PERINATAL JOURNAL

Original Article

Perinatal Journal 2026; 34(1):1416-1437

https://doi.org/10.57239/prn.26.034100141

# Smartphone education for the elderly in China: A blended learning model

**Wei Na[1], Sheiladevi Sukumaran[2]***

[1]*Jinan Preschool Education College*
[2]*Faculty of Education and Liberal Arts (FELA), INTI International University*

**Abstract**

The increasing global aging population has made elderly education a crucial strategy for enhancing quality of life and promoting active social participation among older adults, directly contributing to Sustainable Development Goal (SDG) 4: Quality Education and its commitment to lifelong learning for all. The rapid digital transformation presents both opportunities and challenges for elderly education, requiring innovative teaching models that integrate technology with traditional learning approaches. This study examines the impact of blended learning on elderly learners' behaviors and learning outcomes, focusing on smartphone education in Daode Street Community, Jinan, China. A mixed-methods research approach was employed, incorporating a literature review, questionnaire surveys, in-depth interviews, experimental research, and a case study. The study compared an experimental group using a blended learning model with a control group engaged in traditional face-to-face instruction. Findings revealed that the blended learning model significantly enhanced knowledge acquisition, skill application, and learning satisfaction among elderly learners. Engagement levels were higher in the experimental group, with learners benefiting from the flexibility of online learning while maintaining the interactivity of in-person instruction. However, challenges such as digital literacy barriers and varying levels of technology acceptance among older learners were identified. The study highlights the need for age-friendly course design, digital literacy training, and stronger community support to optimize blended learning for elderly education and foster digital inclusion among aging populations. These findings offer practical implications for policymakers, educators, and community organizers in developing inclusive and effective lifelong learning programs for aging populations. Future research should explore long-term impacts and the integration of emerging technologies such as artificial intelligence and virtual reality to further enhance elderly learning experiences.

**Keywords:** Blended learning, Elderly education, Digital literacy, Lifelong learning, Smartphone education, Learning behaviors, Learning outcomes, Sustainable Development Goal (SDG) 4, Digital inclusion

## 1.Introduction

In recent years, the rapid advancement of digital technologies including mobile internet, cloud computing, artificial intelligence, and the Internet of Things has profoundly reshaped the way people access information, communicate, and participate in society. These innovations have not only transformed industries and economies, but have also brought significant changes to education by enabling more flexible, personalized, and accessible learning experiences（Guo, 2023). This technological shift coincides with growing imperatives for lifelong learning and digital inclusion, making it essential to examine how elderly learners engage with blended learning approaches, especially through smartphone-mediated instruction (Bagulaya-Abogaa, 2023). This need becomes even more pressing as educational paradigms shift to accommodate the growing demands of lifelong learning and digital inclusion. For older adults, especially those with limited prior exposure to digital tools, smartphones serve not only as communication devices but also as accessible gateways to knowledge, health services, and social participation. As such, understanding the dynamics of their learning experiences in blended settings is critical to ensuring that no segment of the population is excluded from the benefits of digital transformation.

With the acceleration of global aging, the proportion of the elderly population continues to rise, making elderly education a crucial approach to addressing the challenges of an aging society. According to the United Nations' World Population Prospects report, by 2050, the global population aged 60 and above is expected to reach 2.1 billion, accounting for nearly a quarter of the total population (United Nations, 2019). This demographic shift signals not only a transformation in the age structure of society but also calls for a reevaluation of social services, healthcare systems, and educational policies. Within this context, education for the elderly emerges as a

**Correspondence:** Sheiladevi Sukumaran, Faculty of Education and Liberal Arts (FELA), INTI International University, **e-mail:** ---------- , **Received:** October 25, 2025 **Accepted:** December 8, 2025

strategic tool—not only for individual enrichment and empowerment but also for sustaining social cohesion and reducing the burden on public systems by promoting autonomy and active aging.

China, as one of the world's fastest-aging countries, has a large and rapidly growing elderly population. By the end of 2022, the population aged 60 and above in China had exceeded 280 million, accounting for 19.8% of the total population (National Bureau of Statistics, 2023). The rapid progression of an aging society has placed higher demands on elderly education. As societal expectations evolve, elderly learners increasingly seek not just opportunities for pastime or leisure, but meaningful learning experiences that support personal development, social integration, and technological competence. How to improve the quality of life and promote social participation of the elderly through education has become a focus of academic and policy-making circles. There is a growing consensus that elderly education should not be limited to recreational or informal models but should instead be embedded within broader lifelong learning systems that value the contributions of older adults as learners, knowledge-bearers, and community participants.

At the same time, the rapid development of digital technology is profoundly transforming the way society operates (Yi & Chi, 2023). The integration of digital technologies into everyday life—from mobile banking and telemedicine to digital public services—has reshaped the expectations for digital literacy across all age groups. The importance of digital education for the elderly is becoming increasingly prominent, mainly reflected in the following aspects: First, with the deepening of the aging of my country's population, elderly education has become a key link in building a lifelong learning education system for all people and an important part of realizing educational modernization（Wang& et al., 2024）. Under the wave of digitalization, digital empowerment is becoming an important engine to promote the modernization of Chinese-style elderly education, opening up a new development path for elderly education. Secondly, the application of digital technology has effectively alleviated the main contradiction of the current unbalanced and insufficient development of elderly education（Liu, 2023）. Through massive digital resources and information-based teaching methods, it can meet the growing diversified and personalized learning needs of the elderly. Furthermore, digital education has advantages that traditional education cannot match: it can not only provide rich and diverse learning content, but also enhance learning effects through immersive experience, achieve accurate learning effectiveness evaluation, and greatly improve the quality and efficiency of elderly education（Zhang & Wang, 2023）. More importantly, digital empowerment has injected new vitality into elderly education, and through personalized learning support, lifelong learning platform construction and efficient learning model innovation, it provides a practical solution to break the bottleneck of elderly education development（Yuan, 2024）. Therefore, accelerating the development of digital education for the elderly is not only a strategic choice to cope with the aging of the population, but also an important measure to realize educational modernization, which is of great significance to improving the quality of life of the elderly and promoting the harmonious development of society.

The vigorous development of digital elderly education is not only an effective means to address the current shortage of elderly education resources but also a strategic path to innovate elderly education models, guide the direction of elderly education development, and promote the construction and improvement of modern education systems. It reflects a paradigm shift from passive to active learning, from face-to-face dependence to digital empowerment, and from uniform teaching methods to personalized, flexible delivery. Elderly education is gradually transitioning from traditional face-to-face teaching methods to digital transformation. Blended learning, as an educational model that combines the advantages of online and offline teaching, offers new possibilities for elderly education (Mahmood & Noor, 2020). It bridges the accessibility of digital tools with the familiarity and social richness of in-person learning environments, thus providing a more balanced and supportive learning experience for older adults.

As the capital city of Shandong Province, Jinan faces

the dual challenges of a rapidly aging population and the digital transformation of society. According to data from the Jinan Municipal Bureau of Statistics, by 2024, the population aged 60 and above in Jinan is projected to exceed 2 million, accounting for more than 20% of the total population (Jinan Municipal Bureau of Statistics, 2024). This demographic trend intensifies the urgency of developing effective elderly education models that can be deployed at scale. The growing learning demands of the elderly population and the limited supply of elderly education resources have created a significant gap. Educational infrastructure, teaching personnel, and tailored curricula often lag behind the needs of this expanding demographic group. On the other hand, with the advent of a new digital era characterized by informatization, intelligence, and networking, information technologies such as big data, digital twins, block-chain, virtual reality, and artificial intelligence have profoundly impacted various aspects of elderly education, including teaching models, course models, management models, and educational decision-making (Yi & Chi, 2023). These technologies not only transform pedagogical approaches but also facilitate real-time monitoring, personalized learning pathways, and data-informed policy decisions. They provide opportunities and momentum for the transformation and development of elderly education, especially in the context of cities like Jinan that are actively exploring smart city strategies.

Against this backdrop, exploring educational models suitable for elderly learners in Jinan communities, particularly the design and implementation of courses based on blended learning, holds significant practical importance for expanding the supply of high-quality elderly education resources and improving the efficiency of elderly education (Bai et al., 2018). The integration of smartphone-based instruction into blended models offers a promising pathway for engaging elderly learners in digital environments while maintaining the support and structure of face-to-face interaction. It addresses the challenges of scale, cost, and personalization, and aligns with broader efforts to build inclusive, responsive, and future-ready community education systems. Given the significance of these issues, this study aims to examine the learning behaviors and outcomes of elderly learners participating in a blended learning environment, using the smartphone education program in Jinan, China as a case study. Through this inquiry, the study seeks to generate insights that may inform policy development, instructional design, and community-based interventions to enhance the educational experiences of older adults in rapidly aging urban contexts.

