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From Diagnosis to Action: Instructional Design for the Digital Inclusion of Older Women in the Amazon

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Abstract: *Background:* The digital divide disproportionately affects elderly women, especially those living in socioeconomically and geographically vulnerable contexts, such as the Brazilian Amazon. While digital technologies are increasingly embedded in everyday life, older women often face structural barriers to access, literacy, and meaningful use of mobile applications. *Purpose:* This study aims to present a structured, inclusive, and evidence-based educational model for digital inclusion of elderly women in the Amazon region. It focuses on the adaptation of the Mobile Device Proficiency Questionnaire (MDPQ) and the development of a contextualized instructional design grounded in andragogy and lifelong learning principles. *Methods:* A quasi-experimental study was conducted involving 32 elderly women, with data collected using a linguistically adapted MDPQ-18. The data supported the planning and implementation of digital literacy workshops organized according to the ADDIE instructional model. *Results:* The adapted MDPQ-18 showed reliable internal consistency and helped identify specific gaps in digital competencies. Five workshops were conducted in partnership with local institutions, reaching 70 participants and achieving an overall completion rate of 84.3%. Participant feedback indicated high satisfaction and improved confidence in mobile device usage. *Conclusion:* The results highlight the feasibility and social relevance of tailored instructional approaches for empowering digitally excluded elderly women. The integration of diagnostic tools, accessible language, and intergenerational support can foster digital autonomy, improve well-being, and contribute to more equitable digital citizenship.

Keywords: Digital Inclusion, Elderly Women, MDPQ, Andragogy, Lifelong Learning, Instructional Design, ADDIE, Amazon Region

1 Introduction

This article is an extended and revised version of a previous publication, which focused on the translation and adaptation of the MDPQ-16. The present version introduces a broader instructional model, a deeper theoretical expansion, and presents new empirical findings based on implementation and evaluation of digital literacy class.

The increasing digitalization of social, economic, and governmental activities has deepened historical inequalities in access to and use of digital technologies, especially among vulnerable populations such as older women living in peripheral areas with low connectivity, as is the case in the Brazilian Amazon region. Although population aging is underway in several countries, digital inclusion programs targeting the elderly—particularly women—remain scarce, uncoordinated, and disconnected from local contexts [Nakayama *et al*., 2023], [Molala and Makhubele, 2021].

The use of digital technologies by Brazil's older population presents a significant challenge [Bocchini, 2020]. For instance, the increasing adoption of smart TVs in the country is often accompanied by usability difficulties for older adults, who tend to continue watching traditional broadcast television due to challenges in navigating streaming applications such as *Netflix* and *YouTube* [Velho and Herédia, 2020]. While several initiatives promote girls' participation in STEM education and encourage women's entry and retention in technology fields [Pinheiro *et al*., 2023], a noticeable gap remains regarding older women. In the Amazon region, digital inclusion barriers for elderly populations include the lack of appropriate environments and resources, as well as the need to develop methodologies and practices specifically tailored to this audience [Araújo *et al*., 2022]. The women reaching old age today are part of generations that historically had fewer opportunities for education and access to technology, making them disproportionately affected by digital inequality [The United Nations Organization, 2021].

In this context, this study proposes a methodological approach to promote the digital inclusion of older women, anchored in a pedagogical model based on andragogy, the lifelong learning paradigm, and the ADDIE instructional design model (Analysis, Design, Development, Implementation, and Evaluation). For diagnosing digital competencies and constructing the instructional design, the *Mobile Device*

Proficiency Questionnaire (MDPQ) was adapted and applied, rewritten in plain language to ensure textual and cognitive accessibility for the target audience [Roque and Boot, 2018; Sanches *et al*., 2022].

The originality of this proposal lies in the integration of four theoretical-methodological pillars: (i) the use of a validated self-assessment instrument for mobile device digital proficiency, linguistically and culturally adapted (MDPQ-18); (ii) the planning of training workshops based on the ADDIE model, promoting a design focused on the needs of older populations; (iii) the application of andragogical principles and lifelong learning as educational guidelines [Machado *et al*., 2011; Hozjan, 2009]; and (iv) articulation with community institutions (NGOs and public social service centers—CRAS), which enabled the practical implementation of the proposal in real-world contexts, for the implementation of the Tecer Mulher Project (in Portuguese, Projeto InTercâmbio Tecnológico Intergeracional para a Mulher Idosa) or TMP .

The main contributions of this work include: (i) demonstrating that adapting the MDPQ-16 into plain language is both feasible and effective for mapping digital competency gaps in low-tech-literacy populations; (ii) structuring a training pathway based on diagnostic evidence, with a high rate of adherence (84.3%) and satisfaction; and (iii) emphasizing intergenerational and affective learning as a strategy for empowering older women digitally, thereby enhancing their citizenship and social well-being.

This article is organized as follows: **Section 2** presents the theoretical framework, covering the foundations of digital inclusion, digital proficiency, andragogy, and instructional design; **Section 3** discusses related work; **Section 4** details the methodology of the project; **Section 5** presents the main results from the application of the MDPQ-18 and the implementation of the training workshops; finally, **Section 6** presents the conclusions, limitations, and future research directions.

2 Theoretical Framework

This section presents the theoretical foundations underpinning the digital inclusion project for older women in the Amazon region. It outlines an overview of the digital inclusion landscape for older adults (**Subsection 2.1**), the definitions adopted for digital competencies and digital proficiency (**Subsection 2.2**), the concepts of andragogy and lifelong learning that inform the present educational approach (**Subsection 2.3**), the ADDIE model for instructional design (**Subsection 2.4**), and finally, how these frameworks align and complement one another (**Subsection 2.5**).

2.1 Digital Inclusion of Older Adults

The digital inclusion of older people is a topic that demands greater attention in light of global population aging and increasing reliance on digital technologies [Pinheiro *et al*., 2020]. Several factors may hinder this inclusion process, such as physical limitations that make it harder to use digital devices—particularly due to visual, auditory, or motor impairments, exacerbated by the miniaturization of components, as seen in CAPTCHA security tests. Many applications feature complex interfaces, and touchscreen devices require dexterity to operate. Additionally, cognitive decline and memory loss in many older adults reduce their problem-solving abilities, further complicating digital exclusion [Xu *et al*., 2024].

Another challenge is the lack of familiarity, which can lead to fear of making irreversible errors while using devices. Many older adults have had little to no contact with digital technology for most of their lives [Xavier, 2022]. Digital exclusion may isolate older adults from virtual interactions, negatively impacting their mental health and overall well-being [Brasil, 2023].

In countries with rapidly aging populations, governments have implemented various initiatives to promote digital inclusion among older adults. For instance, the Chinese government has developed applications tailored to the needs of the elderly and offered training opportunities to reduce digital exclusion [Li and Kostka, 2024]. Similarly, age-friendly cities in Spain have launched projects to enhance digital literacy and participation among older adults. These initiatives include active involvement of older people in digital public governance, the promotion of co-created projects, and the adoption of accessibility and universal design standards—essential elements for truly inclusive and age-adapted environments. In such cities, public libraries and schools provide learning hubs mediated by ICT, offering digital tools and practical instruction facilitated by trained staff [Kolotouchkina *et al*., 2023].

Women are disproportionately affected by digital exclusion due to historically lower exposure to technology, lower socioeconomic status, reduced internet access, sociocultural factors (such as gender roles and patriarchy), internalized ageism (feeling digitally incompetent), and external ageism, which fosters social discrimination based on negative perceptions of aging [Choi *et al*., 2020; Molala and Makhubele, 2021; Nakayama *et al*., 2023; da Silva Lopes and de Ulysséa Leal, 2024]. These factors perpetuate gender inequality, even in old age. In Brazil, demographic factors exacerbate the situation. Multiracial populations in the North and Northeast regions of the country have proportionally lower internet access, attributed to factors such as unavailability of services, lack of digital literacy, and cost. Even when access is available, mobile devices and mobile broadband are the predominant means of connection. People living in rural areas—particularly in the Amazon—are significantly less likely to access the internet [Nakayama *et al*., 2023].

