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Bridging generations: a scoping review of teaching technology to the elderly using intergenerational strategies

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ABSTRACT

The proportion of the global population aged 60 and above is projected to nearly double by 2050, emphasizing the urgent need for societies to adapt to the challenges posed by an aging population. As the elderly increasingly face difficulties in navigating digital technologies, which are essential for daily tasks and accessing services, the digital divide often leads to digital exclusion. This scoping review investigates intergenerational strategies used to teach technology to older adults. Seventeen studies from 11 countries were analyzed, highlighting six key intergenerational learning strategies: reverse mentoring, virtual learning, collaborative learning, family intergenerational activities, game play learning, and storytelling. These strategies offer diverse methods for enhancing digital literacy and social engagement, with reverse mentoring showing promise in fostering digital competence, and virtual learning promoting inclusivity across generations. However, barriers such as technological access, ongoing support, and cultural differences complicate implementation. This review underscores the importance of adapting instructional approaches to the needs of the elderly while leveraging intergenerational interactions to bridge the digital literacy gap. It calls for sustained efforts to address user needs, provide technical support, and ensure inclusivity, especially for isolated individuals, to maximize the effectiveness and sustainability of these strategies.

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1. INTRODUCTION

According to the World Health Organization (WHO) [1], it is projected that by 2030, 1 in 6 people worldwide will be aged 60 years or older. This marks a significant demographic shift, as populations across the globe are aging at an unprecedented rate. Factors such as increased life expectancy and declining birth rates have contributed to this phenomenon, which is expected to reshape societies in numerous ways. WHO further emphasizes that the proportion of the global population aged 60 and above will nearly double between 2015 and 2050, from 12% to 22%. This surge in the elderly population highlights the urgent need for societies to adapt, particularly in areas like healthcare, social services, and education. The rise of an aging population is not just a challenge for developed countries; it is a global issue that affects both developed and developing nations. Malaysia, for instance, has its own definition of "elderly," categorizing individuals aged

60 and above in this group. The Department of Statistics Malaysia [2] predicted that the country would become an aging society by 2020, as 7.2% of its population reached the age of 65 and above. This mirrors the global trend and raises concerns about how well-equipped societies like Malaysia are to address the needs of their aging citizens. As digitalization rapidly transforms the world, the elderly face new challenges, particularly in navigating and engaging with technology. Digital literacy, which Czaja *et al.* [3] describe as essential in today's world, is no longer just a skill but a necessity, given that digital technology now permeates every aspect of daily life, from communication to accessing essential services.

LoBuono *et al.* [4] conducted a study that identifies the types of technology most commonly used by older adults. These include essential functions such as communication, staying connected with loved ones, organizing tasks, leisure activities like games or reading, managing photos and memories, productivity tools like calendars, and essential tasks such as managing finances and health. Many of these technologies aim to improve the quality of life for older adults, making day-to-day tasks easier and allowing them to stay engaged with society. For example, messaging apps help them maintain social connections, while mobile banking enables them to manage their finances independently. These technologies can be accessed through a range of devices, including mobile phones, tablets, and computers, which are becoming increasingly user-friendly for older populations. However, despite these advancements, older adults often struggle with adapting to rapidly evolving technologies. Czaja *et al.* [3] explain that while these devices offer numerous benefits, they are also constantly changing, which makes it difficult for older individuals, who may not be as tech-savvy, to keep up. This is compounded by the fact that the elderly often grew up in a world that operated at a slower pace and was more connected on a personal level, as noted by researchers [5]-[7]. The fast-paced development of technology, combined with complex interfaces and frequent updates, creates a digital divide. Many older adults feel incompetent in using new technologies and often seek assistance from others to bridge the gap. Studies suggest that this support typically comes from family members [8], [9], though non-family members, such as community volunteers or peers, can also provide valuable assistance [4], [10]-[14].