## 2.0 Literature Review

Blended Learning is an educational model that integrates online learning with offline teaching, characterized by flexibility, personalization, and technological support (Garrison & Vaughan, 2008). The online component is typically delivered through digital platforms (e.g., online courses, video tutorials), while the offline component emphasizes face-to-face interaction and hands-on practice. The strength of blended learning lies in its ability to adapt teaching strategies flexibly according to learners' needs while balancing the depth and breadth of learning. Singh and Chris Reed (2002) proposed that blended learning is the optimal learning approach that matches the right time, the right learning technology, and the right learning style to deliver the right skills to the right learners, thereby achieving the best learning outcomes. Blended learning combines traditional learning methods with online learning, placing students at the center and teachers in a guiding role. This approach leverages the strengths of both offline and digital approaches, effectively integrating time and information resources to further enhance learning outcomes (Zhao & Sun, 2020) (Wang et al., 2021) (Siregar et al., 2019). In the context of elderly education, blended learning has been recognized as a promising approach to address the specific needs and challenges faced by older adult learners. With the continuous advancement of society, the concept and theoretical framework of blended learning are constantly evolving. Research on its application has expanded across various educational fields (Li & Yang, 2023). Blended learning is widely implemented in higher education, vocational education, and basic education. For example, in higher education, it enhances student engagement and learning outcomes (Means et al., 2014). In vocational education, the combination of simulated training and online learning significantly improves learners' practical skills (Bonk & Graham, 2006). However, its application in elderly education

is still in its early stages, with limited research available—despite its considerable potential.

Elderly education encompasses educational activities designed for older adults, characterized by diverse learning motivations, varying abilities, and practical learning goals (Formosa, 2012). Common teaching models include face-to-face instruction, online learning, and blended learning. Face-to-face instruction emphasizes interaction and hands-on practice, making it well-suited for elderly learners. Online learning offers flexibility but requires overcoming technical barriers. Blended learning, which integrates online and offline approaches, is emerging as a promising model for elderly education (Zhang et al., 2022). Qiao Weide and Zhu Guanhua (2024) highlight that blended learning combines the advantages of traditional classroom instruction with the benefits of digital learning, offering a new approach in the internet era. It not only preserves the strengths of in-person teaching but also leverages online platforms to overcome time and space constraints, fostering both self-directed and collaborative learning (Park, 2021).

Despite the promising potential of blended learning in elderly education, several challenges hinder its widespread adoption. One major obstacle is the digital divide (Jong et al., 2014). Many elderly learners struggle with using digital devices and navigating online platforms, making it difficult for them to engage with online learning components. Limited digital literacy, coupled with physical and cognitive decline, such as reduced vision or memory retention, further complicates their ability to adapt to technology-based education (Sixsmith et al., 2022). Additionally, many elderly individuals lack access to the necessary devices, stable internet connections, or technical support, exacerbating their difficulties in online learning (Timmermann, 1998). Without proper guidance and assistance, they may feel frustrated or discouraged, reducing their willingness to participate in blended learning programs (Cabauatan et al., 2021)

Another key challenge lies in the design and implementation of effective blended learning models for elderly learners (Boelens et al., 2017). Traditional online courses may not be engaging or interactive enough to meet their unique needs and learning preferences. Many elderly learners prefer personalized, hands-on, and socially engaging learning experiences, which are not always adequately incorporated into online content. Furthermore, there is a shortage of instructors trained to teach elderly students using blended learning methods. Educators must develop age-friendly teaching materials, use simple and intuitive digital tools, and create an inclusive learning environment that balances online and offline interaction. Without thoughtful course design and sufficient instructor support, blended learning may fail to achieve its intended benefits in elderly education (Carlsson et al., 2014).

Evaluating the efficacy of blended learning and examining learners' behaviors are crucial areas of inquiry. Learning behaviors encompass the specific actions displayed by learners during the learning process, such as learning motivation, learning strategies, and learning engagement (Boelens et al., 2017). Common methods for measuring learning behaviors include questionnaires, observation, and log analysis (Stroud, 2019). For example, questionnaires can be used to understand learners' motivation and strategies, while observation can document learners' classroom participation. Learning outcomes are a critical indicator for evaluating the effectiveness of educational models, typically comprising knowledge acquisition, skill improvement, and learning satisfaction. Common methods for assessing learning outcomes include testing, questionnaires, and interviews. For instance, testing can evaluate learners' knowledge acquisition, while questionnaires can capture their satisfaction and subjective experiences. By examining the learning behaviors and outcomes of elderly learners in blended learning environments, researchers can gain valuable insights into the factors that contribute to the success or challenges of this educational approach (Dziuban et al., 2018).

In China, the rapid aging of the population and the increasing importance of lifelong learning have led to a growing focus on elderly education. Current research on blended learning in elderly education remains in the exploratory stage. On one hand, existing studies predominantly focus on theoretical discussions, lacking systematic empirical research. Zhang Hongbing et al. (2018) proposed that

promoting the digital transformation of elderly education is a crucial strategy for addressing the shortage of educational resources for older adults. Their research emphasizes a macro-level approach, offering recommendations on top-level design, policy support, and management models to enhance the accessibility and effectiveness of elderly education in the digital age. Similarly, Xie & Yue (2019) have examined the need for blended learning in elderly education from the perspective of modernizing aging governance. They argue that integrating digital learning with traditional methods can improve the inclusivity and sustainability of elderly education, aligning it with broader societal and technological advancements.

Alongside these theoretical and policy-driven perspectives, many studies focus on localized practical experiences, highlighting real-world implementations of blended learning for elderly learners. For instance, Wang Xiaonan (2024) documented the blended learning practices at Hedong District Elderly University in Tianjin, providing valuable insights into how digital tools are integrated into elderly education at the community level. These case studies offer a micro-level understanding of the challenges and successes associated with blended elderly education, shedding light on factors such as learner engagement, technological adaptability, and curriculum design. Such research contributes to refining blended learning models and ensuring they are effectively tailored to the diverse needs of elderly learners. Despite these advancements, there remains a paucity of comprehensive, empirical research examining the specific learning behaviors and outcomes of elderly learners in blended education environments, particularly in the Chinese context. Overall, there is a significant gap in the in-depth analysis of elderly learners' behaviors and learning outcomes in blended learning environments. While existing studies primarily focus on the technical aspects and course design of blended learning, they often overlook a comprehensive examination of how elderly learners engage with these educational models (Picciano, 2009). Key factors such as learning motivation, cognitive strategies, engagement levels, and adaptability to digital tools remain underexplored. Understanding these aspects is crucial, as they directly influence the effectiveness of blended learning and determine whether elderly learners can successfully integrate online and offline educational experiences into their daily lives.

Moreover, much of the existing research remains theoretical, with a lack of empirical, evidence-based recommendations for improving blended learning in elderly education. There is a pressing need for studies that go beyond conceptual discussions and provide practical, data-driven insights into overcoming key challenges, such as reducing technological barriers, enhancing learner motivation, and optimizing instructional strategies (Srivastava, 2023). Without systematic solutions backed by research, it remains difficult to refine blended learning models to better suit elderly learners' needs. Addressing these gaps through in-depth studies and pilot programs can help develop more effective, learner-centered approaches that improve both engagement and educational outcomes for older adults (Helander et al., 2019; Jam et al., 2018).

In summary, the literature highlights both the promise and the complexity of applying blended learning to elderly education. While blended learning models offer flexible, personalized, and resource-efficient educational opportunities, their success depends heavily on addressing barriers such as digital literacy, age-related cognitive limitations, and inadequate instructional design. Although research in general education settings has affirmed the benefits of blended learning, its application in elderly education—especially in China—remains underexplored and largely theoretical. Most existing studies overlook how elderly learners behave, adapt, and derive value from such instructional formats in real-world settings. These gaps underscore the pressing need for empirical investigations that move beyond conceptual models to assess learning behaviors, satisfaction levels, and outcomes among older adults engaged in blended learning. Therefore, this study aims to fill that void by focusing on smartphone-based blended learning in a community setting, exploring how elderly learners experience and benefit from hybrid instructional models. The findings are expected to inform more inclusive, effective, and age-responsive educational strategies that align with the broader goals of lifelong learning and digital equity in aging societies.

## 3. Methodology

This study employed a mixed-methods research approach, integrating both quantitative and qualitative methods for a comprehensive analysis. Questionnaire surveys were conducted before and after the course to assess learning behaviors (such as motivation, strategies, and difficulties) and learning outcomes (including knowledge acquisition, skill improvement, and learning satisfaction). The questionnaire consisted of three sections: basic information, learning behaviors, and learning outcomes. Additionally, in-depth interviews were conducted after the course with selected learners, instructors, and community managers to gain deeper insights into their experiences and perspectives. The interviews explored key areas such as learning motivation, teaching effectiveness, course design, resource support, and future improvements.