2.2 Digital Proficiency in Older Adults

According to Slodkowski *et al*. [2022], digital competencies (DC) in the context of older adults can be defined as the ability to integrate knowledge, skills, and attitudes (KSA) to use digital technologies critically, creatively, safely, and autonomously, solving everyday problems by leveraging digital resources in reflective and adaptable ways. The three core competencies that should guide digital inclusion courses for older adults, as proposed by Machado *et al*. [2016], are Digital Literacy, Digital Fluency, and Digital Proficiency.

Digital Literacy refers to the functional mastery of technology, including reading and writing skills necessary to access knowledge in digital environments. Digital Fluency goes beyond literacy, encompassing the ability to search, evaluate, reflect upon, and critically analyze online information, and use digital tools appropriately. Digital Proficiency, in turn, requires individuals not only to read, write, save, and send documents but to do so critically and strategically, combining different tools efficiently.

The term digital literacy is sometimes used interchangeably with digital competencies [Røkenes and Krumsvik, 2016], though in scientific literature, it is often defined as the user's ability to understand information and complete tasks in digital environments [Castilla *et al*., 2018]. A comprehensive discussion of this terminology across political, sociological, educational, and technological perspectives is provided in Lucas and Moreira [2017]. Frameworks such as the European Digital Competence Framework (DigComp) [Carretero Gomez *et al*., 2017] and aging and technology studies [Oliveira *et al*., 2023a] define digital literacy as a foundational set of skills necessary for achieving digital competencies. The following domains are highlighted in Lucas and Moreira [2017]; Carretero Gomez *et al*. [2017]:

- **Information and Data Literacy:** The ability to locate, retrieve, evaluate, organize, and critically use digital information. For older adults, this is essential for identifying trustworthy content, avoiding misinformation, and making informed decisions, particularly in areas like health and public services.
- **Communication and Collaboration:** Effective use of digital technologies to interact and collaborate with others. This includes email, social networks, video calls, and instant messaging apps (e.g., *WhatsApp*), while also promoting ethical behavior such as respecting others' privacy. These skills help reduce digital isolation.
- **Digital Content Creation:** The ability to create, edit, and enhance digital content (texts, images, videos), as well as understanding copyright and licensing. For older adults, this may involve posting photos or creating simple videos to share experiences, adapting content to various platforms.
- **Safety:** Protecting devices, personal data, and digital well-being. This includes password security, antivirus updates, privacy settings, and avoiding scams. It also includes understanding risks associated with online presence and physical and mental health considerations related to technology use.
- **Problem Solving:** Identifying technical problems, finding solutions, and adapting to new technologies. This includes creatively using tools to solve daily challenges, such as booking appointments or using transport apps, thereby promoting digital autonomy.

Digital Proficiency (DP) is the level of mastery and autonomy with which a person uses digital technologies to access, evaluate, create, and communicate information, solve problems, and participate in society effectively, safely, and critically [do Nascimento *et al*., 2018]. It extends beyond mere technical use to include comprehension, ethical judgment, and adaptability in the face of rapid technological changes. Thus, greater digital competency development corresponds to higher levels of digital proficiency. As digital literacy forms the foundation of competency development, it is also a necessary step toward achieving proficiency. Different levels of digital proficiency exist for each digital competency, as presented by Lucas and Moreira [2017].

Measuring proficiency helps group learners by similar needs, plan training sessions, and develop appropriate teaching materials, thereby avoiding frustration or disengagement among participants with differing skill levels [Petrovčič *et al*., 2019]. However, the vast variety of devices and content delivery formats makes mediating DP highly complex.

Television remains a key companion for older adults living alone, as highlighted in [Skorupska *et al*., 2018]. This same study also highlights the complexity and diversity of interfaces for Smart TVs, VOD (Video On Demand), and OTT (Over The Top) streaming services. Smart TVs are internet-connected devices with built-in operating systems, allowing access to streaming services and apps. Although designed for simplified remote use, they may still pose usability challenges for older adults if not properly adapted. VOD allows users to choose what to watch and when, without a fixed schedule, and includes SVOD (subscription-based, e.g., Netflix), TVOD (transactional, e.g., Apple TV), and AVOD (ad-based, e.g., YouTube). These models emphasize user autonomy. OTT content is delivered via the internet, bypassing traditional cable providers, requiring only internet access. These formats often involve varying interaction models and require greater learning effort, as a single button may serve multiple functions on the remote.

Similarly, the widespread use of tablets and smartphones among older adults has prompted several studies on training programs that support the development of digital skills in mobile contexts [Brivio *et al*., 2018]. Barriers include information overload due to crowded screens, abstract icons and hidden menus, and the use of technical terminology that hinders understanding [Quialheiro *et al*., 2023].

The *Mobile Device Proficiency Questionnaire* (MDPQ), developed by Roque and Boot [2018]; Moret-Tatay *et al*. [2019], is a self-assessment tool designed to measure adults' proficiency in using mobile devices such as smartphones and tablets. It covers eight skill domains: basic mobile device usage, communication, data and file management, internet, calendar, entertainment, privacy, and software problem-solving [Moret-Tatay *et al*., 2019]. The original MDPQ consists of 46 items. Its adapted version, MDPQ-16, includes 16 items and imposes lower cognitive load on participants, which may improve response rates [Roque and Boot, 2018]. The MDPQ is further discussed in Subsection 4.2. The *Computer Proficiency Questionnaire* (CPQ) is another tool used to assess user abilities with computers and internet technologies [Zhang *et al*., 2017].

2.3 Andragogy and Lifelong Learning

Andragogy refers to education tailored to adults, using specific methodologies that draw upon their accumulated life experiences and tacit knowledge. It is traditionally linked to training and professional development for older age groups. Unlike pedagogy, which is centered on children's educa-

tion, andragogy is based on the premise that adults are self-directed learners—meaning they prefer to take responsibility for their own learning and are typically motivated by immediate, practical needs. Gerontagogy is a branch of andragogy specifically focused on older adults, taking into account their cognitive and motor pace, and emphasizing content with personal and social relevance [Machado *et al*., 2011].

Several universities and international organizations have formalized frameworks for adult education. Examples include: *i*) the UNESCO Lifelong Learning Framework, which recognizes adult education as a right and a development strategy [Soek and Haracemiv, 2021]; *ii*) the European Commission's Key Competences Framework, which includes digital competence, autonomous learning, and citizenship [Benvenuti *et al*., 2023]; and *iii*) the PRATT Model (*Five Perspectives on Teaching in Adult and Higher Education*), which evaluates teaching practices based on five orientations: transmission, developmental, learner-centered, engagement, and emancipation [Prantt, 1998].

The expression *Lifelong Learning* refers to an educational approach that recognizes learning as a continuous and permanent process, not limited to childhood or formal schooling. It encompasses formal, non-formal, and informal education [Roque and Boot, 2018]. This approach considers learning throughout all stages of life—from birth to old age—and supports the development of skills to cope with rapid technological and social changes [Thwe and Kalman, 2024].

Lifelong learning and andragogy together form the foundation of educational approaches centered on adult learners. According to Patrício [2014], andragogy emphasizes learner autonomy, prior experience, and intrinsic motivation. The lifelong learning model, on the other hand, asserts that knowledge can be acquired at any stage of life, which is particularly important for historically marginalized populations, such as older women in peripheral contexts [Cangue, 2020].

