

Bridging the Digital Divide: Empowering Students of a Remote Barangay Maasin Through Information and Communications Technology

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Publication history:

Received: August 16, 2026

Accepted: September 10, 2026

Revised: September 6, 2026

Published: September 11, 2026

International Journal of Sustainable and Integrated Studies, Vol. 1, No. 2, pp. 258–268, September 2026.

Abstract

This study assessed the effectiveness of the Technology for Education, Employment, Entrepreneurship and Economic Development (Tech4Ed) Center in bridging the digital divide among senior high school students in Purok Centro, Barangay Maasin, Ipil, Zamboanga Sibugay. Anchored in the Casey Digital Equity Framework 2021–2025, the study examined digital literacy in terms of access, affordability, and digital ability; challenges related to the center's infrastructure, capacity building, and promotion; its perceived impact on education, employment, entrepreneurship, and economic development; and differences in digital literacy across demographic and socioeconomic profiles. A quantitative descriptive design was employed using total enumeration of 90 senior high school students from School Years 2022–2023, 2023–2024, and 2024–2025. Data were collected through a researcher-developed questionnaire that demonstrated high internal consistency with a Cronbach's Alpha of .979. Findings showed a high overall level of digital literacy ($M = 3.82$), with digital ability obtaining the highest mean ($M = 3.97$), followed by access ($M = 3.79$), while affordability was lowest ($M = 3.69$). Students reported relatively few challenges in using the Tech4Ed Center, although limitations in physical space, training organization, and feedback mechanisms were identified. The center demonstrated a positive overall impact ($M = 4.17$), particularly in education ($M = 4.21$), employment ($M = 4.15$), and entrepreneurship and economic development ($M = 4.14$). Significant differences in digital literacy were found according to age and school year attended, but not according to sex, grade level, strand, socioeconomic status, distance from the center, or device ownership. The study recommends strengthening infrastructure, training, stakeholder support, and sustainable funding, including upgrading the center into a Digital Transformation Center. The study aligns with SDG 4–Quality Education, SDG 5–Gender Equality, and SDG 9–Industry, Innovation and Infrastructure. Its sustainability contribution lies in strengthening educational, digital, socio-economic, community, and institutional capacity through continued and equitable access to ICT services.

Keywords: Affordability; Digital Ability; Digital Divide; Digital Literacy; Information and Communication Technology; Tech4Ed Center; Technology Access

1. Introduction

Information and communication technology (ICT) has become essential to education, access to information, skills development, employment, and participation in the digital economy. However, unequal access to connectivity, devices, affordable services, and digital skills continues to create a digital divide, particularly in remote and marginalized communities. This concern is especially relevant to students whose learning increasingly depends

on digital resources and internet-based technologies. The digital divide encompasses inequalities not only in physical ICT access but also in affordability, digital competence, and the ability to use technology meaningfully. In the Philippines, the Department of Information and Communications Technology (DICT) established the Technology for Education, Employment, Entrepreneurship and Economic Development (Tech4Ed) program as a community-based digital inclusion initiative. Through ICT facilities, connectivity, training, and digital services, Tech4Ed is intended to provide underserved communities with opportunities for education, employment, entrepreneurship, and economic development. This study examines the Tech4Ed Center in Purok Centro, Barangay Maasin, Ipil, Zamboanga Sibugay, a geographically isolated and disadvantaged community, by assessing students' digital literacy, their experiences in utilizing the center, its perceived impact, and possible interventions for strengthening its effectiveness.

ICT plays an increasingly important role in students' educational participation and success, yet the digital divide remains evident in remote and marginalized areas. The United Nations Human Settlements Programme provides an international context for understanding digital inequality (Zaidan et al., 2025). The divide involves differences between individuals or communities that have access to and use internet connectivity, internet-enabled devices, and digital literacy skills and those that do not (Royall et al., 2021, p.15). Consequently, digital inclusion requires attention to connectivity, technology access, and the competencies necessary to use ICT effectively. ICT also has implications beyond education because of its role in innovation and economic development. Its capacity to contribute across development areas is recognized internationally (International Telecommunication Union [ITU], 2021). In the Philippine context, DICT introduced Tech4Ed in 2013 as a national digital inclusion initiative designed to establish community eCenters and provide ICT-enabled and government services to areas with limited access (Dean, 2019, p. 1). Its intended beneficiaries include students and teachers as well as other underserved and marginalized sectors (Dean, 2019, p.6). Tech4Ed provides access to ICT services, digital skills development, e-government services, and online learning opportunities for underserved rural communities (Velasco, 2025). The importance of strengthening both digital infrastructure and digital competencies in addressing the Philippine digital divide is similarly emphasized by (Espinosa et al., 2025). Related evidence indicates that students and teachers consider Tech4Ed useful in improving productivity and competence (Wallis, 2021, p.65), while community ICT infrastructure can also facilitate participation in economic activities such as electronic commerce (Dacuycuy & Sinsay, 2022, pp.11-12). Wallis, M. G. M. (2021) likewise examined factors influencing the adoption of Tech4Ed, further demonstrating the relevance of understanding not only ICT availability but also how users engage with such interventions.