To measure the impact of blended learning on elderly learners' educational outcomes, an experimental research design was implemented. The experimental group engaged in both online and offline learning, incorporating video tutorials, online assessments, classroom lectures, and hands-on practice. In contrast, the control group followed a traditional face-to-face teaching model, consisting of in-class lectures and practical exercises. Pre- and post-test data were collected to compare learning progress and effectiveness between the two groups.

### 3.1 Research design

The study was conducted in the Daode Street Community of Jinan City, a well-established pilot site for elderly education with a sound teaching infrastructure and a stable learner base. The focal point of the study was the “2024 Fall Elderly Smartphone Application Course,” targeting older adults aged 60 to 80 years who possessed basic literacy and minimal smartphone experience, making them appropriate candidates for digital skill intervention.

A total of 120 learners were enrolled in the program and divided into two groups based on class structure and demographic balance: the experimental group (Class 1 and Class 2) and the control group (Class 3 and Class 4), with 60 participants in each. The experimental group received a 10-week blended learning intervention, while the control group followed a traditional face-to-face instructional model. Variables such as gender ratio, age distribution, education level, and smartphone usage frequency were controlled to ensure the comparability of both groups.

#### *3.1.1 Research site and participants*

This study was conducted in collaboration with Daode Street Community in Jinan City. With extensive experience in elderly education, the community has long been committed to providing high-quality and efficient educational services for senior residents, demonstrating notable advantages in community mobilization, organizational structure, and practical implementation.

The Daode Street Community School, located in the core area of Huaiyin District, Jinan, covers an area of approximately 800 square meters. It is equipped with 8 multi-functional classrooms, 1 digital learning center, and 1 senior activity center, all featuring barrier-free facilities to fully accommodate the learning and recreational needs of elderly residents. The school's management team consists of 5 full-time and part-time community education administrators responsible for daily operations, course coordination, and activity organization. Its teaching faculty is robust, with 12 contracted instructors and a well-structured community volunteer team. The school offers 45 regular courses covering diverse fields such as health and wellness, smart technology, and cultural arts, delivering over 600 class hours annually and serving more than 2,000 participants. Several of the community's programs have been recognized as Shandong Province Lifelong Learning Brand Initiatives, establishing it as a model case for regional elderly education. These strengths not only ensured the smooth implementation of this study but also provided a replicable practical framework for promoting blended learning models in elderly education.

The selected course focused on daily smartphone applications relevant to elderly users, including social communication (e.g., WeChat), public services (e.g., online hospital registration, QR-based transport), online payments, e-commerce, map navigation, and

cybersecurity awareness. The curriculum emphasized high relevance, ease of operation, and daily utility.

According to baseline data, 69.75% of the participants in the experimental group had a high school education or lower, while 30.25% had a college degree or above. A total of 83.19% reported frequent smartphone use, with only one participant having never used a smartphone. This indicates a generally appropriate level of digital readiness, making the sample suitable for the intended instructional design and data collection.

### *3.1.2 Intervention: Teaching arrangements*

To ensure the study's effectiveness, a comprehensive evaluation of the community's courses was conducted, followed by consultations with multiple instructors. Based on this assessment, the 24 Fall Elderly Smartphone Class was selected for the experiment. The participants were divided into two groups: Class 1 and Class 2 formed the experimental group, which followed a blended learning model combining online and offline teaching, while Class 3 and Class 4 comprised the control group, which adhered to a traditional face-to-face teaching approach. Each group consisted of 60 participants with comparable age and gender distributions, ensuring consistency and reliability in the study. Additionally, for qualitative research, eight interviewees were selected, including four learners (two from each group), two course instructors, and two community managers to provide further insights into the learning experience. The intervention lasted for 10 weeks with a total of 20 class hours. The experimental group received blended instruction in 7 out of 10 sessions, featuring the integration of online and offline activities as follows:

Offline Component: Structured face-to-face sessions led by professional instructors using multimedia presentations and hands-on demonstrations. Teaching assistants provided one-on-one support during class to ensure that all learners could follow along.

Online Component: After each session, supplementary materials including instructional videos, illustrated step-by-step guides, and practice assignments were delivered via community WeChat groups or dedicated mobile apps. These resources enabled learners to review and consolidate knowledge at their own pace.

Peer Support and Technical Assistance: Interest-based learning groups were formed within the community to encourage peer-to-peer collaboration. Additionally, "digital volunteers" provided scheduled Q&A sessions and in-home support for learners needing individualized help.

In contrast, the control group followed a fully traditional face-to-face format. Instruction relied on classroom lectures and printed handouts, without access to online materials or external support mechanisms.

Building on the community's extensive experience in offering smartphone application courses for older adults, the program was designed to address digital literacy needs and focus on practical applications most relevant to elderly learners. The course spanned 10 weeks, with a total of 20 class hours, and focused specifically on smartphone usage for seniors.

In the experimental group, 7 out of 10 sessions adopted a blended learning approach, combining offline classroom instruction for structured teaching with online simulated exercises for reinforcement. Learners were also encouraged to form interest groups to practice their skills collaboratively. Meanwhile, the control group followed a traditional face-to-face approach, where learners were expected to review key concepts using textbooks and practice independently. The detailed course content and teaching arrangements are outlined in Table 1.

**Table 1.** Teaching arrangements for the 2024 fall elderly smartphone classes in daode street community

| ***Week*** | ***Teaching Content*** | ***Teaching Format*** | |
|---|---|---|---|
| | | Experimental Group | control group |
| 1 | Basic smartphone operations | Offline Teaching + Online Practice | Face-to-face Teaching |

| | | | |
|---|---|---|---|
| 2 | Using Social Media Apps (Part 1) | Offline Teaching + Online Practice | Face-to-face Teaching |
| 3 | Using Social Media Apps (Part 2) | Online Teaching | Face-to-face Teaching |
| 4 | Using Payment Apps | Offline Teaching + Online Practice | Face-to-face Teaching |
| 5 | Using Shopping Apps | Offline Teaching + Online Practice | Face-to-face Teaching |
| 6 | Using Entertainment Apps | Online Teaching | Face-to-face Teaching |
| 7 | Using Transportation Apps | Offline Teaching + Online Practice | Face-to-face Teaching |
| 8 | Booking Medical Appointments via Smartphone Offline | Offline Teaching + Online Practice | Face-to-face Teaching |
| 9 | Ordering Food and Purchasing Medicine via Smartphone | Offline Teaching + Online Practice | Face-to-face Teaching |
| 10 | Information Security and Fraud Prevention | Offline Teaching + Online Practice | Face-to-face Teaching |

## 3.2 Quantitative research methods

To comprehensively evaluate the effectiveness of the blended learning model in enhancing elderly learners' digital competencies and engagement, this study adopted a quantitative research approach. The methodology consisted of structured questionnaires and experimental pre- and post-testing, aiming to capture both subjective and objective dimensions of learning outcomes.

### *3.2.1 Questionnaire design and administration*

Structured questionnaires were carefully designed to assess changes in learners' behaviors, attitudes, and perceived outcomes before and after participating in the course. The questionnaire was divided into three major sections, each targeting a specific aspect of the learning process:

Basic Information: This section collected demographic data including gender, age, education level, and prior digital usage habits. These variables served as important control factors to ensure that any observed changes in outcomes were attributable to the intervention rather than background differences.

Learning Behaviors: This section measured key indicators such as learning motivation, use of self-regulated learning strategies (e.g., planning, time management, help-seeking), levels of active participation (including frequency of attendance and interaction), and task completion rates. These variables helped reveal how learners engaged with both the online and offline components of the blended learning model.

Learning Outcomes: This section focused on perceived gains in knowledge and skills, satisfaction with course content and delivery, and self-reported confidence in using digital tools such as smartphones and social media applications. It aimed to capture the learners' internal assessments of their progress and the course's impact.

The questionnaire was administered in two rounds—once before the course commenced (pre-test), and once after the course concluded (post-test). All participants were encouraged to complete both versions under the guidance of facilitators, ensuring high data quality. A total of 119 valid paired responses were collected, representing a high response rate of 99.2%. This robust response rate reflects the strong engagement of the elderly learners and provides a solid empirical foundation for subsequent analysis.

### *3.2.2 Experimental pre- and post-testing*

To supplement the subjective self-reported data from the questionnaires and ensure a more objective measurement of learning gains, experimental testing was conducted. Both pre- and post-tests were developed to assess actual improvements in digital operational skills that were emphasized during the course. These included:

Video calling: Ability to initiate and receive video calls using smartphone apps;

QR code payments: Competence in completing transactions via mobile payment platforms;

Contact management: Skills in adding, saving, and organizing contacts using WeChat.

Each test was composed of practical tasks designed to simulate real-world scenarios that elderly individuals commonly encounter. Scoring criteria were based on two dimensions: accuracy (correct execution of steps) and fluency (smoothness and independence in completing tasks).

