

Research Article

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Innovation and Digitalization Strategy in Technical Education: Assessment of an Ergonomic Universal Working Table for Optimized Instructional Performance

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Abstract

Background/purpose. The study responds to persistent ergonomic, spatial, and instructional challenges in technical-vocational education, particularly within TESDA-accredited programs such as Animation NC II, Illustration NC II, Technical Drafting NC II, and Visual Graphic Design NC III. Traditional tools used in these programs are often bulky, expensive, and poorly suited for flexible instructional delivery. This research aimed to develop and evaluate an innovative, cost-efficient, and ergonomically designed instructional table to enhance teaching and learning performance in technical education.

Materials/methods. Using a developmental research design guided by the ADDIE model, the study created the Notable Ergonomic Universal Working Table. The tool was evaluated by 30 purposively selected respondents—TESDA assessors, teachers, trainers, students, and industry practitioners—using structured quantitative instruments aligned with ISO/IEC 25010 quality standards. Data were analyzed using descriptive statistics.

Results. The table received high ratings in functionality ($M=3.74$), efficiency ($M=3.70$), usability ($M=3.74$), and maintainability ($M=3.75$), with instructional effectiveness rated at $M=3.89$ and competency alignment at $M=3.78$. Overall, the tool was rated highly effective ($M=3.76$) as a multi-functional, portable, and sustainable instructional asset. It significantly addressed limitations found in traditional equipment and supported compliance with TESDA standards.

Conclusion. The study concluded that the Notable Ergonomic Universal Working Table is a strategic educational innovation that enhances instructional delivery and training efficiency in technical education. Its design supports flexible, inclusive, and sustainable learning environments. The study recommends integrating smart technologies in future iterations to align with Industry 4.0 and Education 5.0 frameworks.



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1. Introduction

Now, in the time of Industry 4.0, the mix of new technology and smart school tools is very important for building a strong workforce. TESDA plays a vital role in enhancing Philippine education, focusing on tech-voc and middle-level training. TESDA handles 258 skill programs in 23 sectors, all made to give students skills that match industry needs. Some programs, such as Illustration NC II, Animation NC II, 3D Animation NC III, Visual Graphic Design NC III, Mechanical Drafting NC I, and Technical Drafting NC II, are used as standards in visual arts, ICT, engineering, and construction. These programs follow the TESDA Training Regulation (TR), which shows what skills are needed, how to teach them, and how to check if students are ready for work (TESDA, 2021).

The effective training of students in fields such as illustration, 3D animation, and graphic design necessitates the availability of specialized tools, including drawing tablets and lightboxes, alongside sufficient space for their use. However, considerable financial investment and spatial requirements pose significant challenges for educational institutions. Research indicates that access to adequate resources is crucial for effective learning in creative disciplines (Morales-García et al., 2024). Moreover, the rapid digitization of education has facilitated shared digital learning spaces, potentially alleviating some of the spatial constraints by integrating technology into design courses (Zhao & Gao, 2023). Therefore, innovative solutions are essential to address both the financial and spatial limitations these programs face, ensuring adequate training for students preparing for careers in creative fields.

The College of Industrial Technology (CIT) at Nueva Ecija University of Science and Technology (NEUST) aims to advance its status as a prominent educational institution by broadening its program offerings to align with the demands of Industry 4.0. This initiative includes introducing additional courses such as Technical Drafting NC II, Animation NC II, and Visual Graphic Design NC III. The integration of these programs reflects a commitment to bridging education with industry requirements, crucial for cultivating application-oriented technical skills in response to the evolving economic landscape. Recent research emphasizes that the development of an innovative and technically skilled workforce in vocational education necessitates robust cooperation between industry and educational institutions to meet modern market demands (Wei, 2024; Lu, 2023). By adopting innovative pedagogical approaches and fostering partnerships, NEUST aims to enhance its educational framework while contributing significantly to local and national development goals in education and workforce training.

In the BIT program (Bachelor of Industrial Technology), Innovative instructional tools are critically needed so that teaching and resources are both strong. This course focuses on animation, CAD, and visual arts – all needing strong and flexible tools. So, one researcher made a new smart table called the Notable Ergonomic Universal Working Table. This table is adjustable, easy to carry, and chargeable, with multiple uses. It combines many tools in one – computer table, drawing table, lightbox, and drafting board – but in a small size. It solves money and space problems and makes teaching better.