The European Union has proposed a set of key competences for lifelong learning and adult education, considered essential for personal development, social inclusion, and employability. These competences comprise an integrated set of knowledge, skills, and attitudes that every individual should develop throughout life, regardless of age or occupation [Hozjan, 2009]. These competences are:

- **Communication in the mother tongue:** the ability to express and interpret concepts, thoughts, feelings, and opinions both orally and in writing.
- **Communication in foreign languages:** similar abilities as in the mother tongue, adapted to other languages and cultural contexts.
- **Mathematical competence and basic competences in science and technology:** problem-solving and logical reasoning skills applied to practical daily life.
- **Digital competence (ICT):** confident and critical use of information and communication technologies for work, learning, and communication.
- **Learning to learn:** the ability to manage one's own learning, including time and knowledge organization.
- **Social and civic competences:** the aptitude to participate effectively and constructively in social and professional life.
- **Sense of initiative and entrepreneurship:** the ability to turn ideas into action, take risks, and plan projects.
- **Cultural awareness and expression:** appreciation of cultural heritage, creative expression, and respect for diversity.

In general, continuous learning requires individuals to constantly adapt to changing scenarios and different political and social contexts—such as those brought about by new technologies and transformations in people's ways of life. Developing digital competencies is one of the most important ways of practicing lifelong learning today.

2.4 ADDIE Instructional Design

The ADDIE model is a systematic and widely recognized approach in the field of Instructional Design for planning educational programs and training courses. Its name is an acronym for its five main phases: Analysis, Design, Development, Implementation, and Evaluation [Davis, 2013]. Its structure allows adaptations based on the target audience and context, making it useful both in formal educational environments and in outreach or community-based projects.

In the analysis phase, the focus is on identifying the learners, their needs, knowledge gaps, sociocultural context, available resources, and learning objectives. The design phase is based on the findings from the analysis. In this stage, specific learning goals, content, instructional sequence, and pedagogical strategies appropriate for the target audience are defined. In the development phase, educational materials and instructional resources are produced based on the prior design. The implementation phase involves delivering the educational program to participants, addressing logistical, human, and technological considerations. Finally, in the evaluation phase, tools are used to measure the training's impact and identify areas for improvement. Evaluation can be formative (throughout the process) or summative (at the end).

The ADDIE model is recommended for learning scenarios such as the introduction of new initiatives (e.g., implementation of new systems, policies, or technologies) and performance issues (e.g., low productivity or frequent operational errors), as it provides clarity and objectivity in planning and executing educational activities [Chyung, 2008]. The structure also serves as a foundational model for courses and training programs initially designed as pilots, allowing for later transition to more flexible approaches (such as SAM, Agile Learning, or Rapid Prototyping) [Spatioti *et al*., 2022].

Table 1 presents the adapted version of the ADDIE model used in the context of the project described in this paper. Each phase of the model includes a set of practical strategies implemented in the training course, demonstrating that although the model follows a cyclical/linear structure, there is room for flexibility and adaptation within each stage.

2.5 Alignment of Theoretical Framework

The theoretical framework presented in this paper brings together four foundational pillars that underpin the methodological proposal for digital inclusion of older women in Amazonian contexts: digital inclusion, the development of

Table 1. ADDIE Model Adapted for Andragogical Contexts

Phase	Adaptation for Adults/Elderly	Practical Strategies
Analysis	Participatory diagnosis with active listening. Identification of cognitive, social, and technological barriers.	- Accessible pre-tests (e.g., MDPQ-18) - Group discussions and field observations - Survey of local demands
Design	Modular and flexible planning focused on practical and meaningful objectives for the target audience.	- Workshop sequences based on everyday themes - Clear and contextualized goals - Selection of relevant apps
Development	Creation of materials using plain language, multimodality, repetition, and accessibility principles.	- Illustrated guides and step-by-step tutorials - Subtitled videos and visual metaphors - Practical simulations
Implementation	Workshops with intergenerational support, affective environment, individualized pacing, and humanized mediation.	- Pairs (youth + elderly women) - Constant in-person support - Non-judgmental learning space
Evaluation	Ongoing and formative assessment focused on personal progress and digital self-confidence.	- Simple tests with real-world simulations - Final discussion circle - Feedback questionnaires with emojis

digital skills and proficiency, the principles of andragogy and lifelong learning, and the ADDIE instructional design model.

Digital inclusion of older adults—especially women—is intrinsically linked to structural factors such as gender, territory, ethnicity, and income, as demonstrated by studies pointing to inequalities in access to and use of technology [Nakayama *et al*., 2023; Molala and Makhubele, 2021]. These inequalities directly impact the autonomy, well-being, and digital citizenship of this population. In this context, understanding digital proficiency as the result of developing a set of competencies—based on specific literacies—is essential for planning more effective educational interventions. Literature shows that digital literacy, fluency, and critical thinking represent progressive levels of technological mastery that must be taken into account in the development of training programs [Machado *et al*., 2016; Lucas and Moreira, 2017].

The use of validated instruments, such as the MDPQ, makes it possible not only to identify gaps in digital proficiency but also to tailor teaching and learning processes according to participants' real needs. The application of diagnostic tools supports a learner-centered approach adapted to local realities and becomes a key starting point for developing contextualized educational strategies that are respectful of the cognitive and sociocultural specificities of older adults.

Grounding the project in andragogy and the lifelong learning paradigm reinforces the understanding that adults learn from their experiences and personal motivations. Valuing autonomy, prior knowledge, and the immediate applicability of content is essential to fostering a meaningful and empowering learning environment for older women. Furthermore, alignment with international frameworks of key competences for citizenship and continuous learning highlights digital competence as one of the keys to full participation in contemporary society [Hozjan, 2009; Benvenuti *et al*., 2023].

Finally, the ADDIE model proves to be a suitable methodological choice by offering a cyclical and adaptable structure for planning, developing, implementing, and evaluating training initiatives iteratively and contextually. Its integration with the principles of andragogy and the analysis of digital proficiency results in an instructional design that is learner-centered and experience-based. Altogether, the theoretical framework discussed herein serves as the foundation for the conception and implementation of the project, ensuring pedagogical coherence, scientific rigor, and social relevance.

3 Related Work

This section is structured as follows: **Subsection 3.1** presents a set of tools used to assess digital proficiency in older adults, as identified in recent literature; **Subsection 3.2** highlights key projects and initiatives aimed at digital inclusion for the elderly. Finally, the section concludes with a brief discussion on key findings from the literature regarding digital inclusion for older women (**Subsection 3.3**).

3.1 Instruments for Assessing Technology Proficiency in Older Adults

Numerous instruments for assessing digital proficiency in older adults have been used in several countries as a way to identify learning needs in an increasingly digital world [Oh *et al*., 2021]. The results from these tools contribute to the development of user-centered digital literacy programs.

Regarding the MDPQ approach, three main studies stand out: one from the United States [Roque and Boot, 2018], and two from Europe [Petrovčič *et al*., 2019; Moret-Tatay *et al*., 2019]. The MDPQ-46 and MDPQ-16 were proposed by Roque and Boot [2018]. These tools, along with the CPQ-12, were applied to populations of both older and younger adults in the United States, with scoring based on average responses. Individuals with lower levels of education across all age groups showed the lowest digital proficiency levels.

In addition to MDPQ, other widely used tools for assessing digital proficiency include those listed in **Table 2**:

Choosing the right instrument requires consideration of the target audience, the type of digital tasks to be assessed, and the application context. In Tecer Mulher Project, the adapted version of the MDPQ, written in plain language, cap-

Table 2. Digital Proficiency Assessment Instruments

Instrument	Main Focus	Type	Target Audience
MDPQ (46/16) [Roque *et al*., 2018]	Use of mobile devices (smartphones/tablets)	Self-assessment	Adults and older adults
DigCompSAT [Carretero Gomez *et al*., 2017]	General digital competences (based on the European Framework)	Self-assessment	All educational levels
Digital Competence Wheel [Skov, 2023]	Visualization and self-assessment of 20 digital competencies	Online self-assessment	Educators, students, and professionals
eHEALS [Norman and Skinner, 2006]	Health digital literacy	Self-assessment	Patients, elderly, and caregivers
ICT Proficiency (PIAAC) [OECD, 2019]	Problem-solving in digital environments	Practical evaluation	General population (international studies)

tured participants' initial self-perceptions, serving as a reference for planning educational workshops.