Participants were divided into an experimental group (who received instruction via the blended learning model) and a control group (who participated in traditional face-to-face sessions only). Results from the post-test demonstrated a marked improvement in both groups, but the experimental group achieved a significantly higher average post-test score of 92.86, compared to 89.5 in the control group. Statistical analysis confirmed that this difference was statistically significant ($p < 0.05$).

These results suggest that the blended learning model not only enhances learners' performance in practical digital skills but also boosts their confidence and autonomy in using technology. The integration of online and offline elements appears to create a more effective and supportive learning environment for elderly learners, allowing for repeated practice, flexible review, and personalized guidance.

### 3.3 Qualitative research methods

To enrich the understanding of learners' experiences and contextualize the quantitative findings, this study also incorporated qualitative research methods. Qualitative inquiry was employed to explore the subjective perceptions, emotional responses, and social contexts that influenced participants' engagement with the course, particularly in relation to the blended learning model. This approach enabled the research team to uncover nuanced dynamics that numerical data alone could not fully capture.

#### *3.3.1 In-Depth Interviews*

Following the completion of the program, a series of eight semi-structured, in-depth interviews were conducted to obtain detailed narratives from key stakeholders. The selection of interviewees was purposeful, aimed at reflecting the diversity of perspectives involved in the course design, delivery, and participation. The interview sample included:

Four elderly learners, with two selected from the experimental group (blended learning) and two from the control group (traditional instruction), to allow for comparative insights into learning experiences and perceived benefits or challenges of the different instructional models;

Two instructors who were directly involved in both online and offline course delivery, offering professional observations on learner performance, engagement, and instructional feasibility;

Two community education managers, responsible for logistical coordination, technical support, and learner recruitment, who could speak to the broader implementation environment and institutional support structures.

Interviews were conducted face-to-face or via video call, depending on the interviewees' preferences and availability. Each session lasted approximately 30 to 45 minutes and was audio-recorded with participants' consent. The interview guide was organized around several core themes, including:

- Changes in learning motivation before and after the course;
- Acceptance and adaptability to the blended learning format;
- Perceived usefulness and accessibility of the online learning resources;
- Barriers encountered during the learning process, such as technological challenges or content difficulties;
- Suggestions for improvement, including course design, instructional methods, and support mechanisms.

All interviews were transcribed verbatim and subjected to thematic analysis, following Braun and Clarke's (2006) six-phase model. Initial coding was conducted independently by two researchers to enhance inter-rater reliability. Codes were then grouped into broader categories and refined into

themes that encapsulated recurring patterns across the data.

The analysis revealed several critical factors influencing learner engagement and course effectiveness. For example, learners from the experimental group frequently cited the flexibility and repeated access to course videos as helpful for mastering new skills at their own pace. They also expressed greater confidence in using smartphones for everyday tasks, attributing this to the structured online modules and peer support during face-to-face sessions. However, both learners and instructors noted that initial technological anxiety—particularly among those with no prior exposure to smartphones—posed a significant hurdle during the early stages of the course. This underscores the need for comprehensive onboarding and ongoing technical support in future program iterations.

Community education managers highlighted the importance of localized, personalized guidance, emphasizing that digital transformation in elderly education requires more than just access to online content—it demands the cultivation of trust, motivation, and familiarity with digital environments. They also suggested that involving elderly learners in co-creating course content could increase relevance and participation.

Overall, the qualitative findings provided rich, contextualized insights that not only supported the quantitative results but also revealed areas for pedagogical innovation and systemic improvement. These insights are critical for designing more inclusive, responsive, and effective blended learning models tailored to the specific needs and capacities of older adult learners.

## 4.0 Data collection and analysis

To comprehensively evaluate the effectiveness of the blended learning approach in elderly education, this study adopted a mixed-methods research design, integrating quantitative and qualitative data to provide a more holistic understanding of the research findings.

Quantitative data were collected via Wenjuanxing, a widely used online survey platform in China, allowing for efficient distribution and structured response collection. The survey targeted elderly learners from four community-based classes, including both an experimental group (blended learning) and a control group (traditional face-to-face instruction). A total of 119 valid responses were obtained out of 120 distributed questionnaires, yielding a high response rate of 99.2%. This response rate suggests strong participant engagement and interest in the research.

To complement the quantitative findings and capture the experiential dimensions of the instructional process, eight semi-structured interviews were conducted with key stakeholders, including elderly learners, instructors, and community education managers. These interviews provided in-depth insights into participants' attitudes, challenges, and perceived benefits of the blended learning model.

Importantly, the integration of survey data and interview findings enabled a richer and more nuanced interpretation of results. Quantitative data offered measurable evidence of learning outcomes and technology proficiency, while qualitative data contextualized these findings by revealing learners' personal experiences, motivational factors, and social learning dynamics. This complementary approach enhanced the explanatory power of the study, allowing for triangulation and a deeper understanding of how and why the blended learning approach influenced learning effectiveness in elderly education.

### 4.1 Participant demographics and technology proficiency

An analysis of demographic data reveals that the experimental and control groups were broadly comparable in terms of age distribution, educational attainment, and prior smartphone usage experience, ensuring that any observed differences in outcomes could be attributed more confidently to the learning model rather than to confounding variables.

In the experimental group, which participated in the blended learning model, 69.75% of respondents had an educational level of high school or below, while 30.25% reported holding a college degree or higher. This distribution aligns with national trends in elderly education and suggests that a substantial proportion of older learners enter educational programs with limited formal educational

backgrounds. Such backgrounds may affect learners' cognitive engagement, familiarity with academic environments, and confidence in adopting new learning technologies. These factors are considered in greater detail in later sections when analyzing learning motivation, adaptability, and performance outcomes.

With regard to smartphone usage, data indicated a relatively high baseline level of technical familiarity among the participants. Specifically, 83.19% of learners reported frequent use of smartphones, defined as using the device daily for communication, browsing, or other basic functions. An additional 15.96% indicated occasional use, while only one participant (representing less than 1%) reported having never used a smartphone prior to the course.

This widespread usage suggests that most participants entered the program with basic operational skills, such as unlocking the phone, launching applications, and sending messages. Such baseline proficiency is crucial for the successful implementation of blended learning models, which often rely on participants' ability to independently access online materials, complete digital tasks, and communicate via mobile platforms. At the same time, the data also reflect the heterogeneity of technological experience among older learners, reinforcing the need for differentiated instructional strategies and technical scaffolding to ensure that all learners can effectively engage with digital components.

In summary, the demographic and baseline technology data establish a relatively level playing field between the experimental and control groups. The prevalence of frequent smartphone use provides a favorable foundation for integrating blended learning in elderly education, while the generally lower levels of formal education among participants underscore the need for age-sensitive, accessible, and supportive pedagogical approaches.

These contextual variables serve as important reference points for interpreting the subsequent findings on learning behaviors, skill acquisition, and instructional satisfaction.

### 4.2 Analysis of learning motivation and behavioral patterns

An examination of the primary motivations driving elderly learners to participate in smartphone-based education reveals a range of practical, social, and cognitive needs. As summarized in Table 2, these motivations are closely aligned with the day-to-day realities of older adults, underscoring the functional value and personal relevance of digital literacy in later life.

A significant majority—74.79%—expressed a desire to master basic smartphone functionalities, such as taking photos, making video calls, and sending messages, which represent essential tools for communication and social interaction. Furthermore, 40.36% of respondents explicitly mentioned the use of WeChat to maintain regular contact with family members and friends, highlighting the emotional and relational dimensions of technology use among the elderly.

In terms of practical daily life applications, 66.38% of participants sought to leverage smartphones for convenience-related functions, including making online medical appointments, conducting mobile payments for shopping, and navigating unfamiliar locations through map applications. These motivations reflect a broader trend toward the integration of digital tools into health management and mobility, particularly relevant for aging populations with increased healthcare needs and reduced physical mobility.

Entertainment and leisure also emerged as strong motivational drivers. Over 57.14% of participants reported using apps for music, short videos, and livestreaming, indicating that digital engagement among older adults is not purely utilitarian but also includes recreational and emotional well-being aspects. Moreover, 47.90% indicated an interest in using educational applications, such as digital reading platforms or short-term learning programs, to expand their knowledge base and maintain cognitive vitality.

Taken together, these findings suggest that elderly learners approach digital learning with multifaceted motivations—seeking not only practical competence

but also enhanced social connectivity, personal autonomy, and emotional enrichment. These insights are critical for informing the design of targeted, relevant, and user-friendly educational programs for older adults.

### 4.3 Comparative analysis of learning behaviors

A comparison of learning behaviors between the experimental group (blended learning) and the control group (traditional face-to-face learning) reveals notable differences in engagement, initiative, and learning persistence.