One of the consequences of this digital divide is that some older adults experience digital exclusion. As reliance on technology grows in critical sectors like healthcare, access to health information, and public health resources, those without digital skills or access are left behind. This exclusion is particularly problematic as the healthcare system increasingly shifts towards digital platforms for services like telemedicine, online health records, and e-prescriptions [15]. The COVID-19 pandemic further intensified this issue, as many older adults were forced to rely on digital tools for essential services and social interactions [16]. The pandemic exacerbated social isolation, particularly among the elderly, due to lockdowns and social distancing measures. As in-person gatherings were limited, digital applications like video calls and messaging apps became lifelines for older adults to stay connected with family and friends. Unfortunately, those who lacked digital skills found themselves even more isolated, which negatively impacted their mental and emotional well-being [17]. This situation underscores the importance of digital literacy for older adults, as technology has become indispensable for maintaining social ties and accessing essential services. As a result, there is growing interest in how intergenerational instructional strategies can help older adults adapt to the digital world. Intergenerational learning, where younger individuals teach older adults how to use technology, has proven to be an effective way to bridge the generational divide and reduce the digital literacy gap [8]-[14], [16]-[21].

This scoping review seeks to explore and summarize the instructional strategies and recent issues discussed in existing research related to teaching technology to the elderly through intergenerational approaches. Intergenerational strategies involve interactions between individuals from different age groups, often focusing on older adults and younger generations, such as students or young professionals. These strategies not only provide older adults with practical skills to navigate digital technologies but also foster mutual understanding and collaboration between generations. Previous studies have shown that intergenerational learning offers several benefits, including improving the confidence and independence of older adults in using technology and strengthening social bonds between younger and older individuals. Moreover, these interactions can reduce feelings of loneliness and social isolation for the elderly while offering young people the opportunity to develop teaching and communication skills. This review aims to provide a comprehensive overview of the instructional strategies that have been implemented, the challenges faced, and the outcomes achieved in fostering digital literacy among older adults through intergenerational methods. By synthesizing the findings from various studies, this review will contribute to the ongoing discussion on how to effectively support the aging population in adapting to the digital age.

2. RESEARCH METHOD

This scoping review seeks to explore recent instructional strategies designed to improve the elderly's experience with technologies through intergenerational approaches. The review follows the

framework outlined by Arksey and O'Malley [22], which consists of five key stages: i) identifying the research question, ii) finding relevant studies, iii) selecting published articles, iv) charting the data, and v) summarizing the collected information. By following this process, the study aims to uncover both the strategies and challenges associated with using intergenerational strategies to enhance the digital literacy of elderly. To further clarify the review process, Figure 1 provides a visual representation of the scoping review framework, illustrating each step.

