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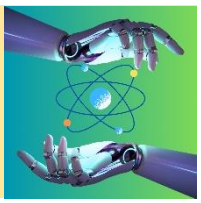

# Enhancing Community Learning Through ICT-Based Education and E-Learning Platforms

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## Abstract

In the digital era, the integration of Information and Communication Technology (ICT) into education has become a strategic approach to improve accessibility, engagement, and learning outcomes. Communities in semi-urban areas, however, often face limited access to technology and insufficient digital skills, creating barriers to equitable education. This study aimed to enhance community learning through the implementation of an ICT-based education program supported by e-learning platforms, addressing both learners and educators. The research employed a participatory action research (PAR) design, involving 60 participants comprising high school students, adult learners, and educators/facilitators. The program was implemented in three phases: needs assessment, capacity building, and e-learning implementation. Data collection techniques included surveys, interviews, focus group discussions, observations, and pre- and post-tests. Quantitative data were analysed using descriptive statistics and paired t-tests, while qualitative data were examined thematically to capture participant experiences. The results revealed significant improvements across digital competencies. Pre-test and post-test scores showed notable increases in basic ICT skills, digital literacy, e-learning usage, and digital problem-solving. Moodle and Google Classroom achieved the highest usage rates, while video conferencing and mobile applications also supported flexible learning. Participant satisfaction was positive, with high ratings for content quality (4.3/5), ease of use (4.2/5), and accessibility (4.1/5). Educators' involvement further ensured sustainability by creating a multiplier effect within the community. The novelty of this study lies in combining ICT-based education with community service, tailoring interventions to local needs while empowering both learners and facilitators. The findings conclude that ICT and e-learning platforms can foster inclusive, engaging, and sustainable educational ecosystems, contributing to digital equity in underserved communities.

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## 1. Introduction

In the digital era, the integration of Information and Communication Technology (ICT) into education has become a pivotal strategy for improving learning accessibility, personalisation, and engagement. Simin Ghavifekr and Wan Athirah Wan Rosdy demonstrated that ICT integration fosters dynamic teaching environments, enhances student creativity, and supports learning beyond traditional classrooms, particularly when teachers are well-prepared and receive adequate professional

development [1–3]. Support for ICT-based learning has also been documented in early studies that reported positive outcomes for low-achieving students and those with complex backgrounds. Liao et al. found that computer-assisted instruction and web-based learning produced moderate yet meaningful improvements in the academic achievement of primary school students [4–6]. These findings highlight ICT's potential to reach and uplift vulnerable learner populations.

The shift to e-learning platforms has promised flexibility and continuity in education. For instance, Cardona-Acevedo et al. found that e-learning technologies at the secondary education level promote personalised learning environments and enhance student engagement, although they also raise concerns regarding ethics and data privacy [7–9]. Meanwhile, Meng's systematic review of online learning during the COVID-19 pandemic noted that while ICT enabled remote learning, challenges such as social interaction deficits and emotional strain persisted, especially in developing countries [10–12]. Evaluating the benefits and limitations of e-learning more broadly, recent literature shows both advantages and obstacles. A review on the benefits and challenges of online education reports that distance learning provides flexibility and expanded access but confronts significant hurdles, including technical infrastructure, learner motivation, and support systems [13–15]. Furthermore, strategic deployment and teacher training remain crucial to realising the full potential of e-learning platforms.

In the context of higher education, Rafiq et al. investigated the impact of digital tools and online platforms in Pakistan, finding that student engagement, motivation, and academic performance significantly improved when adequate technical and institutional support was provided [16–18]. These findings suggest that, beyond technological availability, effective implementation requires sustained capacity building and supportive policies. Building upon these insights, this article aims to explore how ICT-based education and e-learning platforms can be leveraged in community service contexts to enhance learning outcomes for diverse audiences. Drawing from empirical evidence, we will propose practical frameworks for designing, implementing, and sustaining ICT-enabled educational interventions that empower learners, foster inclusion, and promote community development.

## 2. Methodology

### A. Research Design

This community service project employed a participatory action research (PAR) design, emphasising collaboration among researchers, educators, and community stakeholders. The approach was selected to ensure that the development and implementation of ICT-based education and e-learning platforms were responsive to local needs while promoting sustainable community learning outcomes. The PAR framework allowed iterative cycles of planning, implementation, observation, and reflection, ensuring continuous improvement throughout the program.