This table not only fixes technical issues, it helps schools and students grow in a digital way. It helps students focus, learn skills more effectively, and feel like they're doing real work. It's also a good plan for the long term – it can be used in many schools, is easy to bring, and saves costs. The goal is to make students ready for jobs, both local and abroad. With this table, trainers and students get a smart, cheap, and strong tool for learning. It boosts school strength, improves training, and helps the Philippines meet its goal for a strong tech-voc system and skilled workers.

2. Literature Review

2.1. *Technological Innovation and Its Transformative Impact*

Technological innovation has consistently driven strategic transformation across various sectors, including enterprise and education. Rooted in historical contexts such as the industrial revolutions, innovation bridges scientific advancements with practical applications, thereby influencing economic and social development significantly (Gu, 2023). Defined as the introduction of novel or enhanced products or processes characterized by distinctive technological features, innovation remains vital for competitive success (Chen, 2023). Specifically, enterprises play a pivotal role in fostering technological advancements, as acknowledged by scholars who assert that innovation enhances not only production capabilities but also overall economic growth (Luo et al., 2023). In the educational sphere, institutions are increasingly becoming centers for innovation, addressing modern economic demands while cultivating necessary skills in students to prepare them for future challenges (Yereshko et al., 2022). The nexus of technological innovation and education emerges as a critical pathway for achieving sustainable development and heightened competitive advantage in the global economy. Innovation is pivotal in integrating new technologies into production and consumption, facilitating the coordination of diverse resources to develop viable goods, services, and systems. In educational contexts, strategies like product development, ergonomic design, and smart system integration are prioritized to enhance learner outcomes and institutional efficiency. For instance, innovative educational environments exemplify how physical product development can align with contemporary instructional needs, embodying a shift towards innovation that meets the dynamic demands of education (Hugo et al., 2024). Such technological advancements not only serve as instruments for progress but also represent transformational paradigms in sectors such as education, engineering, and information and communication technology (ICT), where creative ideas evolve into tangible or intangible solutions (Jiang & Yan, 2023). As intellectual assets, innovations are further safeguarded by patent systems, which grant exclusive rights to inventors, promoting creativity and ensuring a competitive edge (Melgar et al., 2022). Thus, the strategic implementation of innovation within education is essential for cultivating an environment conducive to growth and adaptation in an ever-evolving economic landscape.

2.2. *Ergonomic and Functional Advancements*

An essential dimension of strategic product innovation involves the incorporation of ergonomic principles, which optimize human performance, safety, and comfort in diverse working environments. Features such as adjustability, convertibility, portability, and rechargeability have become critical success factors in the design of instructional and professional tools. Watkins (2017) introduced a height-adjustable table for both seated and standing work, advancing inclusivity in workspace environments. Zhu et al. (2016) engineered smart desks and chairs with automatic adjustment features to support user stability and adaptability. Salame and Abdallah (2020) demonstrated that ergonomic drafting tables alleviate physical stress and musculoskeletal strain, highlighting how ergonomic functionality directly correlates to productivity and long-term usability. Other design innovations also respond to collaborative and space-efficient needs. For instance, modular tables for dynamic learning environments (Richter et al., 2020) and convertible school furniture (Hutagalung, 2017) have proven strategically valuable in institutions with limited spatial resources. These ergonomic innovations are aligned with organizational strategies aimed at maximizing human capital performance while minimizing cost and space constraints.

2.3. *Innovations in Portability and Rechargeability*

The strategic integration of portability and rechargeable capabilities in product design reflects both environmental and functional considerations. Portability enables equipment to be repositioned

with minimal effort, enhancing spatial agility and operational flexibility. Tarmizi et al. (2019) introduced the i-Desk—featuring wheels and built-in USB ports—as a responsive innovation to modern classroom and workplace demands. Anvesh et al. (2020) likewise developed a foldable engineering drafter to improve portability and space conservation. On the other hand, rechargeable technology—particularly through lithium-ion battery systems—has revolutionized energy efficiency in electronics, appliances, and transport (Hayner et al., 2012). The development of dual-powered tools, such as rechargeable electric fans (Festus et al., 2017), represents the move toward sustainable and cost-effective resource use. In educational institutions, rechargeable systems reduce long-term utility costs and eliminate the need for fixed power infrastructure, enabling the decentralization and scalability of learning environments.