The experimental group demonstrated a markedly higher degree of active engagement in both online and offline learning activities. Specifically, 85% of these learners completed online learning tasks on time and were observed to actively participate in classroom discussions, asking questions and exchanging experiences with peers. By contrast, in the control group, the proportion of task completion dropped to 74.58%, and only 62.71% of learners regularly engaged in in-class interactions.

In terms of self-directed learning behaviors, the experimental group once again outperformed their counterparts. Approximately 90% of participants in this group conducted independent reviews of learning materials after class, using mobile devices to revisit video tutorials or practice tasks introduced in class. In contrast, only 66.1% of control group members engaged in post-class review, pointing to a potential limitation of the traditional instructional model in promoting sustained, autonomous learning.

These behavioral differences are visually represented in Figure 1, which clearly illustrates the enhanced participation and initiative associated with the blended learning format. The data suggest that when supported by well-designed digital resources and an interactive instructional structure, elderly learners can exhibit strong motivation and capacity for lifelong learning.

However, qualitative data from interviews reveal that technical and design challenges persist, potentially limiting full engagement for some learners. For instance, several participants from the experimental group reported difficulty navigating digital interfaces, despite the availability of printed or video-based instructional guides. Small font sizes, non-intuitive icons, and complex menu structures were cited as major sources of frustration. In addition, the lack of personalized design features—such as adjustable text size, voice-assisted navigation, or simplified screen modes—was identified as a barrier that prevented some users from fully accessing and benefiting from the online components.

Meanwhile, learners in the control group also faced challenges, albeit of a different nature. Approximately 50% expressed difficulty in retaining lecture content, attributing this to the absence of supplementary learning materials or review tools. Without access to recorded sessions or printed summaries, they struggled to reinforce their understanding after class, leading to diminished learning outcomes and reduced confidence in skill application.

In summary, while the blended learning model clearly enhances engagement and self-regulated learning, its success depends heavily on the usability and inclusivity of the digital interfaces. The findings emphasize the need for age-friendly design, accessible navigation systems, and consistent scaffolding to ensure that technological innovations truly serve all learners—particularly older adults who may have limited prior experience with digital environments.

**Table 2.** Motivation and learning behaviors of elderly learners

| *Category* | *Experimental Group (%)* | *Control Group (%)* |
|---|---|---|
| Basic Functional Skills | 74.79 | Comparable |
| Social Needs | 40.36 | Comparable |
| Daily Convenience | 66.38 | Comparable |
| Entertainment | 57.14 | Comparable |
| Knowledge Expansion | 47.9 | Comparable |
| Online Task Completion | 85 | 74.58 |
| Classroom Participation | 85 | 62.71 |
| Self-Directed Review | 90 | 66.1 |
| Retention Difficulties (Control) | - | 50 |

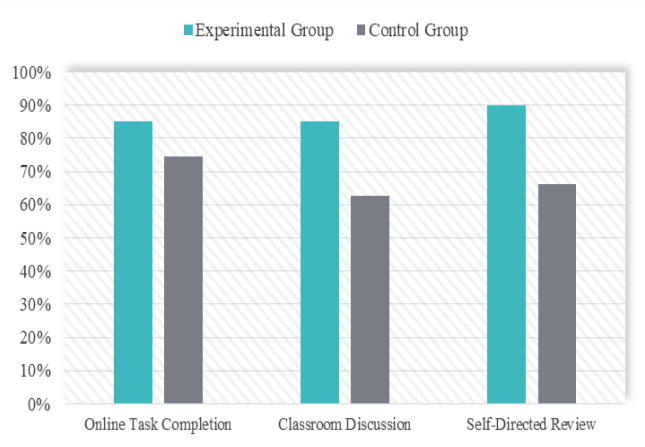


**Figure 1.** Learning engagement activity

## 4.3 Analysis of learning outcomes

To comprehensively evaluate the effectiveness of the blended learning intervention, this section presents an analysis of three key outcome dimensions: knowledge acquisition, learning satisfaction, and learning confidence. Quantitative test scores were triangulated with survey results and qualitative interview data to ensure the robustness of findings.

### *4.3.1 Knowledge acquisition*

Knowledge acquisition was assessed using a standardized post-course test designed to evaluate proficiency in smartphone-based operations. The results revealed that the experimental group—which received blended learning instruction—achieved a mean score of 92.86 (out of 100), significantly higher than the control group's average score of 89.5. Statistical analysis ($p < 0.05$) confirmed that the difference was significant, indicating that the blended model was more effective in facilitating learning among elderly participants.

Further disaggregated analysis showed that learners in the experimental group demonstrated particularly strong performance in video calling functions, QR code payments, and basic WeChat communication skills, suggesting that multimodal instruction combining face-to-face guidance and digital practice resources played a critical role in reinforcing key competencies. These results underscore the pedagogical advantage of a blended approach in enhancing both conceptual understanding and operational proficiency for elderly learners who often benefit from repeated, contextualized practice opportunities.

### *4.3.2 Learning satisfaction*

Learning satisfaction was measured through post-course surveys, which asked participants to rate their overall experience and satisfaction with course delivery, content relevance, and instructional support.

In the experimental group, 63.33% of learners reported being "highly satisfied", with an additional 21.67% indicating general satisfaction. Respondents particularly appreciated the integration of digital materials and classroom instruction, which they described as mutually reinforcing. The flexibility to review online tutorials at their own pace and the opportunity to seek real-time support during in-person sessions were commonly cited as factors contributing to their high satisfaction.

By contrast, in the control group, only 32.2% of learners reported being "highly satisfied", and a larger share (52.54%) expressed only moderate satisfaction. Interview responses revealed that while learners found the course content appropriately structured and relevant, they experienced difficulty retaining information after class due to the lack of supplementary review materials. This limitation often led to frustration when attempting to apply skills independently, thereby diminishing overall satisfaction.

These findings support the conclusion that blended learning models can significantly enhance learner satisfaction by offering a more flexible, supportive, and engaging environment that addresses the specific cognitive and memory-related challenges commonly faced by older adults.

### *4.3.3 Learning confidence*

Another key dimension of learning effectiveness is the degree to which learners gain confidence in applying newly acquired skills, particularly in digital contexts that many elderly individuals initially find intimidating.

Post-course survey results showed that 93.33% of learners in the experimental group reported increased confidence in using smartphones, with 78.33% indicating a "high level of confidence." In comparison, while the control group also reported improvement, only 81.35% of its members reported increased confidence, and a significantly lower 38.98% expressed a high level of self-assurance.

This stark contrast suggests that the scaffolded support structure inherent in the blended model—combining hands-on guidance, peer interaction, and asynchronous digital resources—may be instrumental in building digital self-efficacy among older learners. The opportunity to repeatedly practice tasks, revisit instructions, and receive immediate feedback in both online and offline settings appeared to reduce anxiety and increase a sense of mastery.

Qualitative data from interviews further corroborated these findings. Learners in the experimental group described feeling "less afraid of making mistakes" and "more willing to explore smartphone functions" after completing the course. Some even reported acting as informal digital mentors for peers or family members, reflecting a newfound sense of competence and social contribution.

### *4.3.4 Summary*

As visually represented in Figure 2, the experimental group consistently outperformed the control group across all three indicators—knowledge acquisition, learning satisfaction, and learning confidence. The difference was particularly pronounced in confidence levels, highlighting the role of blended learning in transforming not just what learners know, but how they feel about applying their knowledge.

In sum, these outcomes provide compelling evidence for the pedagogical validity and practical utility of blended learning in elderly digital education. By simultaneously addressing cognitive, emotional, and experiential dimensions of learning, the blended model emerges as a highly effective strategy for enhancing digital inclusion and lifelong learning engagement among aging populations.

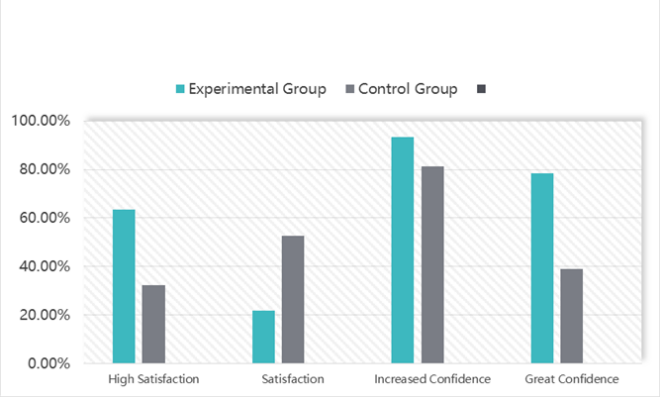


**Figure 2.** Experimental and control groups in terms of learning satisfaction and confidence

## 4.4 Analysis of factors influencing learning behaviors and outcomes

The analysis of influencing factors through correlation and regression methods revealed several key variables that significantly shaped elderly learners' behaviors and educational outcomes within the blended learning model. Notably, age and educational background emerged as primary determinants of adaptability and engagement with online components.