### B. Participants and Setting

The program was conducted in a community learning centre that serves youth, adult learners, and local educators in a semi-urban area. A total of 60 participants were involved, consisting of 40 learners (high school students and adult learners) and 20 educators or facilitators. The selection of participants employed purposive sampling, prioritising individuals with limited access to conventional education resources but a high willingness to engage in ICT-supported learning.

### C. Intervention Procedure

The intervention was implemented in three phases:

a) Needs Assessment: Surveys, focus group discussions, and interviews were conducted to identify participants' learning needs, digital literacy levels, and technological accessibility.
b) Capacity Building: Training sessions were organised for educators and learners covering basic ICT skills, digital literacy, and the use of e-learning platforms such as Moodle and Google Classroom.
c) E-Learning Implementation: Customised online learning modules were developed, integrating multimedia content, interactive assessments, and collaborative discussion forums. Learners

engaged in both synchronous (virtual classes via video conferencing) and asynchronous (self-paced modules) learning activities.

**D. Data Collection Techniques**

To evaluate program effectiveness, both qualitative and quantitative data collection methods were employed:

a) Pre- and Post-Tests: Conducted to measure knowledge improvement and digital literacy competencies.
b) Surveys: Distributed to assess participants' perceptions of usability, accessibility, and satisfaction with ICT-based learning.
c) Interviews and Focus Groups: Carried out with educators and learners to gather in-depth feedback on challenges and opportunities.
d) Observation: Monitoring of learner participation, interaction, and engagement levels throughout the sessions.

**E. Data Analysis**

Quantitative data from pre- and post-tests and surveys were analysed using descriptive statistics and paired t-tests to identify significant improvements in knowledge and skills. Meanwhile, qualitative data from interviews, focus groups, and observations were analysed thematically to capture insights on participants' experiences, challenges, and suggested improvements.

**F. Ethical Considerations**

The research adhered to ethical standards by ensuring informed consent, voluntary participation, and data confidentiality. Participants were informed about the project's objectives, potential benefits, and their right to withdraw at any stage. The program also ensured that digital tools used complied with data privacy and security guidelines.

## 3. Result & Discussion

**Figure 1** demonstrates a clear improvement in participants' digital literacy competencies following the intervention. The pre-test scores across all four categories—Basic ICT Skills, Digital Literacy, E-Learning Usage, and Digital Problem Solving—were relatively low, ranging between 40 and 50. However, after the training program, the post-test results show significant increases, with scores ranging from the mid-70s to above 80. This indicates that the designed learning activities were effective in enhancing participants' abilities in various aspects of digital literacy. The most significant gain can be observed in Basic ICT Skills, where participants' scores rose from approximately 47 in the pre-test to nearly 78 in the post-test. This suggests that the intervention successfully addressed fundamental technology skills, which serve as a foundation for more advanced digital literacy practices. The structured training sessions, as described in the methodology, seem to have provided participants with the practical exposure and confidence needed to operate ICT tools effectively.