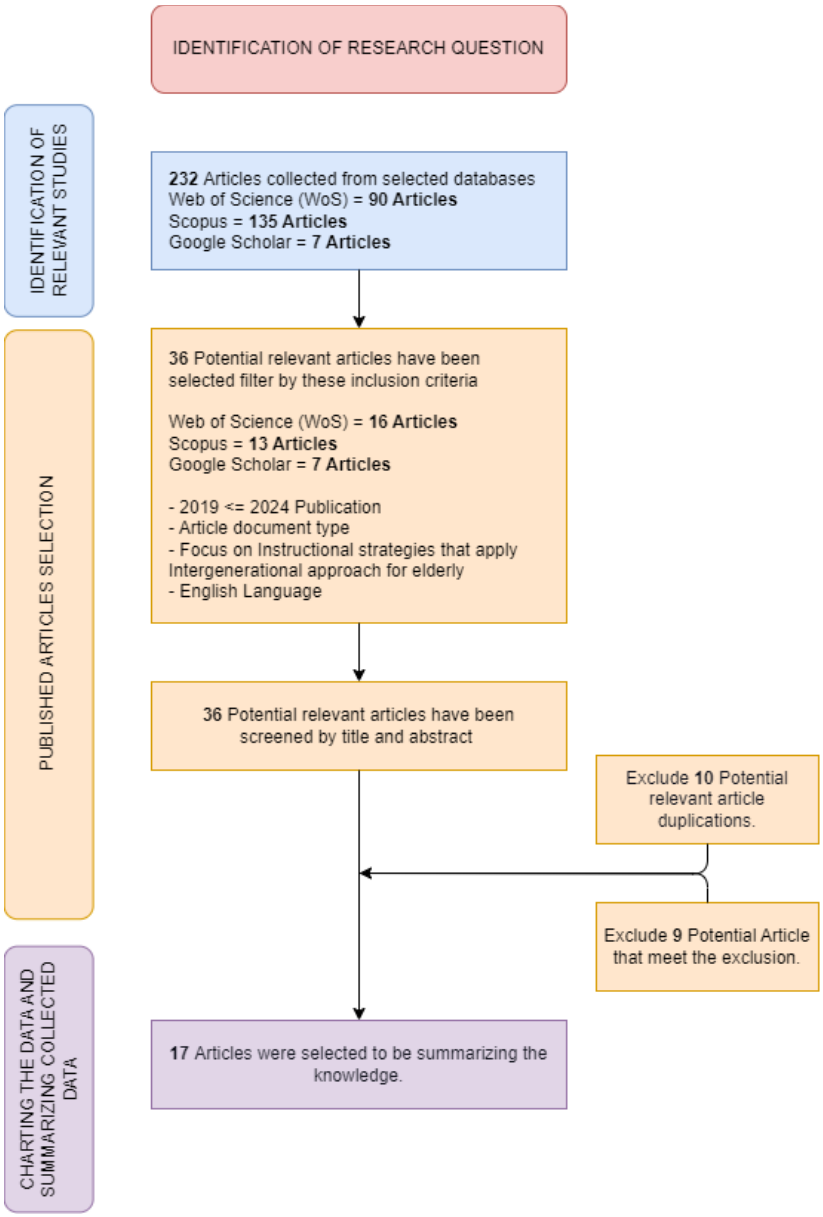

Figure 1. Scoping review framework

The data gathered in this review will help shape clear objectives and eligibility criteria [23]. To effectively address the first stage of the scoping review, the research questions were developed using the population, concept, and context (PCC) framework, as recommended by the Joanna Briggs Institute (JBI) [24]. This framework ensures that the study focuses on key areas of interest while developing relevant research questions [25]. As noted by Aromataris and Munn [26], using the PCC framework helps guide the creation of a search strategy that dissects the research questions into manageable components. This process allows the research questions to serve as the foundation for the entire study, helping to ensure a targeted and thorough investigation.

The primary goal of this scoping review is to identify intergenerational instructional strategies that have been recently used to improve elderly users' ability to engage with technologies. Additionally, the review will explore the challenges and issues raised by previous studies regarding the use of intergenerational methods in teaching technology to elderly. The research questions guiding this study are as follows: i) what are the effective intergenerational teaching methods currently used to help the elderly learn technology? and ii) what challenges have been highlighted in previous studies regarding the implementation of these intergenerational teaching strategies? By answering these questions, the study will compile a body of knowledge that addresses the needs of elderly in a digital world. The PCC framework helps structure the search for relevant literature by identifying key search terms [27]. These terms are carefully chosen using online thesauruses and are combined with Boolean operators, truncation, and wildcards to form search strings, as illustrated in Table 1. These search strings are then used to explore databases such as Web of Science, Scopus and Google Scholar, of which offer multidisciplinary resources and advanced search capabilities [28]-[30].

Table 1. The search string

Database	Search string
Web of Science	**TS =** ((“effect*” **OR** “benefit*” **OR** “advantage*” **OR** “outcome*”) **AND** (“digital* application*” **OR** “digital*” **OR** “application*” **OR** “software”) AND (“strateg*” **OR** “method*” **OR** “design*” **OR** “instruct*” **OR** “teach*” **OR** “instruction* strateg*” **OR** “instruction* design*” **OR** “instruction* method*”) **AND** (“intergeneration* approach*” **OR** “intergeneration*” **AND** (“Elder*” **OR** “older*” **OR** “senior*” **OR** “older* adult*”))
Scopus	**TITLE-ABS-KEY** ((“effect*” **OR** “benefit*” **OR** “advantage*” **OR** “outcome*”) **AND** (“digital* application*” **OR** “digital*” **OR** “application*” **OR** “software”) **AND** (“strateg*” **OR** “method*” **OR** “design*” **OR** “instruct*” **OR** “teach*” **OR** “instruction* strateg*” **OR** “instruction* design*” **OR** “instruction* method*”) **AND** (“intergeneration* approach*” **OR** “intergeneration*”) **AND** (“Elder*” **OR** “older*” **OR** “senior*” **OR** “older* adult*”))
Google Scholar	((“effect*” **OR** “benefit*” **OR** “advantage*” **OR** “outcome*”) **AND** (“digital* application*” **OR** “digital*” **OR** “application*” **OR** “software” **OR** “technology”) **AND** (“strateg*” **OR** “method*” **OR** “design*” **OR** “instruct*” **OR** “teach*” **OR** “instruction* strateg*” **OR** “instruction* design*” **OR** “instruction* method*”) **AND** (“intergeneration* approach*” **OR** “intergeneration*” **AND** (“Elder*” **OR** “older*” **OR** “senior*” **OR** “older* adult*”))

Article selection for this scoping review is critical to avoid bias and ensure that the findings are valid and reliable, as emphasized by Salmond and Bennet [24]. To ensure a rigorous selection process, multiple authors review the articles, cross-checking decisions to ensure that all influential factors are considered [31]. Inclusion and exclusion criteria, shown in Table 2, are used to narrow the results, ensuring homogeneity among the selected studies [24]. Duplicate articles, which may appear when using multiple databases, are removed to avoid redundant data.