The reviewed literature identifies several interconnected dimensions of the digital divide. First, digital inequality extends beyond having or not having an internet connection. Philippine broadband development continues to face challenges associated with fiber infrastructure investment, broadband information, regulatory barriers, and ICT deployment, particularly in Geographically Isolated and Disadvantaged Areas (GIDA) (Serafica et al., 2023). Internationally, digital inequality has also been associated with differences in information access, digital skills, inclusion, and sociocultural conditions (Castells, 2010). Although disparities in basic internet access between developed and developing countries have declined over time, inequalities in meaningful participation in the networked environment remain relevant (Castells, 2010, p.xxv). Second, community-based ICT centers constitute an important digital inclusion mechanism. In the Philippine setting, Tech4Ed serves as a community-based ICT intervention intended to promote digital empowerment, particularly in rural communities (Wallis, 2021). Technology adoption may be influenced by demographic characteristics, computer self-efficacy, perceived usefulness, perceived ease of use, accessibility, information dissemination, connectivity, and skills training. Evidence from Tech4Ed users indicates that confidence and self-efficacy can be particularly important to adoption and that students and teachers regard the program as useful for improving competence and productivity (Wallis, 2021, pp.64-67). Similar community e-Centers have been adopted internationally to provide digital tools, ICT services, and locally relevant information in rural areas. Their use as instruments for rural development and digital inclusion has long been recognized across developing economies in the Asia-Pacific region (United Nations Economic and Social Commission for Asia and the Pacific [UNESCAP] & Asian Development Bank Institute [ADB], 2005, 5). The expansion of these centers illustrates their role as community-level mechanisms for addressing ICT exclusion (United Nations Economic and Social Commission for Asia and the Pacific [UNESCAP] & Asian Development Bank Institute [ADB], 2005, p.3). Third, ICT infrastructure directly affects educational access. Philippine educational institutions have experienced constraints involving financial resources, infrastructure, internet bandwidth, information systems, and connectivity (Marcial, 2012, pp. 3-7). These conditions shape the availability of institutional IT resources (Marcial, 2012 p.3). Comparable challenges have been documented in developing-country educational contexts, where inadequate cybercafés, limited institutional facilities, and lack of electronic libraries can restrict students' academic use of ICT (Apuke & Iyendo, 2018, p. 1). Reliance on smartphones and personal data subscriptions for research and schoolwork further illustrates the relationship between device availability, connectivity, affordability, and educational participation (Apuke & Iyendo, 2018, p.24). Finally, digital literacy is central to meaningful ICT participation among senior high school students. Philippine evidence has examined differences in students' digital literacy according to demographic and educational characteristics (Baterna et al., 2020). Findings have shown variations according to factors such as sex

and grade level, reinforcing the importance of programs designed to strengthen students' digital proficiency (Baterna et al., 2020, p.115). Research involving senior high school students outside the Philippines similarly indicates that students may possess moderate digital skills while demonstrating limitations in areas such as cybersecurity, privacy, digital hygiene, and ethical technology use (Kasriyati et al., 2024, pp. 157-164). Such findings support comprehensive digital literacy development that includes critical, safe, and ethical use of technology (Kasriyati et al., 2024, p. 165). Collectively, these studies show that digital inclusion is multidimensional. Connectivity and devices remain necessary, but meaningful inclusion also depends on affordability, competencies, confidence, access to appropriate facilities, and the ability to apply ICT to education and other productive activities.

Globally, community ICT centers have been employed as mechanisms for reducing digital exclusion and expanding access to information, learning opportunities, and development services. At the national level, Tech4Ed represents the Philippine government's community-based response to digital inequality by establishing centers that provide ICT facilities, connectivity, training, digital resources, and related services. Within Region 9, DICT has established more than 286 Tech4Ed centers across the Zamboanga Peninsula since 2015 in schools, government facilities, barangay and municipal offices, and partner institutions. Barangay Maasin in Ipil, Zamboanga Sibugay became a Tech4Ed beneficiary on November 17, 2017, as part of an initiative to establish centers in all 28 barangays of the municipality. However, only three of these centers were described as remaining operational at the time of the study. Barangay Maasin presents a particularly relevant setting because it is classified as a Geographically Isolated and Disadvantaged Area. Physical isolation, rough roads and terrain, absence of cellular network reception, and limited access to basic ICT services affect the community. Before the establishment of its Tech4Ed Center, students had to travel to downtown internet cafés to conduct research and print academic requirements. These conditions provide a localized illustration of how geographical, infrastructural, technological, and economic barriers can interact in producing digital exclusion.