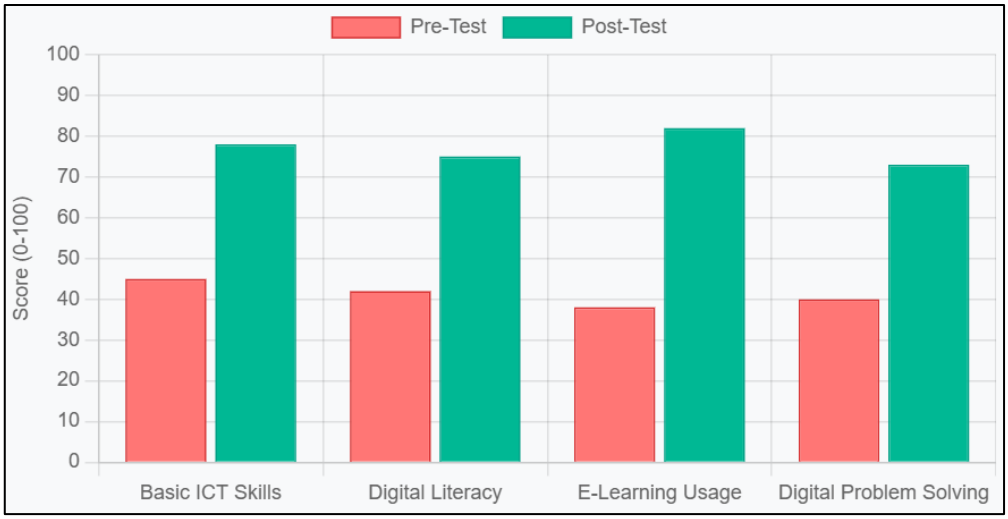


**Figure 1**: Comparison of Pre-Test and Post-Test Digital Literacy Results

E-Learning Usage also shows a substantial improvement, with scores increasing from around 42 to 82. This indicates that the training not only improved participants' general ICT knowledge but also equipped them with the ability to engage effectively with online learning platforms. Given that the integration of e-learning is a crucial aspect of education in the digital era, this improvement reflects the program's success in preparing learners for technology-mediated education environments. Ultimately, the results in Digital Problem Solving underscore the significance of critical thinking in digital environments. Although pre-test scores were relatively low at about 43, post-test scores rose to 73, showing notable progress. While this gain is slightly lower compared to other areas, it demonstrates that participants became more adept at applying their ICT knowledge to solve practical problems. This aligns with the article's objective of fostering not only technical familiarity but also functional digital literacy, which empowers learners to navigate challenges in digital spaces effectively.

**Figure 2** illustrates the three core phases of the ICT-Based Education Program implementation: Needs Assessment, Capacity Building, and E-Learning Implementation. This structured model highlights a systematic approach that ensures the program responds effectively to participants' actual conditions and requirements. The phased progression also reflects the principles of participatory action research (PAR), where cycles of planning, implementation, and reflection are emphasised to generate sustainable outcomes. The first phase, Needs Assessment, provided a foundation by identifying participants' digital literacy levels and learning needs through surveys, focus group discussions, and interviews. This stage was crucial for contextualising the intervention, ensuring that the program design was not generic but instead tailored to the realities of learners and educators. By recognising limitations in ICT access and digital competency, the project established a baseline that guided the selection of content, tools, and teaching strategies.

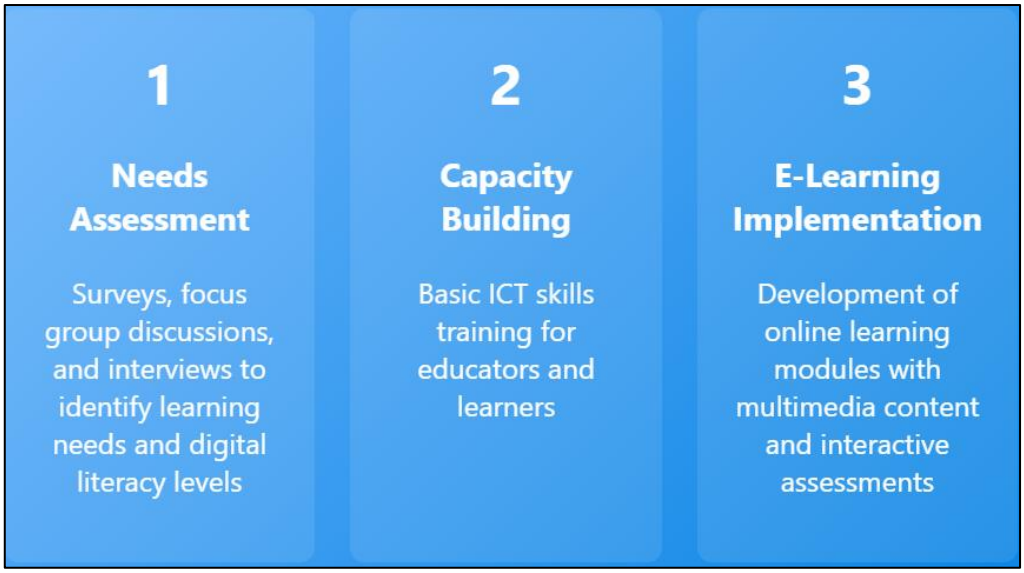


**Figure 2**: Implementation Phases of ICT-Based Education Program

The second phase, Capacity Building, focused on equipping both learners and educators with essential ICT skills. Training activities covered fundamental computer operations, internet navigation, and the use of e-learning platforms. This stage was not only about skill acquisition but also about building confidence in using digital tools for educational purposes. The emphasis on educator readiness reflects findings in prior literature that teacher competence is a critical factor in successful ICT integration. Finally, the E-Learning Implementation phase represented the practical application of knowledge gained. Online learning modules were developed with multimedia content and interactive assessments, promoting active participation and engagement. By combining synchronous and asynchronous approaches, the program catered to learners with diverse learning styles and schedules. This stage demonstrated the potential of ICT-based education to provide flexible, inclusive, and interactive learning experiences, supporting the broader aim of community empowerment through technology.