In the field of digital inclusion for older adults, [Petrovčič *et al*., 2019] conducted a study in Slovenia applying the MDPQ to two sample populations—older adults and young adults—using *GoLivePhone* (GLP) and Android devices. The authors adapted the MDPQ-46 to a MDPQ-28 and a shorter version, MDPQ-14. All three versions were validated using Pearson correlation and Cronbach's alpha. The Spanish study [Moret-Tatay *et al*., 2019] adapted the MDPQ and CPQ for both face-to-face and online administration to three age groups: young, middle-aged, and elderly. Scores were calculated using the mean and standard deviation of responses. Older participants showed the lowest levels of technological proficiency, significantly impacting their digital inclusion.

Recent Brazilian studies such as Balduino *et al*. [2024], Pessoa *et al*. [2024], and da Cruz *et al*. [2024] have also confirmed, through construct validity and reliability analyses, that the MDPQ is an effective tool for digital inclusion programs. These tools help improve program design to better serve the elderly population. The studies also revealed that participants with lower age and higher education tended to score higher in digital proficiency, while advancing age correlated with decreased mobile device proficiency. In particular, Pessoa *et al*. [2024] highlighted the urgent need to create and validate tools tailored to the specific needs of Brazilian seniors, so results better reflect the local context. The present work contributes to this research landscape by proposing a new adaptation of the MDPQ and presenting findings from research conducted in the Brazilian Amazon region.

Regarding instructional methods and development of educational materials for elderly digital inclusion, de Sales *et al*. [2013] investigated the creation of learning resources using a user-centered design approach. The study identified a need to adapt instructional materials to the specific characteristics of older adults, considering cognitive, emotional, and physical changes common in this age group. Printed materials and video lessons were created and positively evaluated by participants for prioritizing comprehension, experience, and respect for their limitations.

Tilvitz and Areosa [2022] studied the phenomenon of digital inclusion through mobile phones and smartphones among Brazilian seniors, 90% of whom were women. Findings showed that over 80% of this population tend to avoid or reduce smartphone use due to the lack of simplified or adapted resources for their needs. A significant portion also expressed interest in learning more about smartphone use.

Both de Sales *et al*. [2013] and Tilvitz and Areosa [2022] provide strong justification for the development of this current work, emphasizing the importance of promoting digital skills and inclusion for elderly women in the Amazon region.

The MDPQ-16 was selected due to its proven applicability in elderly populations, reduced cognitive load, and the feasibility of plain-language adaptation. While more extensive versions such as the MDPQ-46 provide deeper granularity, the simplified 16-item version offered a better balance between comprehensiveness and accessibility, especially for participants with lower literacy levels. The subsequent adaptation to MDPQ-18 introduced local relevance without compromising clarity.

3.2 Initiatives for Digital Inclusion of Older Adults

Digital inclusion for older adults has been widely discussed in recent studies, particularly in relation to methodologies and social impacts, with *smartphones* emerging as a central tool, as explored in this section.

In Oliveira *et al*. [2023b], the integration of ICT learning into adult education programs is discussed, highlighting smartphone training as a strategy for promoting autonomy. Tecer Mulher Project, in turn, adopts an intergenerational approach, connecting youth and elderly individuals for collaborative learning. Meanwhile, Rosa *et al*. [2023] focused on the digital inclusion of older women in a remote environment, emphasizing the challenges of digital learning. In contrast, Tecer Mulher Project implements in-person courses to promote more immersive learning experiences.

The study by Silva *et al*. [2024] presents the experience of a university extension course held in Recife-PE, covering topics such as social media, recipe websites, and digital Bibles. The present proposal shares the same goal but differentiates itself by incorporating linguistic adaptations to match the participants' communication style, valuing intergenerational knowledge exchange, and conducting a formal study of local needs using a scientific tool, alongside the development of an instructional design based on a formal model from the literature.

In Gomes *et al*. [2024], an instructional design model was developed to help older adults prevent online scams. TMP also addresses digital safety but does so within a broader con-

text of digital literacy. A similar perspective is observed in the study by Mota *et al*. [2024], which analyzed the usability of banking apps for older adults. This project aims not only to empower older users but also to train younger participants (tutors and instructors in the team) to reflect on how to design intuitive interfaces. This includes avoiding complex elements that may confuse older users and identifying accessible design principles such as larger buttons, readable fonts, and digital assistance features.

The authors in Galetti *et al*. [2023] discussed the issue of equity in digital inclusion among older adults during the pandemic, stressing the importance of adapted methodologies. Tecer Mulher Project differentiates itself through its intergenerational approach, encouraging knowledge exchange between generations. Another distinctive feature is the proposal of a collaborative and strategic instructional design that facilitates the creation, implementation, and evaluation of the learning experience. To this end, the project adopts the ADDIE model, which divides the process into five phases: *Analysis*, *Design*, *Development*, *Implementation*, and *Evaluation* [de Oliveira *et al*., 2021; Vieira *et al*., 2022]. A comparison of recent related studies and their differences from TMP, according to the ADDIE model, is presented in **Table 3**.

3.3 Analysis of Literature Findings

The analysis of the reviewed studies reveals significant advances in understanding the digital needs of the elderly population, as well as pedagogical and methodological strategies to promote their digital inclusion. Overall, assessment tools such as the MDPQ, in its various versions and cultural adaptations, have proven effective in detecting gaps in digital proficiency and guiding formative actions more aligned with local realities. Both national and international studies emphasize the importance of accessible language, self-assessment, and operational simplicity as fundamental criteria for the effectiveness of these tools.

Regarding training initiatives, there is a growing emphasis on methodologies centered on the adult learner's experience, aligned with the principles of andragogy and the lifelong learning paradigm. Strategies such as the use of contextualized content, multimodal materials, and intergenerational learning stand out as good practices for engaging older adults in the critical and autonomous use of digital technologies. Projects focused on digital security, accessibility in banking applications, and the development of everyday digital skills reinforce the importance of approaches that foster not only usability but also participants' digital confidence.

Despite these advances, there is still a notable lack of projects specifically targeting older women, particularly in peripheral or geographically remote regions far from urban centers. Studies addressing the intersectionality of gender, aging, and digital exclusion are scarce, revealing a critical gap that must be urgently addressed. Additionally, limitations remain in the use of rigid instructional models that are not sensitive to the cognitive, social, and emotional particularities of this population.

This work seeks to address these gaps by proposing an extension experience aimed at promoting digital inclusion among older women in the Amazon region. It employs an adapted version of the MDPQ alongside an instructional design based on the ADDIE model. This approach combines methodological rigor with social sensitivity, prioritizing strategies of affective engagement, accessible language, and learner empowerment throughout the educational process. Thus, the work contributes to advancing more equitable and situated educational practices, especially in the field of digital skills for historically marginalized populations.

4 Methodology

This section presents the methodology adopted for the project (**Subsection 4.1**), the instrument adapted from the literature to identify the learning needs of the target audience (**Subsection 4.2**), as well as the methodology for lesson planning (**Subsection 4.3**).

4.1 Project Methodology

The project was developed in three phases: *i*) identification of learning needs, *ii*) course planning and development, and *iii*) course implementation and results assessment. The course "Unveiling the Use of Utility Applications on Smartphones" was offered to five different groups.

In phase *i*), a formal tool called the *Mobile Device Proficiency Questionnaire* (MDPQ) was used in conjunction with structured interviews (presented in **Subsection 4.2**). The results from this phase informed the subsequent planning stage, phase *ii*), in which the workshops and course content were defined. This second phase adopted a Contextualized Instructional Design methodology to organize the content according to the identified needs and established objectives. This phase aligns with key principles of andragogy, prioritizing prior experience, immediate needs, and practical motivation.