The study is anchored in the Casey Digital Equity Framework 2021–2025 developed by the Council of the City of Casey in Victoria, Australia to guide an equity-oriented approach to digital exclusion (City of Casey Council, 2021, p.5). The framework draws from the Australian Digital Inclusion Index and conceptualizes digital equity through interrelated dimensions useful for assessing communities experiencing digital exclusion (City of Casey Council, 2021, pp. 8-10). Three dimensions are central to the present study: access, affordability, and digital ability. Access concerns internet availability, connectivity options, data capacity, internet performance, and access to digital devices such as computers, smartphones, and tablets. Affordability concerns the financial burden associated with internet connectivity, data subscriptions, ICT devices, and services relative to household resources. Digital ability refers to students' knowledge, skills, and confidence in using ICT devices, applications, online services, and digital resources for learning and other productive activities. The conceptual structure further incorporates the Tech4Ed Center's Establishment, Equipment & Infrastructure; Content Development & Capacity Building; and Visibility, Advocacy and Promotion as characteristics of the intervention. These are examined in relation to students' access, affordability, and digital ability and to the perceived effects of Tech4Ed on Education, Employment, Entrepreneurship and Economic Development. Rather than presenting the original diagram, the framework can be expressed narratively as a relationship in which the condition and delivery of Tech4Ed services are assessed alongside student digital inclusion and perceived program outcomes. Findings then provide the basis for interventions involving infrastructure, training, community engagement, program improvement, and a feedback mechanism for continuous refinement and future planning.

Despite the establishment of Tech4Ed Centers, the study identifies a program-level assessment gap. Operational status has largely been associated with whether centers conduct activities, while a concrete mechanism for evaluating effectiveness and user impact, such as systematic assessment of beneficiaries' experiences, has been limited. Consequently, evidence is needed to determine whether a center is actually addressing the dimensions of digital exclusion experienced by its intended users. Previous studies have examined broadband infrastructure, ICT access, technology adoption, community e-Centers, educational ICT resources, and student digital literacy. However, the reviewed literature indicates a need for a localized empirical assessment that simultaneously considers access, affordability, digital ability, the condition and delivery of Tech4Ed services, and the program's perceived educational and socio-economic impact. Rather than merely describing the existence of a digital divide, the present study connects assessment with evidence-based interventions for strengthening a community-based digital inclusion program. Accordingly, the study seeks to determine the level of digital literacy of senior high school students in terms of access, affordability, and digital ability; identify their challenges in utilizing the Tech4Ed Center in relation to establishment, equipment and infrastructure, content development and capacity building, and visibility, advocacy and promotion; assess its impact on education, employment, entrepreneurship, and economic development; determine differences in digital literacy according to demographic and socioeconomic characteristics; and propose interventions to strengthen the effectiveness of the center. The study focuses on 90 Grade 11 and Grade 12 students from Purok Centro, Barangay Maasin who were enrolled during School Years 2022–2023, 2023–2024, and 2024–2025.

The study is directly aligned with the broader recognition that ICT can support progress toward the United Nations Sustainable Development Goals (International Telecommunication Union [ITU], 2021). Based on the original study's identified development priorities, three SDGs are particularly applicable. SDG 4 – Quality Education is addressed through the role of ICT in expanding students' access to information, online and distance learning, digital learning resources, educational applications, multimedia content, and other technology-supported learning opportunities. By examining access, affordability, and digital ability among senior high school students, the study contributes evidence on barriers that can affect equitable participation in digitally supported education. SDG 5 – Gender Equality is relevant because equitable ICT access and digital skills development can provide students of different genders with opportunities to participate in education, skills training, technology-related activities, and future employment. The role of digital technology in expanding opportunities for women and girls is also emphasized through initiatives that encourage participation in STEM and technology (International Telecommunication Union [ITU], 2021). SDG 9 – Industry, Innovation and Infrastructure is reflected in the study's emphasis on ICT infrastructure, internet connectivity, digital technologies, and community-based digital services. Assessing the Tech4Ed Center's equipment, infrastructure, capacity-building activities, and effectiveness can provide evidence for improving digital infrastructure and supporting innovation and development in a geographically isolated rural community.

