and creative technology teachers across fourteen public junior high schools using total enumeration. Descriptive statistics, including weighted mean and percentage distribution, and thematic analysis were utilized. Findings revealed a significant disparity between funded and non-funded schools. Funded schools demonstrated moderate to high readiness across teachers, facilities, instructional materials, training, and financial resources, while non-funded schools were largely unready due to insufficient training, limited infrastructure, lack of standardized materials, and inadequate funding. Challenges were strongly evident in non-funded schools, whereas funded schools reported minimal constraints. Non-funded schools relied on adaptive strategies such as community support, improvisation, and use of free digital tools, though these approaches raised sustainability concerns. Despite these limitations, robotics education presented opportunities for enhancing technical skills, creativity, engagement, and career readiness. The study concludes that sustainable robotics integration requires alignment of institutional capacity, technical expertise, and financial support, and recommends institutionalized training, improved infrastructure, standardized materials, and sustainable funding mechanisms. The study aligns with SDG 4 (Quality Education), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 17 (Partnerships for the Goals), as it promotes equitable access to STEM education, innovation, and collaborative resource mobilization. It contributes to educational, socio-economic, and institutional sustainability by supporting inclusive STEM development, strengthening workforce readiness, and informing policy and program improvement in public schools.

Keywords: Educational Robotics, Financial Resources, Instructional Materials, Public Junior High Schools, Readiness, STEM Education, Teacher Readiness, Training

1. Introduction

Artificial intelligence (AI) and robotics have become transformative forces across education, industry, and society, enabling automation, improving efficiency, and enhancing learning processes. In education, particularly within STEM, robotics serves as a multidisciplinary tool that integrates engineering, programming, and critical thinking while fostering innovation and problem-solving skills. In the Philippine context, the integration of robotics aligns with national policies and global development goals but faces significant challenges related to resources, teacher preparedness, and implementation gaps. This study assesses the readiness of public junior high schools in the Province of Albay in offering robotics, focusing on institutional capacity, challenges, and opportunities to support sustainable and equitable STEM education.

1.1 Background of Robotics Education Readiness in Public Junior High Schools in Albay

Artificial intelligence (AI) has significantly influenced education, business, and technological advancement by enabling automation, improving processes, and supporting data-driven decision-making (Adam G. et al., 2022). Robotics, as an extension of AI, enhances human-robot interaction and supports precision, efficiency, and collaboration across industries (Terra, 2025). In education, robotics promotes computational thinking, problem-solving, and interdisciplinary learning within STEM frameworks (Atman Uslu et al., 2023). In the Philippines, educational reforms such as Republic Act No. 2067, Republic Act 10533, and RA 7796 emphasize scientific advancement, STEM integration, and technical-vocational training to prepare learners for global competitiveness. Programs like the Special Science Education (STE) and Creative Technology curriculum aim to develop technological proficiency and innovation skills among students (DepEd Order No.

55, s. 2010; K to 12 Curriculum Guide in Creative Technologies, 2017). Despite these initiatives, national assessments indicate that science and mathematics performance in the Philippines remains a concern (Paderna, E., et al. 2021). The integration of robotics is seen as a strategy to address this gap; however, challenges such as limited funding, lack of equipment, and insufficient teacher training persist.

1.2 Themes and Insights on Robotics Implementation Variables (Teachers, Facilities, Instructional Materials, Training, and Financial Resources)

Existing literature highlights robotics as an effective pedagogical tool that enhances student engagement, motivation, and learning outcomes across STEM disciplines (Erol, Onur, et al., 2023; Papadakis, Stamatios, et al., 2021). Robotics supports cognitive development through computational thinking, abstraction, and problem-solving (Aslanoglou, Kyriaki, et al., 2025; Cheung, Kelvin, et al., 2020). Studies emphasize the importance of teacher readiness, training, and pedagogical competence as key determinants of successful robotics integration (Atman, Nilufer, et al., 2023; Altinok, Hakan, 2022). Similarly, institutional factors such as facilities, instructional materials, and financial resources significantly influence program implementation (Kumari, Prerna, et al., 2023; Kumar, Sanjeev, et al., 2024). Research also underscores the benefits of robotics in fostering creativity, innovation, and interdisciplinary learning (Sun, Zhonghua, et al., 2022; Cevizci, Funda, 2022; Kim, ChanMin, et al., 2023). Moreover, robotics contributes to affective and social development, including collaboration, motivation, and self-efficacy (Gul, Yasin, et al., 2023; Yamani & Almazroa, 2024). However, literature also identifies persistent challenges, including high costs, lack of training, and unequal access, particularly in resource-constrained settings (UNESCO, 2023; Cho, Yong Ju, et al., 2023). Emerging solutions such as virtual robotics, open-source platforms, and community partnerships offer potential pathways to overcome these barriers.