**Figure 3** presents the demographic composition of the 60 participants in the ICT-Based Education Program, comprising high school students, adult learners, and educators/facilitators. The distribution highlights the program's inclusivity, engaging both direct beneficiaries (students and adult learners) and enablers (educators). This diverse participation aligns with the program's objective of building digital literacy across multiple community segments, ensuring that the impact extends beyond individual learners to the broader educational ecosystem. High school students formed the largest group, as reflected in the figure. Their inclusion is significant because this demographic is remarkably adept at adapting to technology, making them ideal candidates for ICT-based learning interventions. By equipping young learners with digital competencies, the program supports long-term educational transformation, preparing them not only for higher education but also for future professional environments that demand digital literacy.

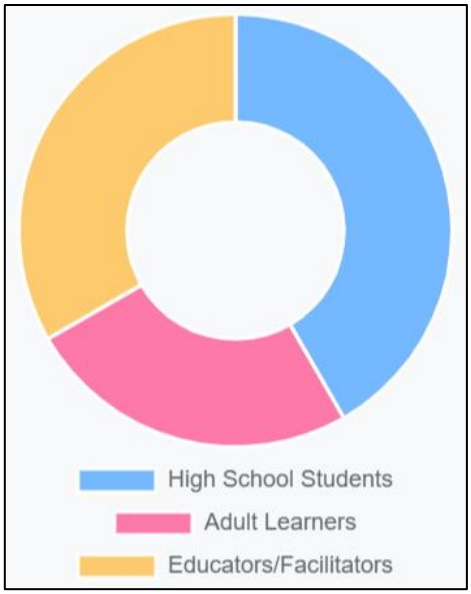


**Figure 3**: Participant Demographics (N=60)

Adult learners represented a substantial portion of the participants, underlining the importance of lifelong learning opportunities. Many adults in semi-urban or rural areas often have limited access to formal ICT training, which places them at a disadvantage in an increasingly digital society. Their participation in this program demonstrates a growing demand for digital upskilling among non-traditional learners and highlights the program's role in addressing social equity by bridging digital divides across generations. Finally, the involvement of educators and facilitators is crucial for the sustainability of ICT-based education. Their participation ensures that knowledge transfer is not one-directional but reinforced through classroom practices and community learning initiatives. By strengthening the digital capacity of educators, the program created a multiplier effect: empowered teachers can continue to train new learners beyond the project's timeframe. This integration of facilitators reflects the participatory action research (PAR) approach, which values collaboration and long-term capacity building.

**Figure 4** illustrates the usage rates of different e-learning platforms employed during the program, namely Moodle, Google Classroom, video conferencing tools, discussion forums, and mobile applications. Among these, Moodle achieved the highest usage rate, approaching 100%. This result demonstrates its effectiveness as the central learning management system, integrating multimedia resources, interactive assessments, and structured learning pathways. Its dominance reflects the participants' positive reception of a platform that is both versatile and widely adopted in educational contexts. Google Classroom also recorded a strong usage rate, slightly below Moodle. Its integration was beneficial for task management, assignment submissions, and feedback, features that educators and learners found intuitive. The high adoption rate of Google Classroom aligns with global trends in digital education, where lightweight, accessible platforms support both formal and informal learning. Together, Moodle and Google Classroom formed the backbone of the program's digital learning environment, ensuring reliability and flexibility.