The development of educational materials was guided by the principles of plain language [Sanches *et al*., 2022], with all content adapted for the target audience. According to Sanches *et al*. [2022], Plain Language is both a social cause and a communication technique, ensuring that everyone has the right to understand information that guides their daily lives. To support comprehension, slides included illustrative images, reduced text density, and translations of technical terms into Portuguese.

Still in phase *ii*), digital *e-books* and informational booklets were produced and shared with students as support materials. The creation of these materials was informed by Valletta [2015], ensuring alignment with contemporary best practices for educational technologies and academic writing.

Phase *iii*) consisted of course implementation using Dialogical Classes, a methodology widely recommended for elderly learners [Cachioni *et al*., 2015]. In dialogical classes, teachers and learners exchange knowledge and experiences around the topics discussed, creating interdependence through a shared process of giving and receiving information. The first session began with an open dialogue circle, where participants were invited to reflect on their difficulties and aspirations regarding smartphone use. The final session of each course was dedicated to evaluating participants' satisfaction with the format and content of the course.

Table 3. Comparison between studies and Tecer Mulher Project using the ADDIE model

Study	Analysis	Design	Development	Implementation	Evaluation
Oliveira *et al*. [2023b]	Identification of smartphone usage challenges	Modular course structure	Digital educational materials	Remote classes	Usability questionnaires
Rosa *et al*. [2023]	Need for remote digital inclusion	Creation of digital guides	Accessible video content	Asynchronous tutorials	Feedback via email and forums
Silva *et al*. [2024]	Lack of in-person courses for the elderly	Planning of interactive workshops	Simplified audiovisual resources	In-person sessions	Observation and interviews
Gomes *et al*. [2024]	High rate of online scams targeting the elderly	Development of digital safety content	Practical simulations	App-based training	Learning monitoring
Mota *et al*. [2024]	Usability challenges with banking apps	Course design on digital usability	Guided practice exercises	Individual follow-up	Hands-on testing with real apps
Galetti *et al*. [2023]	Inequality in access to digital technologies	Intergenerational learning strategy	Formation of collaborative groups	Meetings between young and elderly	Qualitative impact assessment
Tecer Mulher Project	Low digital inclusion and social exclusion of older women in the Amazon region	Intergenerational and community-based approach	Development of accessible booklets and e-books	Hands-on workshops with mentorship	Ongoing evaluation through feedback and engagement metrics

4.2 MDPQ

The MDPQ was first proposed by Roque and Boot [2018] and is organized into 8 domains comprising a total of 16 positive declarative items, hence named MDPQ-16. It was originally applied in Florida (USA). Each item has five possible responses on a scale from 1 to 5, with the following meanings: never tried (1), not at all (2), not very easily (3), somewhat easily (4), and very easily (5). The original MDPQ-16 is written using technical terminology such as ”instant messaging application”, ”portable device”, ”information storage”, and ”search engines”. It also includes application examples such as *AIM, Yahoo Messenger, MSN Messenger, Skype, FaceTime*, among others, which may not be commonly used or recognized in other parts of the world.

The MDPQ-16 was translated into Brazilian Portuguese and then rewritten using the “Comunica Simples” method, which is based on seven plain-language principles (empathy, information hierarchy, familiar words, concrete language, short sentences, direct order, and diagnostics) to make content more cognitively and linguistically accessible Sanches *et al*. [2022]. Furthermore, the Likert scale was adopted for responses, given its broader recognition and familiarity. The scale ranged from 1 (strongly disagree) to 5 (strongly agree), without loss of interpretive value relative to the original format.

Additionally, a new domain with two items was created and added to the translated MDPQ-16. This new domain, titled “Resource/Performance Optimization,” although conceptually similar to the original “Data and File Storage” domain, was designed to capture users’ recent concerns about mobile device storage capacity and multimedia file management. As a result, the translated version became the MDPQ-18, presented in **Table 4**.

The MDPQ-18 was printed and administered to the target audience with the assistance of a researcher. Data collection occurred over a three-week period, from February 26 to March 15, 2024. Participants were invited through three types of community organizations: (*i*) nine women engaged in weekly activities at a Social Assistance Reference Center (CRAS), (*ii*) six women from nonprofit institution 1 with ongoing elder support programs, and (*iii*) seventeen women actively participating in a religious community group (also nonprofit institutions). The recruitment followed an incidental sampling approach based on the institutions’ availability and willingness to collaborate with the university outreach project. Before administering the MDPQ-18, the extension project and its objectives were presented to participants, including the intended use of the collected data. Following this preliminary session, researchers conducted individual interviews with women who met the study’s age criteria. All participants were provided with detailed study information and signed an informed consent form.

Since this was an opinion-based study, no personally identifiable or sensitive data were collected. Data analysis was carried out using the JASP software and the Python programming language, which were used to organize and visualize the results through tables and charts.

To assess the instrument’s reliability and validity, Cronbach’s Alpha [Cronbach, 1951] was used to measure the internal consistency of each domain. Additionally, average variance extracted (AVE) and composite reliability (CR) metrics were applied [Valentini and Damasio, 2016]. Descriptive statistical analysis was also conducted to compare the participants’ self-assessment levels across different domains.

This study aimed to answer the following two key research questions:

Q1: What is the average proficiency level of older women users in using mobile devices (smartphones)?

Q2: Which domains represent the highest and lowest proficiency levels for these users?

This study was submitted to the university’s Research Ethics Committee in alignment with Brazilian regulatory standards. However, following Resolution CNS No. 510/2016 [Brazil. The National Council of Health, 2016], the Committee determined that formal approval was not required, as this research qualifies as a public opinion study under Article 2(XIV). The study’s sole purpose was to describe participants’ subjective valuations (e.g., service evaluations), with anonymized data collection ensuring no identifiability. Public opinion research under these conditions is exempt from review by the CEP/Conep System [Brazil. The National Council of Health, 2022]. Nevertheless, informed consent was obtained from all participants to uphold institutional transparency standards.

Table 4. Positive Statements (QA) by Domain.

Domain	Code	Item
1 - Basic Mobile Skills	E1Q1	I know how to turn my phone on and off.
	E1Q2	I can adjust my phone's screen brightness.
2 - Communication	E2Q1	I can send and receive text messages.
	E2Q2	I know how to make a phone call using my mobile.
3 - Data and File Storage	E3Q1	I can find a photo or video taken with my camera on my phone.
	E3Q2	I know how to send a photo or video to a contact from my phone.
4 - Internet	E4Q1	I can browse the internet using my phone.
	E4Q2	I know how to use a search engine like Google (voice or typing).
5 - Calendar and Digital Agenda	E5Q1	I can find a specific date in the phone's calendar (e.g., a holiday).
	E5Q2	I know how to set reminders in my phone's calendar/agenda.
6 - Entertainment and Fun	E6Q1	I can play music or watch videos on my phone.
	E6Q2	I know how to download apps on my phone.
7 - Privacy and Security	E7Q1	I know/think that my phone needs a password.
	E7Q2	I know how to set a password on my phone.
8 - Troubleshooting and Software Management	E8Q1	I know my phone's system is Android (or "apple icon") and I know how to update it when needed.
	E8Q2	I know how to fix apps when they freeze.
9 - Resource/Performance Optimization	E9Q1	I know how to uninstall apps on my phone.
	E9Q2	I know how to delete files (photos/videos) when the "memory full" or "no space" message appears.

4.3 Course Methodology

The content structure for the course sessions was planned based on the findings from phase (*i*), as previously discussed. The resulting instructional design served not only for course implementation—ensuring that elderly participants developed digital skills applicable to their daily lives—but also for the development of educational materials and related research. **Table 5**, structured according to the ADDIE model [Vieira *et al.*, 2022], presents the planned approach. The ADDIE model ensures that each session has clear objectives, practical activities, and a structured evaluation methodology.

The table is divided into five main columns: Main Topic (which describes the content focus of each class), Objective (the specific learning goal for that topic), Activities (what participants did in practice), Tools (technological and educational resources used), and Evaluation (methods to verify learning or engagement).