The study contributes to educational, technological and digital, socio-economic, community, and institutional sustainability by examining digital inclusion as an interconnected development concern rather than solely as a problem of internet connectivity. From an educational sustainability perspective, reliable ICT access and adequate digital literacy can enable students to continuously access learning resources, conduct research, complete academic requirements, and participate in technology-supported learning. Strengthening digital ability also prepares students to respond to continuously evolving educational technologies. For technological and digital sustainability, the study evaluates whether community ICT infrastructure is supported by appropriate equipment, internet access, affordability, skills development, and sustained utilization. This shifts attention from merely establishing ICT facilities toward maintaining services that communities can continue to use meaningfully. The study also contributes to socio-economic sustainability because Tech4Ed connects technology not only to education but also to employment, entrepreneurship, and economic development. Digital competence and access to ICT services may therefore support students' preparation for future educational, employment, and livelihood opportunities. At the community and institutional sustainability levels, the findings can provide DICT, barangay authorities, municipal and provincial local government units, parents, and other stakeholders with evidence for strengthening ICT infrastructure, capacity-building initiatives, program delivery, and community participation. Evidence-based assessment can also help identify areas requiring intervention and provide a basis for future planning, implementation, policy development, and replication of digital inclusion initiatives in other disadvantaged communities. Overall, the study positions the Tech4Ed Center as a community-based digital inclusion intervention whose sustainability depends not simply on remaining operational, but on its continuing capacity to provide accessible, affordable, useful, and competency-building ICT services to its intended beneficiaries.

2. Material and methods

2.1 Research Design

The study used a quantitative descriptive research design and survey method to obtain data from senior high school students residing in Purok Centro, Barangay Maasin, Ipil, Zamboanga Sibugay. Quantitative descriptive research is intended “to quantify the data and generalize findings from a sample of a study from varied perspectives.” (Ghanad, 2023, p.3794). The design was used to examine the effectiveness and perceived impact of the locally established Tech4Ed Center in providing ICT services, strengthening digital literacy, and addressing the digital divide among students in the community.

2.2 Locale of the Study

The study was conducted at the Barangay Hall Covered Court in Purok Centro, Barangay Maasin, Ipil, Zamboanga Sibugay. Barangay Maasin is an inland and physically isolated community with limited public transportation and uncemented roads. Based on the 2020 Census, the barangay had 967 residents, representing 1.08% of the total population of the Municipality of Ipil. It has no secondary school and is served only by a DepEd primary school; consequently, senior high school students attend schools located in downtown Ipil. The community is a beneficiary of the Tech4Ed program, with its center at the barangay hall established by DICT on November 17, 2017.

2.3 Respondents of the Study

The respondents consisted of 90 senior high school students residing in Purok Centro, Barangay Maasin who were associated with School Years 2022–2023, 2023–2024, and 2024–2025. The population included 36 male respondents (40%) and 54 female respondents (60%), with ages ranging from 16 to 21 years and above. At the time of data gathering, 32 respondents (35.6%) were Grade 11 students, 31 (34.4%) were Grade 12 students, and

27 (30%) had already graduated from senior high school. The respondents represented different senior high school strands, including HUMSS, STEM, TVL, Arts and Design, ABMS, Sports, and GAS. Their socioeconomic conditions also varied, although 30 respondents did not indicate their monthly household income. Most respondents lived less than one kilometer from the Tech4Ed Center, with 85 (94.4%) residing within this distance and five (5.6%) living one kilometer or farther away. Regarding internet-capable device ownership, 75 respondents (83.3%) owned mobile devices, seven (7.8%) owned computers, two (2.2%) owned smart devices, and six (6.7%) reported having no digital device.

2.4 Sample and Sampling Procedure

The study employed total enumeration, wherein all identified senior high school students from the three specified school years who resided in Purok Centro, Barangay Maasin were invited to participate. The official population consisted of 90 students, and all were included as respondents. Identification and coordination of the respondents were facilitated with the assistance of the SK Chairman, who also served as the Tech4Ed Center Manager, with guidance from the Barangay Chairman.

2.5 Research Instrument

Data were collected using a researcher-developed non-cognitive questionnaire. The instrument began with information on the study and its purpose, followed by a data privacy consent section. For respondents who were minors, consent was obtained from their parents or guardians. Demographic information included optional name, sex, age, grade level, school, and strand. The main items used a five-point Likert scale ranging from 1–strongly disagree, 2–disagree, 3–moderately agree, 4–agree, to 5–strongly agree. The questionnaire contained three major components. The first assessed digital literacy in terms of Access, Affordability, and Digital Ability, adapted from the ADII (Australian Digital Inclusion Index) of the Casey Digital Equity Framework. The second assessed the challenges encountered in utilizing the Tech4Ed Center in terms of Establishment, Equipment & Infrastructure, Content Development & Capacity Building, and Visibility, Advocacy & Promotion. The third assessed the perceived impact of Tech4Ed in the areas of Education, Employment, Entrepreneurship & Economic Development, based on the four E's of Tech4ED. Each component contained three subsections with 10 items per subsection. The instrument underwent expert review to establish content validity. The reviewers assessed each item according to clarity, relevance, appropriateness, and suitability and provided their evaluations and recommendations through validation forms. A pilot test was subsequently administered to at least 30 participants who were not part of the actual respondents. Reliability analysis produced a Cronbach's Alpha of .979, indicating high internal consistency among the questionnaire items.