Table 2. Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Publish years	2019 until 2024	Less than 2019
Document type	Article	Book, Chapter in book, Book series, Proceeding, Review Article
Language	English	Non-English
Approach/Focus	Instructional strategies, Intergenerational for elderly	Other approach, too-medical centered, application development, intergenerational for younger generation, application design, not using technology as a teaching tool

This review focuses on articles published between 2019 and 2024, ensuring the inclusion of recent and relevant data. The search process, which began in December 2023 to September 2024, adheres to the approach suggested by Higgins and Deeks [31] to minimize the risk of publication overlap. Okoli [27] also supports this method of determining publication dates following the start of the search. To maintain the integrity of the review, only English-language articles and those classified as “articles” are included. This decision is intended to prevent issues like mistranslation and misinterpretation [30]. During the screening phase, studies that focus on intergenerational instructional strategies for teaching technology to the elderly are assessed based on their titles and abstracts, with irrelevant articles excluded [31]. The selected articles are then organized according to the research questions, and the data are analyzed to identify the strategies and challenges discussed in previous studies.

3. RESULTS AND DISCUSSION

This research identified 17 relevant articles from the World of Science, Scopus and Google Scholar databases. The intergenerational study involving elderly individuals using digital technology was carried out in 11 countries as depicted in Figure 2. Based on the total of 17 selected articles, three studies were conducted in the United States and China; Spain, Canada and Korea contributed two studies each; while one study came from Brazil, Spain, Bahrain, UK, Taiwan, Korea, Japan and New Zealand. Out of the17 selected articles, seven paper was published in 2023, six were published in 2022, two papers were from 2021, one paper were from 2020, and one paper were published in 2019. The age range of the respondents for all 17 studies fell between 54 and 90 years. Based on the thematic analysis conducted, six themes were developed. The themes consist of: reverse mentoring, virtual learning, collaborative learning, family intergenerational, game play learning and storytelling.