2.4. The Universal Working Table as an Innovative Solution

Synthesizing these strategic innovation dimensions, the notable ergonomic universal working table brings together key design principles—portability, adjustability, rechargeability, and convertibility—into a single, cost-effective, and functional instructional asset. The development model applied incorporates both TRIZ (Theory of Inventive Problem Solving) and Rogers’ Diffusion of Innovations Theory, ensuring that the innovation is both technically viable and responsive to end-user adoption behaviors (Kurt, 2018; Rogers, 2003; Ilevbare et al., 2013). By following the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), the innovation process strategically addressed institutional challenges observed in animation, drafting, and ICT training. The outcome is a multifunctional table that contributes to institutional strategies in resource allocation, learning space optimization, and competency-based instruction. This aligns with broader innovation strategies in educational governance—particularly in optimizing instructional capital to meet national certification standards set by TESDA and performance expectations of industry stakeholders (Cara, Gamit, & Santos, 2025). The universal working table thus serves as a scalable model for instructional innovation, advancing not only student learning outcomes but also institutional competitiveness and sustainability. Future enhancements may include digitization features or integration with smart learning platforms, further aligning it with corporate digital strategy, resource efficiency, and performance management frameworks.

While current ergonomic tools offer flexibility and health benefits, critiques point out that many such innovations remain costly or inaccessible to institutions with limited budgets (Zhou et al., 2018). Additionally, modular furniture often suffers from structural fragility, making long-term maintenance a concern (Park & Lee, 2019). These limitations highlight the importance of developing low-cost yet robust solutions such as the universal working table.

3. Methodology

3.1. Research Design

This study adopted a developmental research design to systematically conceptualize, build, and evaluate a strategic instructional product. Following the framework established by Richey (1994), the research focused on the creation of a Notable Ergonomic Universal Working Table that integrates functional and ergonomic features to support technical-vocational competencies in Animation, Drafting, and ICT. The product development was structured using the ADDIE instructional model, which includes phases for analysis, design, development, implementation, and evaluation (Kurt, 2018). This design approach allowed the researcher to not only develop a solution tailored to end-user needs but also ensure alignment with performance standards and institutional strategy.

3.2. Research Locale and Strategic Justification

The study was conducted in Nueva Ecija, one smart spot in Central Luzon, Philippines. This place was selected due to its numerous tech-voc activities, as well as the high level of engagement from

schools and community members. Also, many TESDA programs are already in that area, so it's a good place to test new tools and teaching ideas. This location helps the goal of the study – to make a solution for school problems and improve training, especially in provinces and rural areas where resources are not always enough.

3.3. Sampling and Participants

The researcher used purposive sampling to select participants with relevant expertise in technical drafting, animation, and instructional design. The sample included three key groups. First were industry and community-based practitioners such as animators, CAD operators, and visual graphic designers, who assessed the table's technological and ergonomic attributes using ISO/IEC 25010 standards. Second were teachers, trainers, and students actively engaged in technical-vocational education who evaluated the instructional usability of the table. Lastly, TESDA-accredited assessors were included for their deep understanding of competency standards under national training regulations, especially for Animation NC II, Illustration NC II, Technical Drafting NC II, and Visual Graphic Design NC III. The 30 participants were composed of 12 male and 18 female respondents, aged between 25 to 55 years old, with 3–20 years of experience in teaching or industry practice. This purposive sample ensured diverse yet relevant feedback for prototype evaluation. The number was deemed sufficient for a pilot developmental study, where detailed feedback rather than statistical generalizability was prioritized.

3.4. Instrumentation and Validation

Three sets of tailored evaluation tools were designed to gather data from each respondent group. The tools measured technological effectiveness (functionality, efficiency, usability, and maintainability), instructional usability, and compliance with competency standards. Each tool used a 4-point Likert scale structured as follows: 1 – Not Functional, 2 – Functional, 3 – Very Functional, 4 – Highly Functional. Field experts reviewed the instruments for face and content validity. Internal consistency was established through reliability testing using Cronbach's Alpha, which yielded a coefficient of 0.84, indicating strong internal reliability across items.