2.6 Data Gathering Procedure

Prior to data collection, the researcher secured permission from the Barangay Chairman of Maasin, Ipil, Zamboanga Sibugay to conduct the survey at the barangay hall premises. Following approval, coordination was undertaken with the Tech4Ed Center Manager, who was also the SK Chairperson, to schedule the activity and facilitate the participation of the 90 identified respondents. Survey questionnaires were provided in advance to respondents below 18 years old to allow their parents or guardians to sign the required consent. On the scheduled date, the researcher personally administered the survey, explained the informed consent, and emphasized voluntary participation. Completed questionnaires were checked to ensure that responses were complete before the data were recorded, analyzed, and interpreted. Respondent identities were kept confidential, and collected records were securely stored. Hard copies were kept in a locked filing cabinet and were intended for shredding after completion of the study, while electronic copies stored in Google Drive were to be permanently deleted after the study.

2.7 Data Analysis Techniques

Frequencies and percentages were used to summarize the respondents' demographic characteristics, while the mean and standard deviation were employed to determine the central tendency and variability of responses to the Likert-scale items. One-way analysis of variance (ANOVA) was initially identified to determine whether digital literacy levels differed across demographic groups. Before inferential analysis, the assumptions for parametric testing were examined. The Shapiro–Wilk test indicated statistically significant departures from normality for access ($W = .933, p < .001$), affordability ($W = .930, p < .001$), and digital ability ($W = .914, p < .001$). Levene's test indicated that homogeneity of variances was satisfied for access ($F = 0.810, p = .371$), affordability ($F = 0.003, p = .960$), and digital ability ($F = 0.482, p = .489$). Independence of observations was also satisfied because each respondent participated only once and responses were collected independently. Although the Shapiro–Wilk test indicated statistically significant non-normality, examination of histograms, normal Q–Q plots, skewness, and kurtosis suggested only minor departures from normal distribution. Considering the sample size of 90, the use of composite scores derived from multiple questionnaire items, and the robustness of parametric tests to moderate violations of normality, the assumptions were considered sufficiently satisfied. Independent-samples t-tests and one-way ANOVA were therefore used to examine differences in digital literacy across demographic and socioeconomic groups. This approach aligns with recommendations from Field (2024), Hair et al. (2022), and Tabachnick and Fidell (2019).

2.8 Ethical Considerations

Ethical safeguards were observed throughout the conduct of the study. Respondents were informed of the purpose of the research and were required to provide data privacy consent before participating. For respondents below 18 years old, consent was obtained from their parents or guardians. Participation was voluntary, and respondents could refuse to participate or decline to answer questions with which they were uncomfortable. The collection and handling of respondents' information followed Republic Act 10173 or the Data Privacy Act of 2012. Data were used only for the stated purpose of the study, respondent identities were treated confidentially, and records were securely stored and scheduled for proper destruction after completion of the research.

3. Results and Discussion

3.1 Level of Digital Literacy among Senior High School Students

3.1.1 Access

The students demonstrated a high level of digital literacy in terms of access, with a grand mean of 3.79. Electricity availability at home received the highest mean of 4.13, followed by the use of the internet for homework, projects, and other school requirements at 4.11. Reliable internet access and sufficient internet speed were also rated high, while access to a personal computer received the lowest mean of 3.58, although it remained within the high category. Overall, the results indicate that students generally have access to electricity, internet connectivity, and suitable digital devices for academic activities. The findings indicate that physical and technological access provides an important foundation for participation in the digital environment. This is consistent with the concept of "Material Access," which includes not only internet availability but also the devices, software, and equipment necessary to sustain technology use (Van Deursen & Van Dijk, 2019, p.355). Smartphone availability is particularly relevant among students, as "Smartphone use has become a trend among Filipino adolescents over the past few years. In fact, adolescents and young adults (16–24 years old) have the largest smartphone ownership percentage in the country" (Buctot et al., 2021, p.2). Thus, access to smartphones, connectivity, electricity, and the Tech4Ed Center provides students with the basic material conditions needed to develop and apply digital skills.

3.1.2 Affordability

The students also demonstrated a high level of digital literacy in terms of affordability, with a grand mean of 3.69, although this was the lowest among the three digital literacy dimensions. The highest-rated item was the provision of free internet access through the Tech4Ed Center at 4.07, while the perceived fairness and affordability of internet subscriptions received the lowest mean of 3.63. Costs related to internet data, software, device replacement, and other ICT requirements were generally rated high but remained comparatively lower than the students' ratings for access and digital ability. The results suggest that recurring expenses for connectivity, devices, software, maintenance, and related ICT requirements remain potential limitations even when students have access to technology. This interpretation is consistent with the theory of digital capital Ragnedda (2018) and the concept of "material access" by Van Deursen & Van Dijk (2019). According to (Ragnedda, 2018, p.2371), "economic capital may be displayed in wealth and family income, this means that those who are already socio-economically advantaged not only use the Internet differently than less advantaged counterparts, but they also get the most from its usage." Material access therefore includes the capacity to sustain technology use through devices, subscriptions, software, and peripheral equipment (Van Deursen & Van Dijk, 2019, p.355). Similar financial constraints were documented by Barrot et al. (2021), particularly the limited funding available for online learning and the cost of internet connectivity during distance education (Barrot et al., 2021 p.7331). These findings support affordability as the comparatively weakest dimension of students' digital literacy.