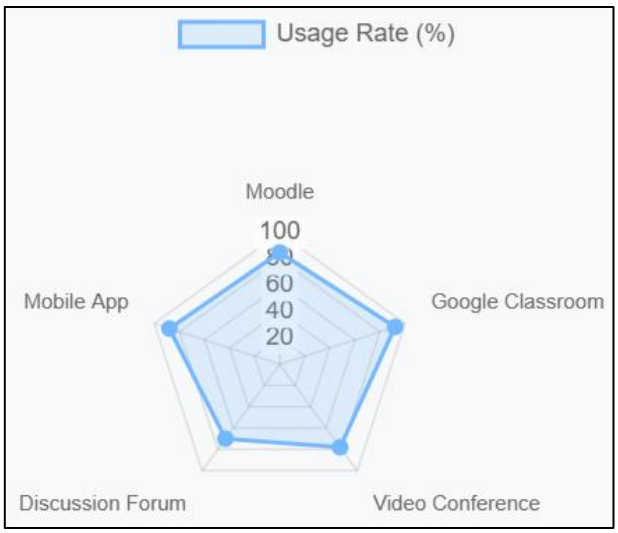


**Figure 4**: E-Learning Platform Usage Rate

Video conferencing and mobile applications demonstrated moderate to high levels of use, reflecting the participants' engagement with synchronous and mobile-friendly learning. The reliance on video conferencing indicates the value of face-to-face interaction, even within digital contexts, allowing for immediate clarification and fostering a sense of community among learners. Meanwhile, mobile applications supported learning beyond traditional computer-based access, enabling participants to continue engaging with materials anytime and anywhere, which is especially relevant in semi-urban areas with varying infrastructure availability. In contrast, discussion forums showed the lowest usage rate. This suggests that learners were less inclined to engage in asynchronous, text-based collaboration compared to multimedia-rich or real-time interaction platforms. While this may highlight a preference for more direct communication tools, it also reveals an area for future improvement: encouraging deeper peer-to-peer engagement and knowledge sharing. Strengthening the use of forums could enhance collaborative learning and critical thinking, aligning with the broader goals of ICT-based education to foster interactive and community-driven learning experiences.

**Figure 5** presents the results of the participant satisfaction survey on ICT-based learning, measured across four dimensions: ease of use, accessibility, content quality, and overall satisfaction. The scores, ranging from 4.0 to 4.3 out of 5, indicate a generally positive reception of the program. These findings complement the improvements shown in earlier figures, suggesting that participants not only enhanced their digital literacy skills but also perceived the learning platforms and content as supportive of their educational goals. The highest rating was given to content quality (4.3/5), which highlights the effectiveness of the multimedia learning modules and interactive assessments developed during the program. This suggests that participants valued not just the delivery tools but also the relevance and clarity of the instructional materials. Aligning with prior research, high-quality digital content significantly contributes to learner engagement and motivation, thereby reinforcing the program's design choices.


**Figure 5**. Participant Satisfaction Survey Results on ICT-Based Learning

Ease of use and accessibility followed closely, scoring 4.2/5 and 4.1/5, respectively. These results demonstrate that the selected platforms Moodle, Google Classroom, and mobile applications were user-friendly and adaptable to participants' varying technological conditions. Accessibility, while positively rated, was slightly lower compared to other dimensions, likely due to infrastructural limitations such as internet connectivity and device availability in semi-urban contexts. This highlights the need for ongoing efforts to address external barriers that may limit full access to e-learning opportunities. Overall satisfaction received a solid score of 4.0/5, indicating that participants were broadly pleased with the program, but also leaving room for further improvement. While learners appreciated the program's usability and content, enhancing collaborative features, such as discussion forums (as reflected in Figure 4), and strengthening support mechanisms could further raise satisfaction levels. These insights underscore that ICT-based education initiatives must continuously adapt, not only in terms of technical design but also in fostering inclusive, engaging, and sustainable learning ecosystems.

## 4. Conclusion

This study demonstrated that integrating ICT-based education and e-learning platforms can significantly enhance community learning outcomes, particularly in contexts with limited access to conventional educational resources. The pre-test and post-test results revealed substantial improvements in participants' ICT skills, digital literacy, e-learning usage, and digital problem-solving abilities, confirming the effectiveness of the intervention. These findings indicate that structured ICT programs have the potential to reduce digital divides and foster essential competencies among diverse learner groups. The three-phase implementation strategy, which includes needs assessment, capacity building, and e-learning implementation, proved to be a systematic and practical framework. The initial evaluation ensured that the intervention was tailored to the actual conditions and needs of learners and educators. The capacity-building phase equipped participants with the necessary skills and confidence to engage with technology, while the e-learning implementation phase successfully delivered interactive and multimedia-rich content that supported flexible learning opportunities.

Participant demographics highlighted the program's inclusivity, engaging high school students, adult learners, and educators. This diverse participation not only ensured direct learning benefits but also facilitated long-term sustainability by empowering educators and facilitators as agents of digital literacy. Moreover, the strong usage rates of platforms such as Moodle and Google Classroom, alongside positive satisfaction ratings for ease of use, content quality, and accessibility, emphasise that well-designed ICT interventions are both practical and acceptable for learners in semi-urban communities. Overall, the results affirm that ICT-based education and e-learning platforms are powerful tools for community empowerment and educational equity. By addressing local needs, providing capacity-building opportunities, and leveraging accessible digital platforms, such programs can foster inclusive, engaging, and sustainable learning ecosystems. Future initiatives should focus on strengthening collaborative learning features, overcoming infrastructural barriers, and scaling similar interventions to other communities to maximise the transformative potential of ICT in education.

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