3.5. Developmental Procedure and Strategic Approach

Guided by the ADDIE model, the development of the working table began with an analysis of challenges associated with bulky, non-ergonomic, and expensive commercial equipment. These challenges were verified by feedback from teachers, trainers, and TESDA assessors. The design phase emphasized compactness, portability, rechargeability, and adjustability—features drawn from current ergonomic trends (Salameh & Abdallah, 2020; Zhu et al., 2016). CAD software (AutoCAD 2020) was used in designing the structural and electrical components of the table, ensuring precision and feasibility during fabrication.

In the development phase, materials were procured both locally and online. The researcher fabricated components such as an adjustable stand, tilting desk, and rechargeable lighting system. The table was constructed using common industrial materials (e.g., GI tubular sheets, acrylic, wood, lithium-ion batteries), and production timelines were closely managed to ensure project efficiency across all phases of the ADDIE model.

During implementation, the table was introduced to participants through demonstrations, either face-to-face or via video due to pandemic constraints. Respondents were guided in testing the product, simulating real-world use during instruction or assessment sessions.

The final evaluation phase involved the use of online Google Forms for data collection. Participants assessed the product based on their role, whether technological, instructional, or competency-based, ensuring multidimensional feedback. Due to COVID-19 restrictions, product

demonstrations were conducted both face-to-face and online via pre-recorded videos and synchronous Zoom sessions to ensure safe and accessible evaluation procedures.

3.6. Data Analysis

The quantitative data from all three respondent groups were analyzed using descriptive statistics, specifically frequency, percentage, and weighted mean scores. The ISO/IEC 25010 framework served as the basis for evaluating the product's technological quality, while instructional and competency assessments were aligned with TESDA Training Regulations. Responses were interpreted using standardized Likert scales with verbal interpretations such as "very functional" or "highly effective" to aid analysis.

3.7. Ethical Considerations

The study strictly complied with the provisions of the Data Privacy Act of 2012 (Privacy.gov.ph), ensuring the confidentiality and voluntary participation of all respondents. Informed consent was obtained digitally. Additionally, full credit was given to all sources through in-text and bibliographic citations, upholding ethical research and reporting standards.

4. Results

4.1. Identified Deficiencies in Traditional Training Equipment

The study engaged 30 respondents—comprising TESDA trainers, teachers, and assessors—to determine the common problems encountered in using traditional tools for Animation NC II, Illustration NC II, Technical Drafting NC II, and Visual Graphic Design NC III. Based on the aggregated responses 26% (13 out of 30) of respondents identified that traditional fluorescent-based light boxes consume significantly more power than LED alternatives. This is a crucial issue in the context of rising energy costs and sustainability goals. Following this, 18% (9 out of 30) pointed to the lack of adjustability in brightness as a critical shortfall, limiting learners' control over visual clarity—an essential factor in animation and drafting tasks. 16% (8 out of 30) expressed concern over the inflexibility of table legs, hindering ergonomic comfort, especially during long training hours. Furthermore, 14% (7 out of 30) identified both the fixed angle of inclination and oversized bulk of drafting tables and light boxes as obstructive in maximizing limited classroom space. Finally, 12% (6 out of 30) reported the stationary and immobile nature of traditional tools as a challenge in dynamic training environments. These findings underscore a gap in the training infrastructure, particularly the absence of customizable, portable, and energy-efficient equipment that meets the ergonomic and instructional needs of learners and assessors.

4.2. Quantitative Assessment of the Developed Universal Working Table

The Notable Ergonomic Universal Working Table was evaluated using structured instruments aligned with ISO/IEC 25010 quality standards. The assessment encompassed four key dimensions—Functionality, Efficiency, Usability, and Maintainability—yielding the following results:

- **Functionality:** $M = 3.74$, $SD = 0.21$ – Rated as Very Functional. High-performing features included the animation disc rotation mechanism ($M = 3.90$), which enhanced animation workflows, and the convertibility of the tabletop ($M = 3.75$), allowing transitions between multiple functions.
- **Efficiency:** $M = 3.70$, $SD = 0.24$ – Rated as Very Efficient. Respondents highlighted the device's cost-effectiveness and energy-efficient LED lighting system powered by a rechargeable lithium battery.
- **Usability:** $M = 3.74$, $SD = 0.20$ – Rated as Very Usable. Key ergonomic features such as height adjustability (five levels) and a tilting mechanism (0° , 30° , and 60°) were highly appreciated, especially for constrained learning spaces.