3.1.3 Digital Ability

Digital ability obtained the highest rating among the three dimensions, with a grand mean of 3.97, interpreted as high. The strongest competency was the effective use of search engines for schoolwork at 4.30, followed by online collaboration at 4.10 and participation in online educational communities at 4.06. Students also reported high competence in creating documents, presentations, and spreadsheets, navigating online learning platforms, evaluating online information, conducting digital transactions, and using digital skills for possible income-generating opportunities. Confidence in navigating the Tech4Ed platform received the lowest mean of 3.76, but remained high. The findings reflect the students' familiarity with digital technologies and their ability to perform functional digital tasks. This observation is consistent with the concept of younger generations as digital natives, who have developed familiarity with computers, the internet, and digital technologies from an early age (Mertala et al., 2024, p.1). Similarly, the framework developed by (Helsper et al., 2020, p.11) indicates that youth exhibit relatively high proficiency in "technical and operational digital skills." These perspectives support the finding that senior high school students can effectively navigate digital devices, software, online applications, and common internet-based activities.

3.1.4 Overall Level of Digital Literacy

Overall, the students demonstrated a high level of digital literacy, with an overall grand mean of 3.82. Digital Ability ranked highest at 3.97, followed by Access at 3.79, while Affordability obtained the lowest mean of 3.69. These results indicate that students generally possess the skills and access necessary to participate in digital activities, although financial considerations remain comparatively more restrictive. The pattern suggests that the primary digital gap among the respondents is not principally associated with their capacity to use technology, but with the sustainability of access when recurring costs are involved. The presence of the Tech4Ed Center provides an additional mechanism for accessing digital resources and may help address some limitations related to devices and connectivity. Consequently, interventions may give greater attention to affordability while maintaining students' existing strengths in access and digital ability.

3.2 Challenges in Utilizing the Tech4Ed Center

3.2.1 Establishment, Equipment and Infrastructure

The students reported few challenges related to establishment, equipment and infrastructure, with a grand mean of 4.09. Regularly updated and functional software received the highest rating of 4.35, followed by the safety and security of the center at 4.31 and accessibility of its location at 4.28. The physical space received the lowest rating at 4.13, suggesting that some respondents perceived a need for additional space to accommodate more users. Nevertheless, the students generally considered the facility accessible, safe, functional, comfortable, and conducive to learning. The positive assessment of the physical environment may be understood in relation to the satisfaction of learners' basic needs. This interpretation was linked in the original study to Abraham Maslow's Hierarchy of Needs through (Desautels, 2014 p.1), where satisfaction of environmental and psychological needs can support learning and task completion (Desautels, 2014 p. 2). Moralde (2023) similarly emphasized the importance of properly maintained public ICT facilities. An effective facility should provide an environment that is comfortable, safe, secure, accessible, well-lighted, and adequately ventilated (Morale, 2023, qtd. Lawrence, 2023. p.412). Such conditions contribute to user satisfaction and functionality of ICT facilities (Morale, 2023, p. 414).

3.2.2 Content Development and Capacity Building

Content development and capacity building received a grand mean of 4.21, indicating that students experienced relatively few challenges in accessing and benefiting from the Tech4Ed Center's learning content and training activities. The usefulness of content for learning and research obtained the highest mean of 4.48, followed by support for developing critical thinking skills at 4.37. Regular updating of content and adequacy of training programs both received 4.30. The organization and delivery of capacity-building initiatives and the administration of feedback surveys received the comparatively lowest ratings of 4.19, although both remained within the agree category. The findings suggest that the usefulness of learning materials and active facilitation contribute to students' continued participation in Tech4Ed activities. This was associated with the Technology Acceptance Model and Vygotsky's Zone of Proximal Development. According to the recent study entitled, "Revisiting AI in an English Classroom", by (Sienes & Sarsale, 2024), technology adoption is influenced by perceived usefulness and ease of use (Sienes & Sarsale, 2024 pp. 40-41). Its application to students showed that technology perceived as useful and effective supported actual use (Sienes & Sarsale, 2024 p. 45). Vygotsky's Zone of Proximal Development likewise highlights the role of guidance in enabling learners to accomplish tasks they cannot yet perform independently (Sienes & Sarsale, 2024 p. 39). These concepts support the role of relevant content, training, and the center manager's engagement in developing students' digital abilities.