Each session listed in **Table 5** lasted between 1 and 2 hours. Some sessions were longer due to topic complexity and participant questions, such as the session on "Banking Apps." Some topics were addressed together in a single session, such as "Food Delivery Apps" and "Ride-Hailing Apps," due to their thematic proximity. The selected apps included both nationally known and regionally popular platforms.

Each class was taught by the same team of three undergraduate students: one instructor and two tutors.

Table 6 illustrates the dialogic teaching plan for the Digital Communication session, based on Cachioni *et al.* [2015], as defined in the instructional design. The methods used in this class included practice-based learning with WhatsApp and Instagram, as well as interactive discussions for experience sharing and collaborative learning.

At the end of the course, during the final session, an evaluation survey was administered (complemented by observational methods). Participants were invited to answer anonymously if they felt comfortable. The survey was provided in both Google Forms and printed format. To maximize response rates, oral consultations were also conducted. Since this was an opinion-based study, no personal or sensitive data were collected. The survey questions are presented in **Table 7**. To ensure accessibility, especially for elderly participants unfamiliar with writing, Likert-type response scales were used (**Figure 1**), and oral facilitation was provided during the survey process.

Figure 1. Example of Likert-type response scale adapted with emojis for improved accessibility by elderly learners.

5 Results Achieved

This section presents the results obtained from the application of the MDPQ instrument regarding the target audience's proficiency level (**Subsection 5.1**), the participation of older adults in the project's activities (**Subsection 5.2**), an evaluation of the implemented actions (**Subsection 5.3**), and the main lessons learned (**Subsection 5.4**).

5.1 Needs Assessment with the MDPQ

To assess the learning needs of elderly women, a group of participants was defined (**Subsection 5.1.1**), as well as an approach for validating and analyzing test results (**Subsection 5.1.2**), presented below.

5.1.1 Participants

All participants were recruited from a Social Assistance Reference Center (CRAS) and a nonprofit institution through incidental sampling due to the difficulty of recruiting elderly women for university activities. The selected sample included 32 female participants aged between 50 and 85 years.

Table 5. Workshop Structure of Tecer Mulher Project according to the ADDIE Model

Main Topic	Objective	Activities	Tools	Evaluation
Proficiency Test	Diagnose participants' initial digital skill levels [Silva *et al*., 2024].	Initial questionnaire and practical tests	Printed forms and Google Forms	Self-assessment and individual feedback
Digital Security	Teach online protection measures and scam prevention [Gomes *et al*., 2024].	Scam simulations[1], secure password creation	Scam simulators, WhatsApp, SMS	Practical exercises and group discussions
Food Delivery Apps	Teach use of online food delivery services [Mota *et al*., 2024].	Navigation in iFood, Tonolucro, aiqfome and order simulation	Smartphones with preinstalled apps	Assisted order placement and difficulty analysis
Ride-Hailing Apps	Teach safe use of Uber and 99 [Galetti *et al*., 2023].	Account creation, ride requests, and safety analysis	Uber, 99, inDrive, Urbano Norte, Losamo apps	Account verification and ride simulation
Media Streaming	Explore music and video platforms [Rosa *et al*., 2023].	Create playlists and search for favorite content	YouTube Music, Deezer, Spotify	Presentation of playlists and peer feedback
Navigation and Maps	Teach Google Maps usage for urban mobility [Gomes *et al*., 2024].	Location search, route planning, and Street View	Google Maps and GPS	Route simulation and questionnaire
Digital Communication	Use of WhatsApp and Instagram for socialization [Silva *et al*., 2024].	Message, audio, and video calling practices	WhatsApp, Instagram, Facebook Messenger	Sending a message to the course group
Banking Apps	Teach secure online transfers and payments [Mota *et al*., 2024].	Simulation of payments, PIX, QR code scanning	Banking apps, QR Code, PIX	Simulated payment execution and Q&A
Final Evaluation and Closure	Review of course content and certificate delivery [Galetti *et al*., 2023].	Final quiz, group discussion, sharing of experiences	Printed and digital forms	Final test and certificate delivery

Table 6. Methodology for the Digital Communication Session

Time	Activity	Tools	Evaluation
20 min	**Introduction to Digital Communication** – Concept, importance, and impact on daily life [Silva *et al*., 2024].	Multimedia presentation (slides, short videos)	Initial questions to assess prior knowledge
15 min	**Using WhatsApp and Instagram for Socialization** – How to send messages, audio, and video calls.	WhatsApp, Instagram, Facebook Messenger	Message/audio sent to course group
10 min	**Privacy and Security Settings** – Adjustments to avoid scams and unauthorized access.	App settings	Review of personal privacy settings
10 min	**Discussion: Benefits and Risks of Digital Communication** – Fake news, scams, and good practices.	Case studies and real news	Group discussion and experience exchange
15 min	**Simulation: How to Identify and Avoid Scams?** – Analysis of fake messages and phishing.	WhatsApp and scam examples	Scam identification exercise using instructor examples
10 min	**Supervised Practice: Daily Digital Communication** – Message sharing in group, sending photos and videos.	WhatsApp and Instagram	Sending multimedia messages to the course group
10 min	**Group Reflection and Closure** – Review of learning and participant feedback.	Collective discussion	Final questions and improvement suggestions

Table 7. Course Evaluation Survey

No.	Question
Q1	Did the course meet your expectations?
Q2	Do you feel you learned the presented content?
Q3	Did you like the instructor's explanations?
Q4	How do you evaluate the course duration?
Q5	How do you evaluate the quality of instruction?
Q6	Did the topics covered in the course meet your needs?
Q7	Do you have any suggestions for improving the course?
Q8	What is your overall opinion about the course?

All participants owned an Android smartphone and had used it for at least three months. The main characteristics of the sample are summarized in **Table 8**. The table presents participant counts by age group, education level (primary, secondary, higher), experience with smartphones, and whether they had internet, a tablet or computer, and smart TV at home.

A quasi-experimental study was conducted with this target audience. This type of study shares features with both experimental and observational designs but does not fully meet the criteria of a controlled experiment [Campbell and Stanley, 1963]. The sample selection was incidental, which enabled quick and effective data collection aligned with the study's goals. The exclusive inclusion of women allowed a deeper analysis of gender-specific barriers in accessing and using digital technologies. This approach provided insights for planning lifelong learning initiatives to promote greater equity in digital inclusion.

5.1.2 Analysis of MDPQ Results

The chart in **Figure 2** shows the standard deviation across item responses. Axes E1, E5, E7, and E9 show standard deviations above 1.5, indicating high response variability, particularly in basic mobile knowledge, calendar/agenda use, privacy and security, and resource optimization. These standard deviations closely resemble those observed in Roque and Boot [2018] with an elderly population.

Conversely, E2 and E3, related to communication and

Table 8. Sample Characteristics.

Variable	Category	Number	Percentage
Age	50–59	11	0.34
	60–69	12	0.37
	70–79	8	0.25
	80–89	1	0.03
Education	Primary	15	0.46
	Secondary	14	0.43
	Higher	3	0.09
Experience with device (years)	1–5	9	0.28
	6–10	4	0.12
	>11	19	0.59
Home Internet Access	Yes	28	0.87
	No	4	0.12
Tablet/Computer at Home	Yes	8	0.25
	No	24	0.75
Smart TV at Home	Yes	20	0.62
	No	12	0.37

data/file storage, respectively, showed the least variation. These results again mirror previous findings from the MDPQ validation with elderly users.