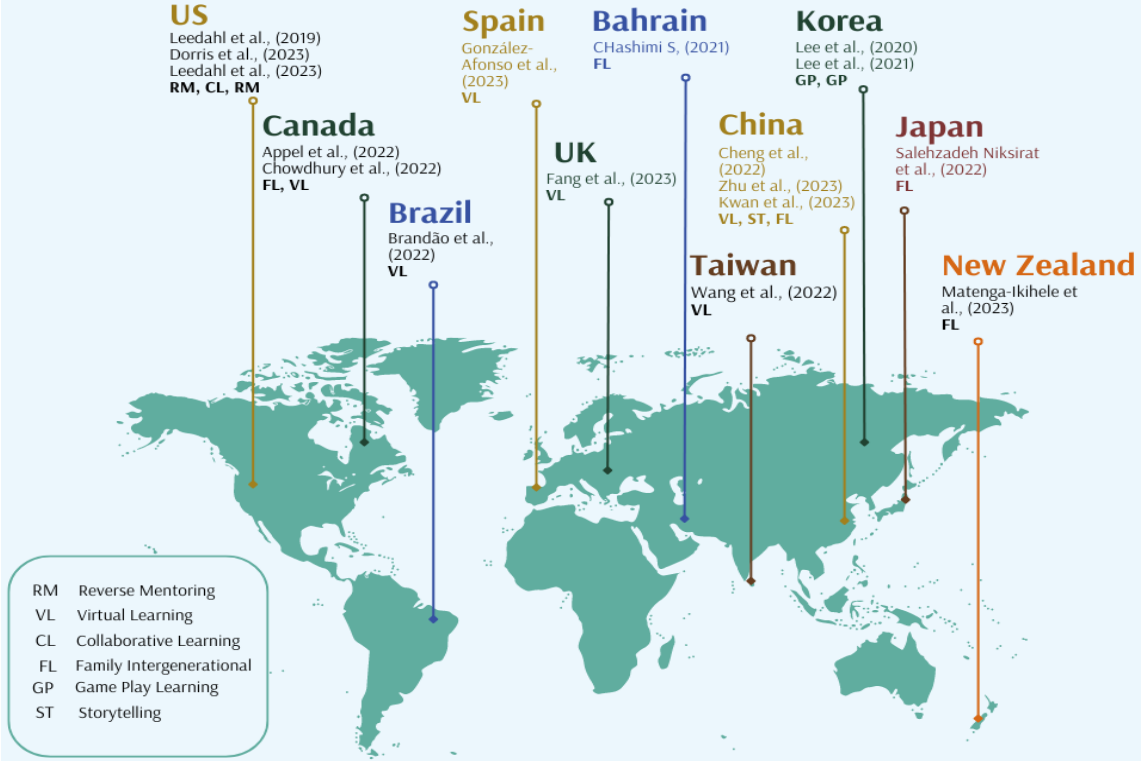

Figure 2. Types of intergenerational learning strategies employed across different countries

3.1. Reverse mentoring

The two studies, the URI engaging generations program: cyber-seniors and the URI eGen cyber-seniors program highlight the effectiveness of reverse mentoring strategies in intergenerational technology programs. Both programs connect university students with older adults to enhance digital competence among the elderly while also fostering positive attitudes in students toward aging. In the first study [12], students played a key role in teaching older adults how to use technology, which involved strategies such as a flexible trial period to identify the best methods for engagement, structured training sessions to prepare students for mentoring, and the use of personalized teaching modules to cater to the individual needs of participants. The program also emphasized the importance of accurate documentation and reflection for students to understand the impact of their mentoring, as well as active involvement from community partners to facilitate smooth operation and support for participants.

The second study [11] used a quasi-experimental design to further explore the impact of reverse mentoring on digital competence and social engagement. It found that older adults who participated in the program demonstrated significant improvements in digital skills and an increase in technology usage, alongside a reduction in loneliness and an increase in volunteering. Reverse mentoring was effective in this context because it provided personalized, one-on-one sessions tailored to the specific needs and interests of the older adults. The study underscored the value of reverse mentoring in breaking down barriers to technology use among older adults, such as perceived lack of benefit or fear of new technology. Key

strategies across both studies included personalization, where students adjusted their teaching based on participant needs; training and preparation, ensuring students were well-equipped for their mentoring roles; support and resources, providing necessary materials and guidance; community partnerships, which helped in recruiting participants and offering logistical support; and reflection and feedback, allowing continuous improvement of the programs. These strategies demonstrate how reverse mentoring can effectively leverage the technological skills of younger generations to benefit older adults, enhancing their digital literacy and social engagement.

3.2. Virtual learning

The findings from all the studies highlight the success of virtual learning strategies in helping older adults bridge the digital divide and encourage intergenerational learning. In the FIL Project in rural China [9], removing barriers based on education level or socioeconomic status made digital education more accessible to older adults. By allowing them to learn alongside their grandchildren, the project provided a flexible and personalized learning experience that also proved to be cost-effective, as it required only basic electronic devices like smartphones or computers. Similarly, the Playful Living program in Brazil [17] demonstrated the benefits of engaging older adults, including those with cognitive impairments, through inclusive conversations and creative activities like dancing and clowning. This approach encouraged communication beyond traditional speech and helped participants build meaningful connections. While the program showed the potential of remote interaction, it also highlighted the need for in-person digital support for those lacking family or social network assistance. Both studies emphasize the value of intergenerational learning. In the FIL project, grandchildren teach digital skills to their grandparents, creating a responsive learning environment. The Playful Living program uses creative activities to foster mutual understanding and communication between generations. Empowering older adults to choose their learning paths and engage in meaningful activities boosts their confidence and sense of control. These studies suggest that using creative and artistic activities can be an effective way to engage older adults, making communication easier and promoting their well-being. By focusing on inclusivity, empowerment, and tailored support, reverse mentoring through virtual learning can significantly enhance the learning experience and digital inclusion for older adults.