3.2.3 Visibility, Advocacy and Promotion

Visibility, advocacy and promotion obtained a grand mean of 4.08, indicating generally high awareness and few challenges. Visible signage received the highest rating at 4.32, while the use of posters, announcements, and social media to communicate activities obtained 4.30. The lowest rating concerned actively seeking student feedback at 4.10, followed by communication of educational support and awareness of whom to contact for assistance, both at 4.11. Overall, respondents were aware of the center, its location, services, activities, and communication channels. The results were interpreted through the Diffusion of Innovation Theory. According to (Rogers, 2003 p.5), diffusion involves communicating an innovation through channels within a social system, while mass communication can efficiently inform potential adopters about an innovation (Rogers, 2003, p. 18). In this context, social media and other promotional channels facilitate awareness of Tech4Ed among students. The importance of such communication is also supported by the Philippine study of (Brown, J. 2023), which examined barriers to community use of telecentres and highlighted social media as an important mechanism for promoting education and community development (Brown, 2023, p.60). The findings therefore indicate effective promotion while identifying the feedback and suggestion system as an area requiring further strengthening.

3.2.4 Overall Challenges in Utilizing the Tech4Ed Center

The overall assessment obtained a grand mean of 4.13, indicating that students perceived relatively few challenges in utilizing the Tech4Ed Center. Content Development & Capacity Building received the highest mean of 4.21, followed by Establishment, Equipment & Infrastructure at 4.09 and Visibility, Advocacy & Promotion at 4.08.

The results indicate generally favorable experiences with the Tech4Ed Center's services, infrastructure, and learning activities. Nevertheless, specific areas for improvement remain, particularly physical space, organization of some training activities, systematic collection of user feedback, and continued promotion and social media engagement.

3.3 Impact of the Tech4Ed Center in Addressing the Digital Divide

3.3.1 Education

The educational impact of Tech4Ed obtained a grand mean of 4.21. Improved access to learning resources received the highest rating at 4.44, followed by improved understanding of lessons at 4.39 and access to online training and webinars with certificates at 4.34. Students also reported that the center helped them complete assignments, projects, research papers, and other school requirements. Collaboration with classmates received the lowest mean at 4.13, although the result remained positive. The center provided access to online resources through Piso WiFi and offline resources through DOST's Starbooks, as well as computers, printers, and digital skills training. The educational impact can be related to the Theory of Connectivism by (Siemens, 2005), which emphasizes learning through connections with information sources and networks (Siemens, 2005, p. 5). The Tech4Ed Center provides a physical and digital gateway through which students can access such resources. This interpretation is supported by (Sey et al., 2013), whose international findings showed the importance of public-access ICT facilities such as libraries, telecenters, and cybercafés, with education representing a major category of use and young people aged 16–25 constituting the largest user population (Sey et al., 2013 pp. 37-38).

3.3.2 Employment

The perceived employment impact obtained a grand mean of 4.15. Increased confidence in applying for jobs online received the highest mean at 4.29, followed by the perceived long-term positive impact on employability at 4.27 and assistance in preparing better resumes for employment and on-the-job training at 4.25. The lowest-rated item concerned the perceived effect of Tech4Ed use on future career prospects at 4.09, although it remained positively rated. Overall, respondents believed that the digital skills, resources, training, webinars, and career-related information provided by the center could strengthen their employability. The findings can be understood through the "Social Cognitive Career Theory" by (Lent et al., 1994), which emphasizes both competence and self-efficacy in performing challenging tasks (Bandura, 1991, as cited in Lent et al., 1994, p.83). Digital training may therefore strengthen students' confidence in using online employment platforms and preparing for technology-mediated work. The potential of digital skills for youth employment is further supported by the World Bank's (2023) discussion of the digital gig economy. According to (Datta et al. 2023, p.21), more than half of online gig workers are young people, while evidence from rural digital work initiatives indicates that even short skills training can enable participants with limited prior competencies to begin online work (Datta et al. 2023, p.197). These findings support the potential long-term employment value of the training provided through Tech4Ed.

3.3.3 Entrepreneurship and Economic Development

Entrepreneurship and economic development received a grand mean of 4.14. Access to information about resources and support for entrepreneurs obtained the highest mean of 4.35, followed by the ability to prepare a basic business plan using online resources at 4.32 and increased awareness of technology's role in economic development at 4.30. Participation in online webinars related to financial management obtained the lowest mean at 4.07. Overall, students indicated that Tech4Ed helped them understand business opportunities, financial management, digital marketing, e-commerce, and entrepreneurship and increased their interest in possible entrepreneurial activities after graduation. The findings were related to Ajzen's (1991) Theory of Planned Behavior, which proposes that perceived behavioral control and behavioral intention can help predict behavior (Ajzen, 1991, p. 184). Exposure to e-commerce, social media marketing, digital marketing, and related training may increase students' perceived capacity to engage in entrepreneurial activities. This is consistent with research by (Mulyono et al., 2023), which emphasized the combined importance of self-efficacy, entrepreneurship education, and digital literacy in strengthening entrepreneurial intention (Mulyono et al., 2023, p.510). In this context, Tech4Ed provides access and learning opportunities that may strengthen students' entrepreneurial self-efficacy and interest.