1.3 Local, National, and Global Context of Robotics Education for Public Junior High Schools

Globally, robotics education is aligned with the development of 21st-century skills and technological innovation, contributing to workforce readiness and economic competitiveness (Yang, Guowei, 2021). In the Philippines, national policies promote STEM education and digital literacy to address workforce demands and bridge the digital divide (Albert, J. R. G. et al., 2023). At the local level, initiatives such as robotics programs in Camarin High School demonstrate efforts to implement low-cost and context-based robotics education (Galino et al., 2021). However, disparities remain across regions, particularly in provinces like Albay, where resource limitations and implementation challenges affect program sustainability. The adoption of robotics in education is further influenced by broader socio-economic and infrastructural factors, including funding gaps, teacher capacity, and access to technology, which vary across urban and rural contexts.

1.4 Theoretical and Conceptual Foundations of Robotics Readiness Assessment in Albay Public Junior High Schools

This study is anchored on the Triangular Theory of Creativity (Sternberg, 2024), which emphasizes creativity as a combination of skills, knowledge, and motivation, supporting innovation in robotics education. It is also grounded in the Multidimensional Digital Pedagogy Readiness Theory (Fatma, Fahmi, & Darmawan, 2025), which highlights cognitive, psychological, socio-ethical, and systemic dimensions of teacher readiness in digital learning environments. Additionally, the Unified Theory of AI Adoption explains the role of trust, usability, and human-machine interaction in adopting AI-driven technologies. These frameworks collectively support the assessment of readiness in terms of teacher competence, institutional capacity, and pedagogical practices. The study further adopts the ROBO GEAR UP (Robotics: Gauging Educational Adaptability Readiness and Unified Preparedness) framework (Llabore, 2026), which conceptualizes readiness as a multidimensional construct involving teachers, institutions, learners, challenges, and opportunities.

1.5 Research Gaps and Rationale on the Readiness of Public Junior High Schools in Albay Offering Robotics

Despite extensive research on robotics education, there remains a gap between policy and actual implementation, particularly in public schools with limited resources. Existing studies highlight the benefits of robotics but often focus on controlled or well-funded environments, leaving gaps in understanding readiness in resource-constrained settings. In the Philippine context, there is limited empirical evidence assessing the readiness of public junior high schools in offering robotics, particularly across variables such as teachers, facilities, instructional materials, training, and financial resources. Furthermore, there is a lack of localized studies examining challenges, strategies, and opportunities within provincial contexts like Albay. This study addresses these gaps by providing a comprehensive assessment of readiness and proposing an intervention plan to improve robotics education in public schools.

1.6 Alignment of Robotics Education Readiness in Albay with Relevant Sustainable Development Goals (SDGs)

This study aligns with several Sustainable Development Goals (SDGs): SDG 4 – Quality Education: Robotics education enhances STEM learning, digital literacy, and lifelong learning opportunities (Albert, J. R. G. et al., 2023; Yang, Guowei, 2021). SDG 9 – Industry, Innovation and Infrastructure: Integration of robotics supports innovation and technological advancement in education and industry. SDG 11 – Sustainable Cities and Communities: Equitable access to robotics education helps address urban-rural disparities and supports inclusive development. SDG 17 – Partnerships for the Goals: Collaboration among schools, government, and private sectors is essential for resource mobilization and program sustainability. These goals collectively emphasize the importance of accessible, innovative, and inclusive education systems supported by strong partnerships and infrastructure.