Age-related disparities were especially pronounced. Learners aged 75 and above demonstrated notably lower levels of digital engagement, with only approximately 30% actively participating in online learning activities such as watching video lectures, completing online assessments, or participating in virtual discussions. This trend indicates that advanced age may be associated with cognitive decline, reduced confidence in technology use, or increased dependence on in-person social interaction for learning. In contrast, younger elderly learners—those in the 60–70 age group—were significantly more adaptable, indicating a stronger potential for digital inclusion when supported appropriately.

Educational background also played a pivotal role in shaping learning behaviors. Learners with higher levels of formal education, particularly those who had completed high school or above, demonstrated greater initiative, curiosity, and acceptance of online learning modalities. These learners were more likely to explore supplementary digital materials, troubleshoot minor technological issues

independently, and express a more positive attitude toward flexible, self-directed learning. In contrast, individuals with limited prior educational experiences often displayed hesitation, passive participation, or outright resistance to digital content. These findings suggest that lifelong learning experiences contribute to digital readiness, and underscore the necessity of differentiated instructional strategies that respond to learners' varied cognitive and educational starting points.

In addition to demographic factors, the availability and quality of educational technology significantly influenced learning outcomes. The study found that elderly learners benefited most from blended learning environments when structured technical support was provided. Learners who had access to on-site digital assistants, step-by-step guides, or peer help groups demonstrated higher levels of proficiency in applying newly acquired skills—such as using smartphone apps, accessing government e-services, or participating in family video calls. This finding reinforces the central role of human-mediated support in elderly digital learning, particularly in the transition phase from offline to online environments.

Qualitative data collected through interviews and focus group discussions offered additional depth to the quantitative findings. Many participants expressed appreciation for the flexibility and autonomy that video-based instruction provided. The ability to pause, rewind, and repeat content was viewed as especially valuable for learners with memory limitations or slower cognitive processing speeds. Moreover, learners reported increased self-confidence when they could review materials multiple times before applying new skills in practical settings. Nevertheless, instructors and facilitators observed that learner enthusiasm was often higher during group activities and face-to-face practical sessions, suggesting that social interaction remains a core motivational factor for elderly learners.

However, not all learners embraced the online components equally. Instructors noted a disparity in engagement that often corresponded to the aforementioned demographic differences. To mitigate this, educators recommended optimizing online course design by integrating intuitive navigation structures, step-by-step video tutorials, interactive quizzes, and progress tracking features. These enhancements could increase perceived ease of use and provide timely positive feedback, which is especially important for maintaining elderly learners' confidence and motivation.

Despite the clear advantages of blended learning, community-level resource constraints posed significant implementation challenges. Interviews with community managers and program coordinators revealed a lack of dedicated funding, technical personnel, and infrastructure to sustain high-quality digital learning programs. In some cases, outdated equipment, insufficient Wi-Fi coverage, and limited training opportunities for staff impeded the scalability of blended learning models. These resource limitations not only restricted the frequency and quality of online courses but also hindered the establishment of reliable technical support systems essential for elderly learners.

In summary, the study identified a complex interplay of personal, technological, and institutional factors influencing learning behaviors and outcomes in elderly education. While blended learning has demonstrated strong potential to enhance learning engagement and digital empowerment, its effectiveness is highly contingent upon learner characteristics, contextual support systems, and the quality of instructional design. Moving forward, tailored strategies that incorporate age-sensitive pedagogy, differentiated content delivery, and community-based digital infrastructure investment are crucial to maximizing the inclusive potential of blended learning in aging societies.

## 5.0 Discussion of Findings

This study undertook a comparative analysis of learning behaviors and educational outcomes between two groups of elderly learners: one adopting a blended learning model and the other engaged in traditional face-to-face instruction. The findings provide compelling evidence that the blended learning approach holds significant promise for improving the quality, accessibility, and relevance of education for older adults in community settings. In particular, the experimental group—who experienced a hybrid of online and offline learning

activities—consistently outperformed their peers in multiple dimensions, including knowledge acquisition, skill development, digital competency, and overall learner satisfaction.

The data indicate that learners in the blended model demonstrated more robust cognitive engagement, with higher scores on post-course assessments, and showed increased proficiency in applying newly acquired skills to real-life contexts, such as using smartphones for health management, navigation, and social communication. This suggests that blended learning not only facilitates information retention, but also supports the functional integration of digital knowledge into daily living, which is especially critical in an era of rapid technological change and growing digital dependence.

A key contributing factor to this enhanced performance lies in the flexibility and adaptability of the blended model. Unlike traditional classroom-based instruction, blended learning accommodates diverse learning preferences, cognitive rhythms, and life schedules, thereby empowering elderly learners to engage with content at their own pace and revisit challenging material as needed. The asynchronous nature of online learning components—especially video modules—enabled learners to overcome memory constraints, reinforce key concepts, and build confidence incrementally. These benefits were consistently reflected in learners' self-reported improvements in self-efficacy, particularly in relation to technology use.

Moreover, the positive emotional and motivational outcomes reported by the experimental group suggest that blended learning environments may foster a more inclusive and affirming educational experience. Learners expressed greater autonomy, relevance, and enjoyment in blended courses compared to traditional formats, indicating that the model has the potential to support psychological well-being and social participation among older adults. These findings align with theories of adult learning that emphasize the importance of autonomy, purpose, and personal relevance in motivating sustained engagement.

However, while the benefits of the blended model are evident, the study also sheds light on several critical barriers that must be addressed to ensure its long-term effectiveness and scalability. One of the most persistent challenges is technological access and digital literacy. A subset of learners—particularly those aged 75 and above or with limited educational attainment—struggled with navigating online platforms, operating devices, and interacting with digital course materials. These difficulties not only slowed learning progress but also contributed to feelings of frustration and disengagement. Without proactive digital inclusion strategies, such as pre-course orientation, in-class demonstrations, and individualized technical coaching, these learners risk being excluded from the potential benefits of digital education.

Another major challenge concerns sustaining motivation in asynchronous online environments. Despite the overall higher engagement of the experimental group, some learners reported experiencing difficulty maintaining focus or motivation during self-directed study sessions. Factors such as abstract course content, limited feedback mechanisms, and a lack of human interaction were cited as contributing to reduced enthusiasm. This highlights the need for innovative instructional design that integrates multimedia content, gamified elements, interactive tasks, and real-world case scenarios to heighten learner interest and facilitate active engagement.

Furthermore, the study identified the importance of social interaction and peer support in maintaining learner morale and commitment. Participants frequently cited offline group sessions and peer exchanges as critical to their sense of belonging and learning enjoyment. Therefore, blended learning environments must prioritize the creation of community-based learning structures, such as discussion groups, buddy systems, and cooperative projects, to mitigate the isolation that may occur in solitary online learning.

In light of these findings, it is clear that the successful implementation of blended learning for elderly education requires a holistic and learner-centered approach. Key recommendations include:

1) Age-sensitive instructional design: Courses must be tailored to account for cognitive load, sensory

limitations, and emotional needs common among older learners. Instructional materials should be presented in clear, step-by-step formats with ample visual aids and reinforcement activities.

2）Personalized technical support: Community educators and volunteers should be trained to provide individualized guidance on digital devices and platform navigation, ideally through face-to-face interactions and easily accessible help channels.

3）Motivational strategies: Curriculum development should incorporate real-life relevance, storytelling, and outcome-oriented goals that resonate with learners' lived experiences and practical needs.

4）Participatory course development: Engaging learners in the co-design of curriculum content and delivery methods not only improves relevance and contextual fit but also increases ownership and commitment.

5）Institutional support and infrastructure: Sustainable implementation requires investment in digital infrastructure, staff training, and intergenerational partnerships to maintain program quality and continuity.

In conclusion, the blended learning model presents a transformative opportunity for enhancing elderly education, promoting digital inclusion, and supporting active aging. However, to fully realize its potential, educational stakeholders must move beyond a one-size-fits-all approach and commit to adaptive, inclusive, and participatory strategies that reflect the unique characteristics of older adult learners. By doing so, blended learning can become not just a method of instruction, but a platform for social equity, lifelong learning, and community resilience in the digital age.

### 5.1 Recommendations for enhancing elderly education through blended learning

To enhance the effectiveness of blended learning in elderly education, it is crucial to implement a digital and age-friendly transformation of educational courses. Course content should be designed to be concise and easily comprehensible, while the user interface must incorporate large fonts, high contrast, and intuitive navigation to accommodate the cognitive and visual needs of elderly learners (Farage et al., 2012). Diversifying course formats by integrating videos, audio, and graphics can further support varied learning preferences and reduce cognitive load, making educational materials more accessible and engaging (Fidalgo & Thormann, 2017).