Chowdhury *et al.* [32], the focus was on using co-listening to music as a way to enhance interactions between grandparents and their teenage grandchildren. This study built on previous work showing that shared activities like co-listening can strengthen family bonds. Participants in this study enjoyed private, one-on-one interactions facilitated by a private DJ technology probe, which allowed for slow interaction and deep conversations. Despite technological challenges, such as issues with video conferencing and music platforms, the dyads used their technological knowledge to support each other and expressed interest in learning new technologies together. The study suggests that future online systems should incorporate features that promote slow interaction, anticipation, and user control to enhance intergenerational communication.

The next study by [11] focused on integrating technology into traditional intergenerational activities, particularly using VR and tangible user interfaces (TUIs) to make learning more engaging for both older and younger generations. The study developed a VR-based learning system with principles emphasizing simplicity, intuitive operations, and engaging interactions. Results from questionnaires and interviews indicated that the system effectively encouraged participation from both generations and facilitated positive emotional exchanges. Older participants were more willing to embrace technology when it was connected to familiar themes from their own experiences. The study highlighted that VR and TUIs could bridge the generational gap, improve mutual understanding, and enhance the overall learning experience. Overall, these studies demonstrate that integrating creative, interactive technologies into intergenerational activities can significantly improve engagement and communication between different age groups. By addressing technological barriers and incorporating elements that promote planning, surprise, and simplicity, virtual learning strategies can support meaningful connections and learning experiences across generations [33].

The SIMUL project [16] involves young and older participants working together on a shared project. However, the videoconference format didn't effectively bridge the generational gap, leading to separate groups rather than a unified team. To improve future projects, the study suggests creating virtual spaces for informal interactions before and after sessions, in addition to formal meeting rooms. It emphasizes the importance of face-to-face meetings but acknowledges that virtual interactions can be enhanced by addressing ICT proficiency and technical issues. Recruiting a balanced number of older participants and reducing the monitor's role in session facilitation are also recommended. These adjustments aim to better replicate the benefits of in-person interactions in a virtual setting.

3.3 Collaborative learning

The project [21] revealed key insights into the nature of intergenerational collaboration, highlighting how music bridged the generational gap and facilitated meaningful connections. Similar findings emphasize

the effectiveness of shared activities, such as digital games and learning sessions, in fostering communication and mutual respect between generations [34], [35]. Although the adolescent musicians initially felt intimidated by communicating with older adults experiencing cognitive decline, performing familiar musical selections created a shared cultural ground. This aligns with research showing that shared interests, including music and digital games, can reduce generational stereotypes and improve social bonding [36]. Despite technical challenges, such as latency on Zoom, both generations adapted, with the older adults' enthusiasm providing a supportive atmosphere that encouraged the adolescents [37].

3.4. Family intergenerational activities

Activity-based interventions, like yoga and community singing, have been shown to improve mental well-being among older adults, though cultural differences influence acceptance [38]. A study integrating ICT skills with intergenerational mentorship revealed improved mental health and digital literacy [39]. Programs like Digital Buddies, where university students guide older adults, illustrate the positive outcomes of structured intergenerational digital support [40], [41]. Similarly, VR programs that engage both generations, such as the VRCHIVE pilot program, demonstrate the potential of virtual reality to foster connection and reduce loneliness [8]. In Bahrain, older adults expressed eagerness to develop digital literacy, particularly with tailored ICT training that accounts for their life experiences and contexts, supporting other findings that digital inclusion can mitigate feelings of isolation [42].

3.5. Game play learning

Research shows that games facilitate intergenerational communication, with younger partners often assisting older adults in navigating digital environments [43], [44]. Games are particularly effective for life review activities, offering a more dynamic and enjoyable medium for conversations and self-reflection compared to traditional interviews [45]. Recent studies emphasize that game design must account for age-related physical and cognitive challenges, including eyesight, memory, and motor skills [46], [47]. Furthermore, aesthetics that evoke nostalgia and challenge can enhance engagement among older adults [48].

3.6. Storytelling

Digital storytelling has emerged as a promising method to enhance social participation among older adults with mild cognitive impairment (MCI), as shown in studies where digital platforms enabled users to share stories and preserve memories [49]. The integration of storytelling in intergenerational projects promotes a sense of belonging and self-worth among elderly participants, addressing potential challenges related to user interface and accessibility.

4. DISCUSSION

The six intergenerational learning strategies which are reverse mentoring, virtual learning, collaborative learning, family intergenerational activities, game play learning, and storytelling offer diverse approaches to enhancing digital literacy and social engagement across generations. The following Table 3 shows the summarization of intergenerational strategies strength's and challenges from the reviewed studies.