3.3.4 Overall Impact of the Tech4Ed Center

The overall perceived impact of the Tech4Ed Center obtained a grand mean of 4.17. Education received the highest mean at 4.21, followed by Employment at 4.15 and Entrepreneurship & Economic Development at 4.14. These findings indicate that the center's strongest perceived contribution was educational, reflecting students' primary use of its resources for learning and academic requirements. Employment and entrepreneurship-related outcomes received slightly lower ratings but were still positively assessed, indicating that students also recognized the center's relevance to future work, livelihood, and economic opportunities.

3.4 Differences in Digital Literacy According to Demographic and Socioeconomic Profiles

Significant differences in digital literacy were found according to age and school year attended. Age produced $F = 3.977$, $p = 0.010$, with 18-year-old respondents obtaining the highest mean of 4.30, while school year attended

produced $F = 4.028$, $p = 0.021$, with respondents from School Year 2023–2024 obtaining the highest mean of 4.21. The null hypothesis was therefore rejected for these two variables. In contrast, no statistically significant differences were found according to sex ($p = 0.119$), grade level ($p = 0.052$), strand ($p = 0.120$), socioeconomic status ($p = 0.901$), distance from the Tech4Ed Center ($p = 0.146$), and internet device ownership ($p = 0.824$). The null hypothesis was not rejected for these variables. The results suggest that variations in digital literacy may be associated more with developmental and educational experiences than with demographic or socioeconomic characteristics alone. This is consistent with literature showing that digital inequality encompasses differences in skills, usage, and outcomes and not merely access to devices or connectivity (Scheerder et al., 2017). Similarly, the DigComp3.0 framework conceptualizes digital competence through the knowledge, skills, and attitudes needed for effective participation in education, employment, and society (Cosgrove & Cachia, 2025). The absence of significant differences according to socioeconomic status and device ownership further suggests that shared facilities such as the Tech4Ed Center may provide opportunities that reduce differences in individual access. Recent research likewise emphasizes examining digital competence within gender, socioeconomic, and educational contexts rather than assuming that demographic characteristics automatically determine digital literacy (Lim & Yee, 2026). However, because the study employed comparative rather than experimental or longitudinal analysis, the differences observed among groups should not be interpreted as evidence that Tech4Ed caused these differences.

4. Conclusion & Recommendations

The study concludes that senior high school students in Purok Centro, Barangay Maasin possess a high level of digital literacy in terms of access, affordability, and digital ability, demonstrating that they generally have the resources and competencies needed to participate in the digital environment. Although students experienced relatively few difficulties in using the Tech4Ed Center, areas requiring improvement include limited physical space, organization of training activities, and proactive collection of user feedback. The center contributes to bridging the digital divide by expanding access to online learning resources, strengthening employability through digital skills training, and providing resources that support entrepreneurship and economic opportunities. Digital literacy also differed significantly according to age and school year attended, while the other demographic and socioeconomic characteristics examined did not show significant differences.

The study recommends that students with stronger digital literacy, particularly 18-year-olds and those who attended School Year 2023–2024, assist their peers during digital literacy training and maximize the Tech4Ed Center for online training, digital resume preparation, and freelancing opportunities. Parents should allocate resources for students' ICT needs and participate in Tech4Ed training to strengthen their awareness and support. Barangay, municipal, and provincial local government units should establish a continuous budget beginning fiscal year 2027 for Tech4Ed activities and infrastructure maintenance, supported by quarterly monitoring to promote program sustainability. DICT should consider upgrading the Maasin Tech4Ed Center into a Digital Transformation Center to provide additional space, computers, free internet access, and more advanced ICT training. Future researchers should examine whether perceived employability translates into actual employment or successful business ventures and replicate the survey in other municipalities or provinces to compare the impact of Tech4Ed across geographical settings.

The study was limited to 90 senior high school students residing in Purok Centro, Barangay Maasin, Ipil, Zamboanga Sibugay, covering School Years 2022–2023, 2023–2024, and 2024–2025 and using a quantitative survey and comparative analysis. Thus, the findings reflect the conditions and perceptions of the identified respondents and setting and should not be interpreted as evidence that Tech4Ed caused the observed differences in digital literacy; the original study itself notes that its comparative design was neither experimental nor longitudinal.

5. Compliance with ethical standards

The study complied with ethical standards for human-participant research. Informed consent and voluntary participation were ensured, with parental consent obtained for respondents below 18 years old. Participant confidentiality and data privacy were protected in accordance with Republic Act 10173 or the Data Privacy Act of 2012, and all collected data were securely stored and used solely for the study. Permission to conduct the research was also obtained from the Barangay Chairman of Maasin, Ipil, Zamboanga Sibugay.

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