Another critical aspect is the improvement of digital literacy among elderly learners. Prior to course commencement, providing smartphone and online learning platform training can help mitigate technical barriers (Arthanat et al., 2018). Additionally, establishing technical support systems, such as community volunteers or designated support teams, ensures that learners receive timely assistance throughout their learning journey. Offering offline tutoring alongside digital courses is also essential to address personalized learning needs and enhance overall educational outcomes (Alur et al., 2020)

To stimulate learning motivation, it is beneficial to create a blended learning community that facilitates both online discussions and offline interactions. Encouraging engagement within learning groups fosters a sense of belonging and enhances communication among learners, improving the overall learning experience (Chen et al., 2023). Furthermore, setting small learning goals and implementing reward mechanisms, such as certificates or tangible incentives, can boost learners' sense of achievement and increase engagement levels Aligning course content with practical, real-life applications ensures that learning remains relevant and enjoyable for elderly participants (Yi & Chi, 2023).

Building a diversified elderly education ecosystem requires multi-sector collaboration among government bodies, communities, educational institutions, and social organizations. Governments should increase policy support and funding for elderly education while encouraging the development and sharing of educational resources (Yi & Chi, 2023). Communities can leverage their proximity to elderly populations to establish localized blended learning platforms and offer a wide range of courses tailored to learners' specific needs

(Lin et al., 2021). Educational institutions should partner with technology companies to create age-friendly digital tools and platforms that enhance the accessibility and usability of blended learning for older adults (Shadiev et al., 2023). Through such collaborative efforts, an inclusive and sustainable elderly education ecosystem can be developed, providing high-quality learning opportunities and fostering lifelong learning and social participation among seniors (Bai et al., 2018).

The training and development of educators is another crucial factor in improving the quality of elderly education. Teachers should receive specialized training in blended learning methodologies, including the effective use of online teaching tools and course design tailored to elderly learners (Luo et al., 2017). Additionally, educators must develop a deeper understanding of the psychological and cognitive characteristics of elderly learners, enabling them to implement flexible teaching strategies, such as differentiated instruction and personalized tutoring, to accommodate diverse learning needs (Chiu et al., 2018). To ensure the long-term success of blended learning in elderly education, it is essential to establish continuous evaluation and feedback mechanisms. Regular data collection and learner feedback analysis can help assess course effectiveness and identify areas for improvement (Ravindran M, Sillalee S., Sheiladevi,2025). Encouraging elderly learners to participate in curriculum design and refinement fosters a sense of ownership and engagement, further enhancing satisfaction and learning outcomes (Bai et al., 2018).

## 6.0 Conclusion

While this study provides valuable insights into the effectiveness of blended learning in elderly education, several critical areas warrant further exploration to refine current understandings and expand upon the initial findings. Although the study demonstrated significant short-term benefits of the blended learning model—particularly in improving learners' digital competencies, knowledge acquisition, and course satisfaction—the broader implications of these results require additional empirical support. Accordingly, future research should focus on three key dimensions: expanding sample diversity, extending research duration, and exploring the integration of emerging technologies.

First, expanding the sample scope is essential to enhance the representativeness and generalizability of the findings. The current study was primarily conducted in the Daode Street Community of Jinan City, involving a relatively homogeneous group of elderly learners with similar socioeconomic and cultural backgrounds. While the results are encouraging, they may not fully reflect the dynamics present in other urban or rural contexts, nor among populations with varying educational levels, regional characteristics, or degrees of digital literacy. Future research should therefore aim to replicate and extend this study across different geographic regions, including economically disadvantaged areas and ethnically diverse communities. Additionally, comparative studies between urban and rural populations, or between regions with varying access to digital infrastructure, could provide a more nuanced understanding of the prerequisites for successful implementation of blended learning. Such research would also inform localized strategies to bridge the digital divide among older adults.

Second, extending the research timeframe would offer deeper insight into the long-term effects and sustainability of blended learning outcomes. The current investigation focused on a short-term intervention—an autumn smartphone course lasting several weeks—which may not sufficiently capture enduring changes in learners' behaviors, digital engagement, or cognitive development. Longitudinal research designs are crucial for tracking the trajectory of elderly learners over extended periods, assessing how blended learning influences long-term knowledge retention, the transfer of digital skills into daily life, and ongoing motivation to participate in lifelong learning. Moreover, longer-term studies can help identify critical points of learner attrition, changes in learning needs over time, and the evolving support structures required to maintain engagement. This would contribute to the development of more sustainable program models that are responsive to the aging process and the continuous learning needs of older adults.

Third, the integration of emerging technologies represents a promising direction for enhancing the depth and quality of elderly education. With rapid

advancements in digital tools and platforms, technologies such as virtual reality (VR), artificial intelligence (AI), and adaptive learning systems offer transformative potential. For example, immersive VR environments can simulate real-life scenarios to enhance experiential learning, which is particularly beneficial for memory reinforcement and interactive skill-building. AI-based tutoring systems can offer real-time feedback, adapt content to individual learning paces, and detect engagement patterns to proactively address learning difficulties. Furthermore, adaptive learning platforms can personalize content delivery based on user profiles, thereby accommodating diverse cognitive capacities and learning preferences among the elderly. Future studies should investigate how these technologies can be integrated into blended learning environments to improve accessibility, promote digital inclusion, and support personalized learning journeys. Ethical considerations, such as data privacy and cognitive load, must also be factored into technology design and implementation.

In conclusion, while the current study underscores the effectiveness of blended learning in enhancing educational outcomes for older adults, it also highlights the necessity for ongoing refinement and strategic development. A comprehensive approach to elderly education must integrate multiple elements: the promotion of digital transformation, the design of age-friendly and cognitively accessible interfaces, the establishment of robust technical support systems, and the incorporation of motivational strategies tailored to the interests and life experiences of older learners. In addition, a supportive learning ecosystem must be cultivated—one that includes trained educators familiar with geragogical principles, cross-sector collaboration among educational institutions and community organizations, and policy frameworks that prioritize equity and inclusiveness.

By broadening research scope, deepening temporal inquiry, and leveraging the power of technological innovation, future studies can contribute to building a resilient and responsive model of blended learning for elderly education. Ultimately, these efforts will support the realization of inclusive, high-quality lifelong learning opportunities for aging populations, empowering them to participate more fully in the digital society and maintain meaningful social, cognitive, and emotional engagement throughout later life.

## References

Alur, R., Baraniuk, R. G., Bodík, R., Drobnis, A. W., Gulwani, S., Hartmann, B., Kafai, Y. B., Karpicke, J., Libeskind-Hadas, R., Richardson, D. J., Solar-Lezama, A., Thille, C., & Vardi, M. Y. (2020). Computer-Aided Personalized Education. In arXiv (Cornell University). Cornell University. https://doi.org/10.48550/arXiv.2007.

Arthanat, S., Vroman, K., Lysack, C. L., & Grizzetti, J. (2018). Multi-stakeholder perspectives on information communication technology training for older adults: implications for teaching and learning. In Disability and Rehabilitation Assistive Technology (Vol. 14, Issue 5, p. 453). Taylor & Francis. https://doi.org/10.1080/17483107.2018.1493752

Bagulaya-Abogaa, J. (2023). Smartphone-Based Evaluation of Academic Performance with QR Code Scanner Support. In Indian Journal of Science and Technology (Vol. 16, Issue 21, p. 1563). Indian Society for Education and Environment. https://doi.org/10.17485/ijst/v16i21.2462

Bai, X., He, Y., & Kohlbacher, F. (2018). Older people's adoption of e-learning services: A qualitative study of facilitators and barriers. In Gerontology & Geriatrics Education (Vol. 41, Issue 3, p. 291). Taylor & Francis. https://doi.org/10.1080/02701960.2018.1469488

Boelens, R., Wever, B. D., & Voet, M. (2017). Four key challenges to the design of blended learning: A systematic literature review [Review of Four key challenges to the design of blended learning: A systematic literature review]. Educational Research Review, 22, 1. Elsevier BV. https://doi.org/10.1016/j.edurev.2017.06.001

Cabauatan, R. R., Uy, C., Manalo, R. A., & Castro, B. de. (2021). Factors Affecting Intention to Use Blended Learning Approach in the Tertiary Level: A Quantitative Approach. In Higher Education for the Future (Vol. 8, Issue 2, p.