1.7 Importance of Robotics Readiness Assessment to Multidisciplinary Sustainability in Public Junior High Schools

This study contributes to educational sustainability by enhancing the quality and accessibility of STEM education through robotics integration. It supports socio-economic sustainability by preparing learners with skills relevant to the digital economy and future workforce demands. It also promotes technological sustainability by encouraging the adoption of innovative and adaptable learning tools, and community sustainability by addressing disparities in access to technology across different regions. Furthermore, the study contributes to policy and institutional sustainability by providing data-driven insights that can guide educational planning, resource allocation, and curriculum development. By proposing an intervention plan, the study supports long-term, scalable improvements in robotics education within public schools.

2. Material and methods

2.1 Research Design

The study utilized a mixed method research design combining quantitative and qualitative approaches to gather comprehensive data on robotics programs at the school level. Quantitative data were obtained through structured survey questionnaires using a Likert scale to measure respondents' perceptions, while qualitative data were collected through interviews to provide deeper insights and contextual understanding. The integration of these methods enabled a thorough evaluation of the readiness of public junior high schools offering robotics in the Province of Albay.

2.2 Locale of the Study

The study was conducted across the four Schools Division Offices in the Province of Albay, including Albay, Legazpi City, Ligao City, and Tabaco City. The selected schools were distributed across three districts, allowing for a comprehensive analysis of robotics program implementation in varying socio-economic and geographic contexts. These locations provided insights into differences in program delivery, resource availability, and institutional readiness across the province.

2.3 Respondents of the Study

The respondents consisted of department heads and creative technology teachers from public junior high schools offering robotics in the Province of Albay. The study covered fourteen schools implementing the Science, Technology, and Engineering (STE) curriculum with integrated robotics subjects. These institutions were distributed across the three districts of the province. A total of fifty-six (56) respondents participated in the study, representing both funded and non-funded schools to allow comparison of readiness levels.

2.4 Sample and Sampling Procedure

The study employed total enumeration, a non-probability sampling technique, to include all eligible participants within the target population. All department heads and teachers from public junior high schools offering robotics in the Province of Albay were included. This approach ensured complete representation of the population, eliminated sampling bias, and provided comprehensive insights into the readiness of schools in implementing robotics programs.

2.5 Research Instrument

The primary research instruments were a structured survey questionnaire and semi-structured interviews. The questionnaire was designed in alignment with the study objectives and included both closed-ended and open-ended questions. It covered four areas: school profile in terms of teachers, facilities, training, instructional materials, and financial resources; challenges in offering robotics; strategies employed by non-funded schools; and opportunities associated with robotics programs. The instrument underwent expert validation to ensure clarity and reliability prior to distribution.

2.6 Data Gathering Procedure

Data collection followed a structured and ethical process. Formal permission was obtained from the Schools Division Superintendents of Albay, Ligao City, Tabaco City, and Legazpi City, followed by coordination with school principals. Informed consent was secured from all respondents, ensuring awareness of the study's purpose, data use, and participant rights. Questionnaires were distributed and retrieved for validation, checking for completeness and consistency. Interviews were conducted simultaneously to supplement quantitative data with qualitative insights. All procedures adhered to data privacy and ethical standards, and collected data were subsequently compiled, reviewed, and prepared for analysis.

2.7 Data Analysis Techniques

The study employed both descriptive statistical analysis and qualitative analysis to address the research objectives. Weighted mean and percentage distribution were used to analyze the profile of schools in terms of teachers, facilities, instructional materials, training, and financial resources. A 4-point Likert scale was utilized to eliminate neutrality bias and encourage definitive responses, with a midpoint of 2.50 used to interpret positive or negative trends. Qualitative data from interviews were analyzed through categorization and thematic organization of responses to identify strategies and opportunities for non-funded schools. The integration of quantitative and qualitative findings provided a comprehensive understanding of robotics program readiness. The analysis was supported by frameworks emphasizing contextualized and culturally relevant STEM education, highlighting the importance of aligning robotics education with local realities (Anito, Morales, and Palisoc, 2020; Anikarnisia and Wilujeng, 2020). Additionally, the approach considered the role of holistic and technology-driven learning environments in enhancing student engagement and problem-solving skills (Ocaña, Jose Miguel, et al., 2023).