Table 3. Summary of intergenerational strategies strength's and challenges

Strategy	Strengths	Challenges
Reverse mentoring	Promotes digital literacy and positive aging views	Sustaining engagement and resource-intensive training
Virtual learning	Inclusive and flexible learning across generations	Requires family support and access to technology
Collaborative learning	Builds bonds through shared interests like music	Apprehension towards technology and need for support
Family Intergenerational activities	Improves digital skills and well-being within families	Cultural and tech proficiency differences
Game play learning	Enhances cognitive engagement and social interaction	Designing accessible and engaging games
Storytelling	Boosts social participation	Privacy concerns and platform adaptability issues

Reverse mentoring stands out for its innovative role reversal, where younger individuals impart technological skills to older adults. Programs such as URI engaging generations exemplify its success, particularly in fostering digital competence and promoting positive attitudes towards aging. However, the strategy relies heavily on the willingness of older adults to engage with younger mentors, and sustaining long-term participation across both generations remains a persistent challenge. Furthermore, while personalized training is essential for success, it often requires substantial time and resources to ensure the

training is tailored to the diverse needs of older adults. Virtual learning programs, like the FIL project and Playful Living, provide a flexible platform for intergenerational interaction, offering inclusivity for those in different geographical locations. However, a critical limitation lies in its reliance on strong family or social networks. Older adults without access to such support systems may find it difficult to participate, leading to potential social exclusion. Moreover, the digital divide may exacerbate existing inequalities, as access to necessary technology and internet connectivity can be a barrier. Collaborative learning through shared interests, such as music, offers a rich platform for building intergenerational bonds. While these programs can capitalize on common interests to promote learning, initial apprehensions from older adults, especially regarding technology use, often impede early engagement. Additionally, ongoing technical support is required, yet frequently underfunded, making sustainability an issue. Family intergenerational activities, such as Digital Buddies and VRCHIVE, show potential for bridging digital and generational divides by leveraging familial connections. However, they may inadvertently assume a homogeneity in family structures and dynamics that does not exist universally. Cultural differences and disparities in technological proficiency can further complicate the effectiveness of these programs, underscoring the need for more culturally sensitive approaches [50]. Game play learning introduces a novel way to engage older adults cognitively and socially. Despite the potential for enhanced communication and cognitive engagement, the design and accessibility of games for older adults remain significant obstacles. Many older adults may find games either too simplistic or overly complex, requiring a balance between engagement and ease of use to make this strategy viable across a broad spectrum of participants.

Lastly, storytelling as an intergenerational tool, particularly among older adults with MCI, is promising in fostering social participation. However, privacy concerns related to digital storytelling platforms, especially regarding personal data shared in reminiscence activities, present a critical issue that requires careful consideration. Furthermore, these platforms must be adaptable to various settings, whether in homes, care facilities, or community centers, to ensure broad applicability. While all these strategies showcase innovative ways to foster intergenerational learning and digital literacy, they also bring to light significant challenges. The success of these approaches hinges on addressing user needs through continuous technological support, ensuring inclusivity for isolated individuals, and adapting programs to account for cultural and technological diversity. Without these considerations, the long-term impact and scalability of these intergenerational strategies may remain limited.

5. CONCLUSION

In conclusion, the reviewed intergenerational learning strategies includes reverse mentoring, virtual learning, collaborative learning, family intergenerational activities, game play learning, and storytelling in which each offer valuable methods for bridging generational divides and enhancing digital literacy. Reverse mentoring and virtual learning leverage the expertise of younger generations to aid older adults, improving their technological skills and social engagement. Collaborative learning and family intergenerational Activities emphasize shared experiences and family support, strengthening bonds and enhancing digital competence. Game play learning provides interactive and engaging experiences but needs to address accessibility and design issues. Storytelling interventions offer meaningful social interactions for older adults, particularly those with mild cognitive impairment, though they must navigate privacy concerns and adapt to various user needs. In conclusion, these strategies highlight the potential of intergenerational learning to foster meaningful connections and improve digital literacy across age groups. However, successful implementation requires addressing technical challenges, user needs, and cultural contexts to ensure these approaches are inclusive, effective, and sustainable.

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AUTHOR CONTRIBUTIONS STATEMENT

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Tengku Shahrom Tengku Shahdan	✓					✓						✓		✓
Norziana Yahya	✓	✓				✓				✓				

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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