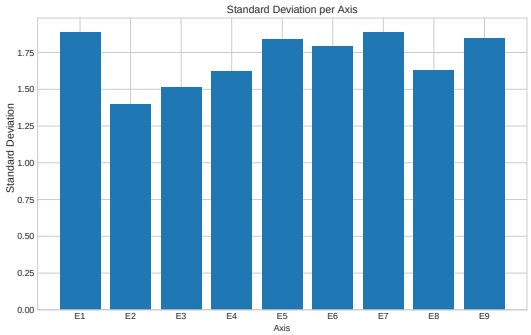

Figure 2. Standard Deviation Analysis

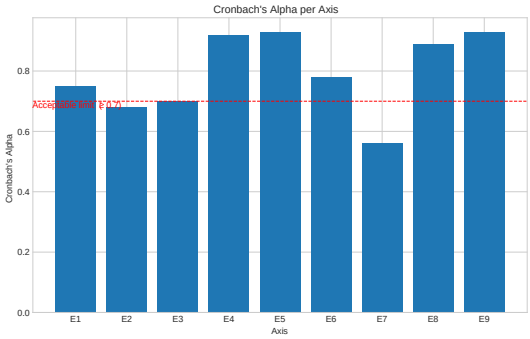

Figure 3. Cronbach's Alpha

Figures 3 and **4** present two reliability measures. Regarding Cronbach's alpha, the red dashed line indicates the minimum threshold for reliability. Axes E4, E5, E8, and E9 scored above 0.8, demonstrating strong internal consistency. E1, E2, E3, and E6 also approached 0.8, still within an acceptable range. E7 (Privacy and Security), however, showed questionable reliability, possibly due to misinterpretation or poor wording following translation from the original test.

Figure 4 shows the AVE comparison across all nine axes. AVE measures the proportion of variance explained by each construct. E1, E2, E3, E6, and E7 show good convergent validity, with AVE values well above 0.5. E4 and E5 fall between 0.4 and 0.5, indicating acceptable convergence. However, E8 and E9 fall below 0.4, suggesting insufficient convergence for the underlying construct. While Cronbach's alpha and AVE often correlate, they measure different aspects; high consistency does not guarantee high AVE, especially with few items per axis Roque and Boot [2018]; Cronbach [1951].

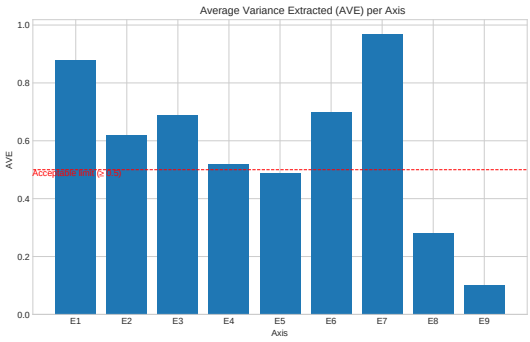

Figure 4. Average Variance Extracted (AVE)

Figure 5 displays the distribution of responses across all axes. A high proportion of responses rated 1 or 2 (red/orange bars) implies a lower proficiency in those areas. At least half of the sample lacked proficiency in calendar use, enter-

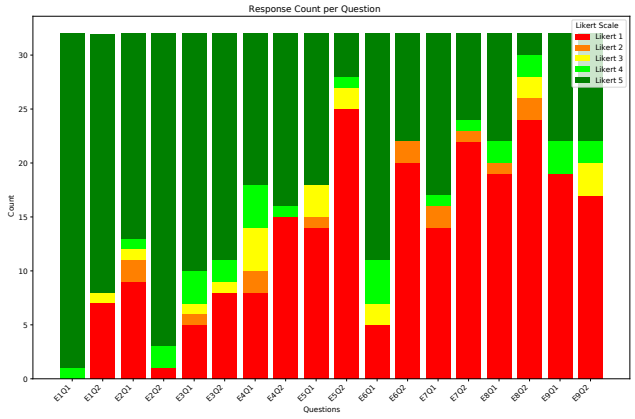

Figure 5. Response Distribution

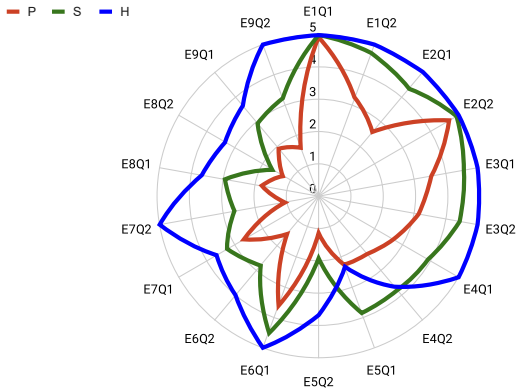

Figure 6. Average Scores per MDPQ-18 Item, where "P, S, H" are Primary, Secondary and Higher.

tainment, privacy and security, problem-solving, and performance optimization.

The MDPQ-18 scores were calculated based on mean values by axis and grouped by education level. Results are shown in **Table 9**. The overall average score is 3.1 (bottom right cell), which answers research question Q1. A positive correlation exists between education level and digital proficiency: higher education correlates with higher scores. The largest difference appears between participants with primary and secondary education. In answer to Q2: the highest-scoring axes across all levels are E1, E2, and E3 (basic phone use, communication, data storage), while the lowest scores are in E5 (calendar use) and E8 (problem-solving).

Table 9. MDPQ-18 Scores by Education Level

	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mean
Primary	4.1	3.63	3.33	2.5	1.7	2.57	1.87	1.53	1.7	2.5
Secondary	4.86	4.64	4.5	3.86	2.89	3.64	2.96	2.29	3.1	3.6
Higher	5.0	5.0	5.0	4.33	3.0	4.5	4.33	3.5	4.3	4.3
Median	4.65	4.43	4.28	3.56	2.53	3.57	3.06	2.44	3.1	3.1

A more detailed performance analysis per item is shown in **Figure 6**. Each radial axis represents Likert scale values, while colored lines show scores by education level: orange (primary), green (secondary), and blue (higher). The further from the center, the higher the score. Initial questions had better results across all education levels. E5Q2 and E8Q2 had the most disagreement among those with primary and secondary education. Interestingly, E5Q2 (setting reminders in the digital calendar) received similarly low responses from participants with higher education.

5.2 Course Implementation Results

To carry out the courses, partnerships were established with three organizations: one governmental (a Social Assistance Reference Center – CRAS) and two non-governmental (NGO1 and NGO2). CRAS and NGO1 serve various vulnerable populations, including older adults, while NGO2 provides care for cancer patients and their families, offering free services through volunteer professionals. All of these entities have been operating for at least 10 years in the municipality.

Each organization is located in a different district, with some demographic differences and variations in the profiles of the people served—many of whom come from surrounding neighborhoods. All partner organizations had suitable rooms and internet access to support the courses.

The choice of partner institutions was based on their availability of physical space and the existence of ongoing activities with elderly participants.

CRAS has a bus used to transport older adults to sports and cultural activities on Wednesdays from 8:30 a.m. to 12 p.m. This logistical support may have contributed to higher retention and engagement of participants in the course.

5.3 Evaluation of Actions

Most of the students already attended other activities at the partner institutions. Participants ranged in age from 42 to 85 years. Although most were elderly women, three women under 60 and one elderly man also enrolled. In total, the five course group included 58 women and 1 man. All participants owned an Android smartphone for at least six months. **Table 10** provides details of each group, including location, duration, class frequency, total hours, number of enrolled students, and number of course completers.

Table 10. Details of TMP Groups

Groups	Location	Period	Frequency	Hours	Enrolled	Completed
T1	NGO1	March–June	Biweekly	12	12	8
T2	CRAS	March–May	Biweekly	10	25	25
T3	NGO2	June–July	Weekly	10	12	11
T4	NGO1	Sept–Oct	Weekly	10	15	12
T5	NGO2	Sept–Oct	Weekly	10	6	3

T1 and T2 were originally planned for 12 hours, with expected completion in June. However, T2 was shortened to make room for other institutional activities. A total of 70 people participated, with 59 completing the course—a general completion rate of 84.3%. T2 (CRAS) had the highest number of participants and a 100% completion rate. In contrast, T5 (NGO2) had the fewest participants and the lowest completion rate at 50%.