- Maintainability: $M = 3.75$, $SD = 0.18$ – Rated as Very Maintainable. Respondents emphasized the modular electrical design and availability of local replacement parts.

These results validate the table’s multifunctionality and effectiveness in addressing cost, spatial, and instructional gaps in technical-vocational training environments.

4.3. Instructional and Competency-Based Effectiveness

The instructional effectiveness of the Notable Ergonomic Universal Working Table was quantitatively assessed by 30 respondents from the academic sector, including trainers, teachers, and students, using a 4-point Likert scale. The overall weighted mean (OWM) was 3.89, interpreted as Very Satisfactory. The highest-rated indicator (3.94) reflected the table’s efficacy as a drafting board, suggesting that users found the angular adjustability and paper compatibility highly beneficial for technical drawing applications. Conversely, the lowest—yet still robust—rating of 3.84 was assigned to the peg bar for animation disc, indicating only minimal concern in its functionality to support layered traditional animation sheets. Complementing this, TESDA-accredited assessors evaluated the table's alignment with competency standards across NC II and NC III qualifications. The results yielded an average weighted mean of 3.78, also interpreted as Very Satisfactory. High scores (3.80 and above) were recorded for features such as the rotating animation disc, LED lighting adjustability, and the convertible tabletop, confirming that the equipment not only meets but enhances the requirements outlined in TESDA Training Regulations for Animation, Technical Drafting, and Visual Graphic Design. As one assessor remarked, the table “meets the basic requirements of a 2D animation desk,” validating its appropriateness for both skills training and competency assessments.

4.4. Overall Effectiveness Evaluation

The summative effectiveness of the ergonomic table was measured by examining key technological indicators—portability, ergonomic lighting, adjustability, safety, and compactness. Across all respondents (teachers, trainers, and TESDA assessors), the tool received an overall weighted mean of 3.76, interpreted as Highly Effective. This assessment underscores the device’s holistic utility across diverse instructional contexts. The most positively rated feature was compactness, scoring 3.87, reflecting strong appreciation for its space-saving design, which is critical in crowded classrooms and laboratories. The LED lighting system, adjustable in brightness and powered by rechargeable lithium-ion batteries with built-in battery management system (BMS), was praised for its efficiency and sustainability. The adjustable height, which supports five levels ranging from 76.2 cm to 101.6 cm, was similarly well-regarded, enhancing usability for learners of various builds and mobility levels. These results demonstrate that the table is not only a cost-effective alternative to multiple traditional devices but also a strategic instructional innovation, capable of improving educational delivery in Architecture, Drafting Technology, Engineering, and Animation programs. With its high ratings across multiple performance domains, the universal working table stands out as a transformative teaching and assessment solution, especially relevant to institutions preparing to become TESDA-accredited assessment centers.

5. Discussion

5.1. Strategic Response to Instructional Gaps

The quantitative results clearly demonstrate that the traditional tools used in technical training suffer from limitations that hinder effective instruction and skill development. The development of the Notable Ergonomic Universal Working Table was a strategic response to these gaps. As identified in Banayat (2023), there is a growing need for instructional tools that are not only functional but also aligned with evolving industry and learner needs. The integration of ergonomic and multi-functional

features directly supports educational innovation strategies that focus on cost-efficiency, flexibility, and performance.

5.2. Innovation Strategy and Educational Technology Efficiency

From a business and corporate strategy standpoint, the universal working table exemplifies an innovation strategy that prioritizes value engineering and user-centered design. By combining multiple tools into one—computer table, drafting board, light box, and drawing table—it successfully reduces the overall training equipment cost by more than 70% while delivering superior functionality. The LED-powered lighting system and rechargeable battery setup reflect a sustainable digital strategy, consistent with energy-conscious corporate policies.

5.3. Alignment with Human Capital Development Objectives

The successful implementation of this tool enhances the learning experience by accommodating different learning environments and personal comfort needs. Adjustable heights and angles cater to learners with diverse physical attributes, echoing the principles of inclusive instructional design. This innovation supports human capital development by empowering educators and learners through tools that improve productivity, engagement, and instructional delivery (Hipolito & Santos, 2025). It also reinforces the institutional capability of training centers to meet TESDA standards and CHED classroom spatial guidelines, allowing smoother alignment with national qualifications frameworks (Commission on Higher Education, 2017; TESDA, 2021).