3. Results and Discussion

3.1 Readiness of Public Junior High Schools in Offering Robotics

3.1.1 Teacher Readiness

The results revealed a significant disparity between funded and non-funded schools in terms of teacher readiness. Funded schools achieved a moderately ready level with an average mean of 3.08, indicating adequate knowledge, training, and confidence in teaching robotics. In contrast, non-funded schools were generally not ready, with an average mean of 1.74. The lowest scores among non-funded schools were observed in recent training (1.55) and troubleshooting skills (1.70), indicating limited hands-on experience and insufficient professional development. This finding highlights a clear digital divide in teacher competence, where funding directly influences technical self-efficacy and readiness. The lack of sustained and adequate training aligns with Rodrigo, Maria Mercedes (2023), who identified insufficient teacher preparation as a primary bottleneck in robotics education. Similarly, the imbalance between pedagogical knowledge and technical fluency noted by Mane, Marian Serika B. (2025) supports the observed gap. The need for specialized AI literacy and advanced competencies further reinforces the argument of Guan et al. (2025) that teacher readiness must evolve beyond basic digital skills.

3.1.2 Facility Readiness

The findings showed that funded schools were moderately ready in terms of facilities with an average mean of 3.12, while non-funded schools remained not ready with a mean of 1.69. Non-funded schools reported critical deficiencies in laboratory space (1.51), availability of robotics kits (1.62), and budget allocation (1.71), although internet connectivity showed slightly better readiness (1.86). These results indicate that robotics readiness is constrained by physical infrastructure, particularly the lack of dedicated laboratories and sufficient hardware. This aligns with Navarro, Jocelyn C. (2022), who emphasized the shortage of specialized facilities in Philippine schools, and Khalil, Ahmad K., et al (2020), who highlighted the necessity of hands-on environments for effective robotics learning. The mismatch between digital capability and physical resources suggests that schools are better equipped for software-based learning than engineering applications, reinforcing the need for integrated infrastructure support.

3.1.3 Instructional Materials Readiness

The results indicated that funded schools were moderately ready with an average mean of 3.12, while non-funded schools were only slightly ready with a mean of 1.79. Scores in non-funded schools clustered between 1.72 and 1.88, reflecting consistent deficiencies in digital resources, structured materials, and assessment tools. This uniform low readiness suggests systemic gaps in pedagogical infrastructure rather than isolated issues. The findings support Petraki, Eleni, et al (2022), who emphasized the importance of structured instructional materials in robotics integration. Similarly, Naval, Reynaldo A. (2022) noted the lack of standardized curriculum in the Philippines, which aligns with the observed challenges. The reliance on non-standardized and improvised materials limits the development of higher-order thinking skills, as also discussed by Dela Cruz, Ruel J., et al (2024).

3.1.4 Training Readiness

The results showed a stark contrast between funded and non-funded schools. Funded schools were highly ready with an average mean of 3.80, demonstrating strong competency in both technical and pedagogical aspects. In contrast, non-funded schools were not ready, with an average mean of 1.63, particularly lacking in pedagogical strategies (1.55) and support systems (1.46). These findings indicate that structured and continuous training is essential for effective robotics education. The lack of ongoing support and professional learning communities reflects systemic limitations in training accessibility. This aligns with the argument of Baser, Kopcha, and Ozden (2021) on the importance of sustained mentorship, and Rodrigo, Maria Mercedes (2023) on the inadequacy of one-time training programs. The results further emphasize that training without practical exposure is ineffective, reinforcing the need for experiential learning.

3.1.5 Financial Resources Readiness

The results revealed that funded schools were highly ready with an average mean of 3.90, while non-funded schools were not ready with a mean of 1.62. Non-funded schools struggled significantly with purchasing equipment (1.62), maintenance (1.53), and accessing funds (1.55), although efforts to seek external funding were slightly higher (1.82). This demonstrates that financial capacity is the foundation of robotics program sustainability. The inability to maintain and replace equipment supports the findings of Corsby, Charles, et al (2020), who noted that lack of consumable funding leads to program failure. Similarly, Lee, Irene, et al. (2020) emphasized that high costs contribute to educational inequality. The results confirm that robotics education requires continuous financial investment rather than one-time funding.