239). SAGE Publishing. https://doi.org/10.1177/23476311211011934

Carlsson, Õ. U., Källberg, N., & Wadensten, B. (2014). Blended Learning Among Elderly Care Managers Inspires Projects That Take Older People's Perspectives into Account. In Home Health Care Management & Practice (Vol. 27, Issue 3, p. 142). SAGE Publishing. https://doi.org/10.1177/1084822314563331

Chen, T., Luo, H., Feng, Q., & Li, G. (2023). Effect of Technology Acceptance on Blended Learning Satisfaction: The Serial Mediation of Emotional Experience, Social Belonging, and Higher-Order Thinking. In International Journal of Environmental Research and Public Health (Vol. 20, Issue 5, p. 4442). Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/ijerph20054442

Chiu, C., Tasi, W.-C., Yang, W.-L., & Guo, J. (2018). How to help older adults learn new technology? Results from a multiple case research interviewing the internet technology instructors at the senior learning center. In Computers & Education (Vol. 129, p. 61). Elsevier BV. https://doi.org/10.1016/j.compedu.2018.10.020

Dziuban, C. D., Graham, C. R., Moskal, P., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. In International Journal of Educational Technology in Higher Education (Vol. 15, Issue 1). Springer Nature. https://doi.org/10.1186/s41239-017-0087-5

Farage, M. A., Miller, K. W., Ajayi, F., & Hutchins, D. (2012). Design Principles to Accommodate Older Adults [Review of Design Principles to Accommodate Older Adults]. Global Journal of Health Science, 4(2). Canadian Center of Science and Education. https://doi.org/10.5539/gjhs.v4n2p2

Fidalgo, P., & Thormann, J. (2017). Reaching Students in Online Courses Using Alternative Formats. In The International Review of Research in Open and Distributed Learning (Vol. 18, Issue 2). Athabasca University Press. https://doi.org/10.19173/irrodl.v18i2.2601

Guo, H. (2023, July). Practical exploration of digital empowerment for lifelong learning and talent cultivation: A case study of Hanzhou Open University. Knowledge Library, *14*, 108-111.

Jam, F. A., Singh, S. K. G., Ng, B. K., & Aziz, N. (2018). The interactive effect of uncertainty avoidance cultural values and leadership styles on open service innovation: A look at malaysian healthcare sector. International Journal of Business and Administrative Studies, 4(5), 208.

Guo, Q., Liang, Q., & Peng, Q. (2022). Analysis on mission responsibility of higher vocational medical students in the new era. Western Journal, 2022(18), 81-85. (In Chinese)

Helander, N., Weck, M., & Meristö, T. (2019). DIGITAL ASSISTIVE TECHNOLOGIES FOR AGEING PEOPLE – LEARNING BARRIERS AND EDUCATIONAL APPROACHES. In EDULEARN proceedings (Vol. 1, p. 210). International Academy of Technology, Education and Development. https://doi.org/10.21125/edulearn.2019.0092

Jong, N. de, Savin-Baden, M., Cunningham, A. M., & Verstegen, D. (2014). Blended learning in health education: three case studies. In Perspectives on Medical Education (Vol. 3, Issue 4, p. 278). Bohn Stafleu van Loghum. https://doi.org/10.1007/s40037-014-0108-1

Lam, J., Lau, N., Shim, C., & Cheung, S. K. S. (2013). Design and development process for blended learning courses. In International Journal of Innovation and Learning (Vol. 13, Issue 3, p. 322). Inderscience Publishers. https://doi.org/10.1504/ijil.2013.052900

Li, F., Shao, Q., Wang, X., et al. (2022). Analysis on the development path of high quality in medical higher vocational colleges in the new era. Chinese Journal of Multimedia and Network Teaching (Mid-Day), 2022(07), 179-182.

Lin, S. (2022). Thinking on improving public health service ability under the concept of "Big Health". Journal of Xiamen Special Zone Party School, 2022(05), 31-36.

Liu, X. (2023). The realistic dilemmas and transformational approaches of digital development in elderly education. [China

Adult Education], 2023(7).

Luo, T., Hibbard, L., Franklin, T., & Moore, D. (2017). Preparing Teacher Candidates for Virtual Field Placements via an Exposure to K-12 Online Teaching. In Journal of Information Technology Education Research (Vol. 16, p. 1). Informing Science Institute. https://doi.org/10.28945/3626

Ma, X. (2021). Ways and suggestions of vocational literacy training for students in higher vocational colleges based on socialist core values. *Journal of Hubei Open Vocational College*, 34(23), 57-58.

Mahmood, H. B., & Noor, S. B. M. (2020). Acceptance, Effectiveness and Relationship of Blended Learning Implementation Among Lecturers in Polytechnic Sultan Mizan Zainal Abidin. In IJIEEB International Journal of Integrated Education Engineering and Business (Vol. 3, Issue 1, p. 1). https://doi.org/10.29138/ijieeb.v3i1.1077

Park, S. E. (2021). Planning for Blended Learning for the Post-Pandemic Era. In American Journal of Biomedical Science & Research (Vol. 13, Issue 3, p. 268). BiomedGrid. https://doi.org/10.34297/ajbsr.2021.13.001868

Picciano, A. G. (2009). Blending with Purpose: The Multimodal Model. In Journal of the Research Center for Educational Technology (Vol. 5, Issue 1, p. 4). http://files.eric.ed.gov/fulltext/EJ837540.pdf

Policy history, achievements, and experience of vocational education with Chinese characteristics since the 18th National Congress of the CPC. *Education and Careers*, 2022(21), 13-20.

Qiao, R. (2022). Research on vocational quality innovation training of higher vocational medical students. *Theoretical Research and Practice of Innovation and Entrepreneurship*, 5(15), 85-87.

Ravindran M, Sillalee S., Sheiladevi (2025). Comparative Awareness of the Learning Crisis among ESL and STEM Tranee Teachers in Malaysia. *Perinatal Journal,25(02)35*.

Ren, C. (2019). Construction and exploration of off-campus practice base for innovation and entrepreneurship of higher vocational medical majors from the perspective of medical education collaboration. *Theoretical Research and Practice of Innovation and* Entrepreneurship, 5(18), 190-193

Shadiev, R., Hwang, W., Altınay, F., & Guralnick, D. (2023). Editorial: Technology-assisted cultural diversity learning. In Frontiers in psychology (Vol. 14). Frontiers Media. https://doi.org/10.3389/fpsyg.2023.1274292

Siregar, N., Siregar, T. M., & Siregar, B. (2019). Blended learning in students' view. In Journal of Physics Conference Series (Vol. 1188, p. 12099). IOP Publishing. https://doi.org/10.1088/1742-6596/1188/1/012099

Sixsmith, A., Horst, B., Simeonov, D., & Mihailidis, A. (2022). Older People's Use of Digital Technology During the COVID-19 Pandemic. In Bulletin of Science Technology & Society (Vol. 42, p. 19). SAGE Publishing. https://doi.org/10.1177/02704676221094731

Srivastava, M. (2023). The Evolution of Education: Navigating 21st-Century Challenges. In International Journal For Multidisciplinary Research (Vol. 5, Issue 5). https://doi.org/10.36948/ijfmr.2023.v05i05.6314

Stroud, R. (2019). The Use of Technology to Support Theories of Learner Engagement. https://doi.org/10.1145/3318396.3318399

Timmermann, S. (1998). The Role of Information Technology in Older Adult Learning. In New Directions for Adult and Continuing Education (Vol. 1998, Issue 77, p. 61). Wiley. https://doi.org/10.1002/ace.7706

Wang, S., Ni, D., & Yu-juan, Y. (2021). Instructional Design of Blended Learning in Higher Education – A Case Study in China (p. 276). https://doi.org/10.1145/3456887.3456948

Wang, Z., Cheng, X., Xu, B., et al. (2024). Theoretical implications, index evaluation and practical approaches to the modernization of elderly education [Journal of Distance Education], 2024(1).

Xie, D., Liu, C., & Fan, Q. (2023). Path of university-enterprise cooperation for education of medical laboratory technology in higher vocational colleges. *College*, 16(04), 54-56. (In

Chinese)

Yang, L. (2022). Study on the path of major structure adjustment under the background of vocational education innovation and development highland construction. Vocational Education Research, 2022(11), 52-57. (2022).

Yuan, C. (2024). Digital empowerment of Chinese-style modernization of elderly education: Realistic dilemmas and practical paths. [China Adult Education], 2024(7), 25-31.

Yi, H., & Chi, R. (2023). TEACHING REFORM OF ELDERLY INFORMATION TECHNOLOGY CURRICULUM BASED ON CDIO. In International Journal of Engineering Technologies and Management Research (Vol. 10, Issue 5, p. 27). https://doi.org/10.29121/ijetmr.v10.i5.2023.1320

Zhao, X.-F., & Sun, D.-T. (2020). The Research on Design and Application of Blended Learning Mode Based on Smart Vocational Education Cloud Platform. https://doi.org/10.2991/assehr.k.200207.014

Zhang, C., Hou, Y., & Wang, J. (2023). Elderly education services for Chinese-style modernization: Value, mechanism and path. [Journal of Continuing Higher Education], 2023(5).

Zhu, L., Li, Y., & Zhan, S. (2021). Exploration on practice education model of higher vocational medical colleges based on virtue and cultivating people. Continuing Medical Education, 35(08), 41-43.