5.4. Market Potential and Strategic Instructional Integration

The positive assessments by practitioners, trainers, and TESDA assessors suggest strong potential for adoption in both academic and industry-based training environments. From a strategic management lens, this presents an opportunity for scale-up, commercialization, and policy integration into technical-vocational education and training (TVET) institutions (Armas, Siat, & Santos, 2025). As emphasized by Javier (2023), strategic educational tools with real-world applications serve as drivers of competitiveness in human capital development. The Notable Ergonomic Universal Working Table fits this mold, offering a tangible model for future educational innovations with business-aligned applications.

5.5. Digitalization as a Strategic Enhancement

The present version of the Notable Ergonomic Universal Working Table effectively meets ergonomic, spatial, and instructional needs. However, to align with global trends in Education 5.0 and smart learning environments, the table presents significant potential for future digital enhancements. These may include Internet-of-Things (IoT) integration for usage tracking and lighting control, app-based adjustment of table height and tilt angles, posture-correction sensors for ergonomic feedback, and cloud-based storage for student work. These smart features could transform the table into a digitally enhanced instructional hub, supporting data-driven instruction and personalized learning experiences (Jacoba et al., 2025). While not part of the current evaluation, these upgrades are strategically aligned with the vision of TESDA and CHED to modernize technical-vocational education through digital innovation.

5.6. Study Limitations and Areas for Future Research

While the study provides strong initial evidence for the table's effectiveness, limitations must be acknowledged. First, the sample size was limited to 30 purposively selected respondents, which may not represent all stakeholder groups in TVET. Second, long-term durability and effectiveness under continuous classroom use were not measured. Finally, while the design was evaluated against ISO/IEC 25010 standards, comparative benchmarking with commercially available alternatives was not

conducted. Future studies may involve larger samples, longitudinal evaluation, and experimental designs comparing student learning outcomes with and without the table's use.

6. Conclusion

The study verified that the Notable Ergonomic Universal Working Table is an effective instructional innovation for technical-vocational education, addressing common challenges such as cost, space limitations, and lack of multifunctionality in traditional tools. Quantitative evaluation confirmed high ratings in functionality, usability, and instructional alignment with TESDA competency standards. The table enhances instructional delivery, promotes efficient resource use, and strengthens institutional readiness for TESDA accreditation. It also supports inclusive and adaptive learning environments by offering ergonomic features such as adjustable height, convertibility, and portability.

7. Suggestion

To further maximize the instructional value of the ergonomic table, schools and training institutions are encouraged to adopt multi-functional tools that are cost-effective, space-saving, and aligned with national training standards. Institutions may consider developing procurement frameworks to support the acquisition of smart, ergonomic tools for use in TVET laboratories and classrooms. Budget allocation should prioritize the integration of such tools into institutional infrastructure plans, particularly in preparation for TESDA accreditation.

Partnerships with technology developers are also recommended to enable the inclusion of smart learning features, such as IoT integration, app-based control, and digital storage capabilities. Training workshops for faculty should be conducted to ensure effective utilization of the technology in classroom settings.

Furthermore, schools may adopt cost-sharing models in collaboration with industry partners to support the sustainable implementation of these innovations. Policymakers are also encouraged to integrate multifunctional instructional tools into CHED and TESDA curriculum delivery guidelines to institutionalize the use of adaptive, innovative technologies in technical-vocational education.

These practical steps can reinforce both instructional performance and national workforce competitiveness, supporting the long-term goals of Education 5.0 and Industry 4.0 readiness.

Declarations

Author Contributions. B.J.D.P.: Conceptualization, literature review, methodology design, data collection, data analysis, instructional product development, manuscript writing, and final editing. The sole author has read and approved the final version of the article.

Conflicts of Interest. The author declares no conflict of interest.

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Ethical Approval. All procedures performed in this study complied with the ethical standards of the Data Privacy Act of 2012 in the Philippines. Informed consent was obtained from all participants. No formal ethics committee approval was required for this study based on institutional guidelines.

Data Availability Statement. The data that support the findings of this study are available from the author upon reasonable request.

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