3.2 Challenges Affecting Robotics Implementation

The results showed that non-funded schools strongly agreed that they faced major challenges across all variables, including teacher readiness (3.40), facilities (3.39), instructional materials (3.39), training (3.39), and financial resources (3.41). In contrast, funded schools consistently strongly disagreed, indicating minimal perceived challenges. These findings reveal a systemic inequity in robotics education, where resource availability determines program success. The lack of training, infrastructure, and financial support creates barriers that prevent effective implementation. This aligns with Negrini, Lucio (2020), who noted that technology remains underutilized without proper training, and Pan (2023), who highlighted gaps in teacher knowledge despite available tools. The findings also reinforce the concept that educational quality is directly linked to resource availability, emphasizing the need for holistic policy interventions.

3.3 Strategies Employed by Non-Funded Schools

The results indicated that non-funded schools rely on adaptive and resourceful strategies, including seeking support from parents, alumni, and local stakeholders, using personal funds, recycling materials, and integrating robotics into other subjects. Teachers also utilized free online tools, simulation platforms, and improvised materials to sustain instruction. These strategies demonstrate resilience and innovation despite limited resources. The use of low-cost and improvised materials reflects a maker-centered approach, while reliance on community support highlights a decentralized funding model. However, these approaches also reveal sustainability concerns, as dependence on personal and external resources is not scalable. The findings suggest that while resourcefulness can sustain programs temporarily, long-term success requires institutional support and structured funding systems.

3.4 Opportunities in Offering Robotics

The results showed that robotics offers significant opportunities for students, including skill development in programming, engineering, and problem-solving, as well as preparation for careers in technology-related fields. Participants also highlighted increased student engagement, creativity, and the development of a growth mindset through hands-on learning. These findings indicate that robotics education contributes to both technical and cognitive development, aligning with global demands for digital and STEM competencies. The emphasis on real-world problem-solving and community-oriented innovation suggests that robotics can serve as a tool for both academic and societal development. The results support the view that robotics education enhances human capital and prepares students for the evolving demands of the digital economy.

4. Conclusion & Recommendations

The study concludes that the readiness of public junior high schools in the Province of Albay to offer robotics is largely determined by a socio-technical divide rooted in funding availability, where funded schools demonstrate moderate to high readiness across teachers, facilities, instructional materials, training, and financial resources, while non-funded schools remain largely unready due to limited hands-on training, inadequate infrastructure, lack of standardized materials, and insufficient financial support. This disparity results in pedagogical improvisation and dependence on personal and external resources, preventing robotics from becoming a sustainable component of the STEM curriculum. The findings further establish that successful robotics integration requires a comprehensive alignment of institutional capacity, technical expertise, and financial sustainability, as framed by the ROBO GEAR UP Theory, while also highlighting the transformative opportunities of robotics in enhancing technical literacy, 21st-century skills, and student readiness for future careers when adequate support systems are in place.

The study recommends a shift toward institutionalized and sustainable support systems across all key areas, including strengthening teacher capacity through specialized and continuous training, improving facilities by converting existing ICT spaces into functional robotics laboratories with stable infrastructure, and standardizing instructional materials aligned with the K-12 framework. It further emphasizes the need to establish sustainable financial mechanisms such as recurring operational funds and legacy funding to eliminate reliance on personal contributions and ensure long-term program viability. For non-funded schools, strategic partnerships with stakeholders, use of simulation tools, and collaborative resource-sharing models are recommended to sustain robotics education despite resource constraints, while schools are encouraged to maximize opportunities through participation in competitions, community-based innovation, and integration of robotics into broader STEM learning to enhance student development and institutional growth.

The study is limited by the strong dependence of findings on funding-based comparisons, which may not fully capture other contextual factors influencing readiness such as variations in school leadership, community engagement, and regional conditions. Additionally, the reliance on existing institutional conditions highlights disparities but does not account for longitudinal changes in program development or the long-term effectiveness of proposed interventions. The findings are therefore bounded within the current socio-technical environment of the selected public junior high schools in Albay, and future research may further explore broader contextual variables and evolving educational conditions.

Compliance with ethical standards

The researcher adhered to established ethical procedures during data collection. Formal permission was obtained from the Schools Division Superintendents of Albay, Ligao City, Tabaco City, and Legazpi City, followed by coordination with school principals. All participants were provided with informed consent forms that clearly explained the purpose of the study, the use of data, and their rights as respondents. Data collection processes ensured confidentiality, accuracy, and compliance with data privacy standards throughout the study.

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