Although the biweekly Groups had an average completion rate of 88% compared to 78% in the weekly groups, one major adjustment during the project was increasing the class frequency from biweekly to weekly, based on participant feedback. According to students, "shorter intervals between classes help keep us motivated to complete the course," even though more frequent meetings may be challenging in vulnerable communities. Feedback from students who dropped out

was not collected.

CRAS had the highest success rate (100%), likely due to the institutional transportation support. The other partners (NGO1 and NGO2) lacked their own transport, which may have contributed to lower retention among elderly participants with limited mobility. T5 (NGO2) had the highest dropout rate, possibly due to transport issues or emotional burden. At NGO1, the average completion rate was 74%, with Group 4 performing better (80%) than T1 (67%). At NGO2, the 50% completion rate suggests that in addition to the lack of transportation, emotional and logistical challenges may have contributed to dropouts.

Figure 7 shows images from course activities. In (a), participants are shown during a class wrap-up dynamic; in (b), they are engaged in a hands-on task with supervision.

Regarding the final survey (described in Subsection 4.3), participation was voluntary, and some students opted out. The highest response rate came from T3 (10 of 11 students), with 3 digital and 7 paper responses. Other Groups had about 40% participation. Open-ended questions (Q7 and Q8) were mostly answered orally in group discussions, and are presented here as sampled results.

In Q1, most respondents reported that the course met or exceeded expectations. Only two marked "Satisfactory," which still reflects a positive perception. No responses marked "So-so" or "Unsatisfactory," indicating a **100% satisfaction rate**. In Q2, all respondents confirmed that they effectively learned the proposed content.

Other questions (Q3, Q5, Q6) received positive feedback exceeding 85%. On Q4, regarding course duration, 30% of respondents suggested that the course could be longer. For Q7 (open-ended), suggestions included: "more courses," "longer sessions," and "how to make videos." In Q8 (overall opinion), 100% selected "Excellent," indicating high acceptance of the course format.

5.4 Challenges and Lessons Learned

The implementation of this project allowed Information Systems students to experience a new reality of digital inclusion. While technology brings significant societal benefits, unequal access to digital knowledge has introduced new forms of exclusion—particularly for those unfamiliar with mobile devices, banking apps, or digital tools.

There is still low adoption of digital banking services by older adults in the Amazon region, often due to unfamiliarity or distrust in digital transactions. This dependence on in-person banking exposes the elderly to unnecessary travel and greater risks of fraud.

The project offered significant learning opportunities for both participants and the student team. Despite growing use of technology, digital knowledge gaps persist, especially among older women. Promoting digital empowerment helped strengthen social and intergenerational bonds. Digital literacy proved crucial for autonomy in essential services such as banking, transport, and communication.

Challenges arose in instructional design. Unlike conventional approaches, teaching elderly women required simplified language, repeated concepts, and accessible materials. Andragogical methods were essential to support participants in learning at their own pace dos Reis and Felix [2021]. The approach was adapted according to andragogy principles dos Reis and Felix [2021], emphasizing repetition and practice. The concept of *lifelong learning* also proved fundamental, reinforcing that digital inclusion is possible at any life stage, given the right opportunities.

Logistical and accessibility issues impacted participation. While CRAS provided free transportation, dropout rates were higher at NGOs, likely due to participants' limited mobility.

6 Conclusion

This paper presented a digital inclusion experience focused on elderly women in the amazon region, through the use of diagnostic tools for smartphone use and hands-on workshops. The methodology, grounded in andragogy, lifelong learning, and the ADDIE instructional design model, proved effective in fostering digital skills and strengthening social and intergenerational bonds.

One key contribution was the adaptation of the MDPQ-16 to a Plain Language version (MDPQ-18), making the diagnostic more accessible to the target audience. Results based on self-reported responses provided valuable insights for planning the workshops, identifying priority topics and recurring difficulties.

Despite positive outcomes, several limitations were noted. As a self-reported tool, MDPQ-18 may not fully reflect objective proficiency. Even with rephrased questions and interview-style delivery, complete understanding could not be validated. The study's scope was also limited to three community groups, reducing generalizability.

Pedagogically, instructional design required further refinement for content accessibility. Evaluation methods had to be adapted to the profile of participants, relying on qualitative feedback to better understand individual progress and challenges.

Future work will include refining teaching materials, developing hybrid evaluation strategies (qualitative and quantitative), and using more robust tools like MDPQ-46. The initiative also aims to expand to additional Groups and regions, incorporating participant feedback and scaling its impact across Brazil's Amazon territory.

Declarations

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Portions of this manuscript benefited from the use of AI tools (ChatGPT, based on the GPT-4 architecture by OpenAI) to support the organization of references, text refinement, and generation of tables. The system was used specifically in the writing of the abstract, the structuring of instructional design content in LaTeX, and in translating and editing bilingual sections.

Figure 7. Project activities: (a) class closing dynamic and (b) supervised practical activity.

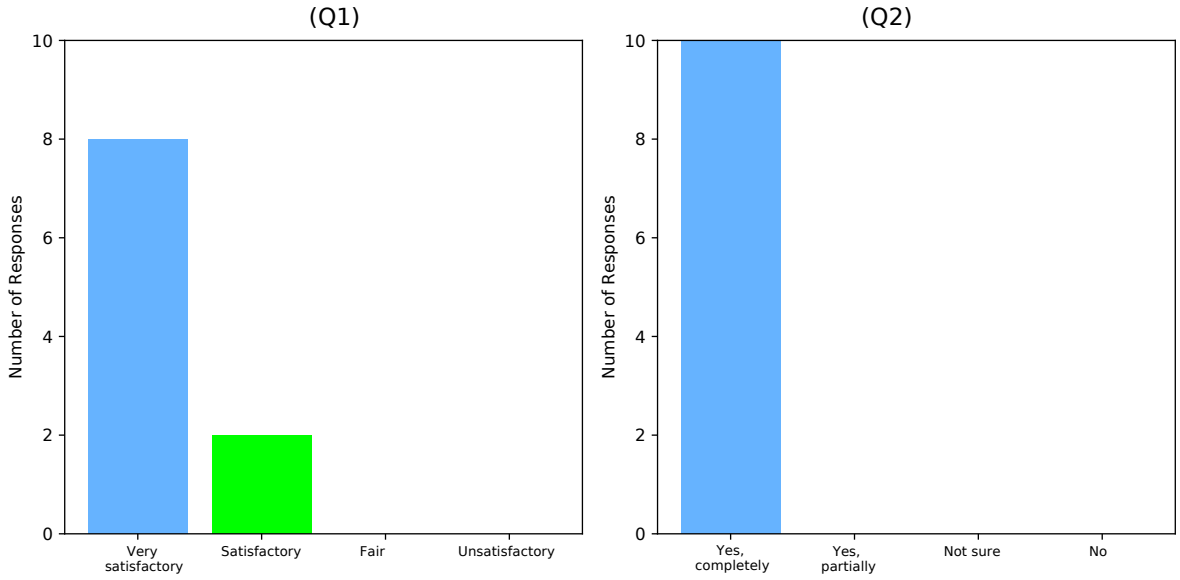

Figure 8. Evaluation survey results from Group 3

The authors ensured human validation for all AI-assisted content. No data analysis, participant responses, or conclusions were generated or interpreted solely by AI systems. We recognize that while AI tools contributed to text clarity and structure, all academic interpretations and ethical decisions remain the responsibility of the authors.

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Authors' Contributions

CA, GN and LS were responsible for the conception and design of the study and served as the primary authors of this manuscript. GS, DA, BA, and IS contributed to the implementation of the workshops and data collection. All authors participated in the analysis and interpretation of the results, critically reviewed the manuscript, and approved the final version for submission.

Competing interests

The authors declare that they have no competing interests related to this work. No commercial, financial, or personal relationships influenced the research, analysis, or conclusions presented in this study.

Availability of data and materials

The datas generated and/or analysed during the current study are available in `https://github.com/leiasousa/TecerMulher`. This availability enhancesconsultation, reproducibility, and, consequently, the principles of open science and knowledge sharing.

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