Learning of Older Adults with Technology: Implications for Future Research

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Abstract: With the rapid development of technologies and continuing aging of the world population, lifelong learning of older adults with technology has attracted more attention in recent years. Using a systematic review approach, we reviewed research addressing the lifelong learning of older adults using technology from 2010 to 2021 to reveal the research characteristics and themes. We determined possible gaps in the existing body of literature and recommend future research developments in lifelong learning of our global aging population with technology. In the study, we found educators, academic researchers, and social work practitioners' increased interest in promoting formal and experiential lifelong learning opportunities and digital inclusion for older adults. With a clear understanding of reviewed research, we provide evidence-based suggestions for future research and the practice of lifelong learning by tapping into the power of technology with more precise and meaningful approaches.

Key Words: Lifelong learning, older adults, technology
The European Union has proposed that social and economic inclusion and quality of life for an aging population can be achieved through innovative solutions incorporating ICT (European Economic and Social Commission, 2010). Similarly, to bridge the digital divide, the Australian government committed to investing $50 million to ensure that older adults would be equipped with the skills and knowledge to participate in the modern digital economy (Commonwealth of Australia, 2015). Also, one of the goals of the United Nations in its 2030 Agenda for Sustainable Development (United Nations, 2021) is to ensure inclusive and equitable quality education and to promote lifelong learning opportunities for all, increasing the proportion of youth and adults with ICT skills.

Lifelong learning, which resides in sociology and gerontology while intersecting with many other disciplines such as education, social work, and health care, aligns well with this U.N. goal. Scholars have conducted theoretical and empirical research on the technology used to promote learning, including studies of technology used to combat social isolation (Baker et al., 2018); technology acceptance in general by seniors (Peek et al., 2014); and reviews on the use of assistive technology for seniors within healthcare settings (Ramprasad et al., 2019; Yusif et al., 2016). Despite researchers' enthusiasm, there are few or no current systematic literature reviews of research on the intersection of lifelong learning of older adults and technology.

To fill the research gap, we conducted a systematic literature review of original, peer-reviewed research studies on the learning of older adults or seniors with technology that used quantitative, qualitative, and mixed-methods approaches. This systematic review aimed to achieve the following objectives: (1) to gain a deeper understanding of characteristics and themes, (2) to identify challenges and gaps, and (3) to seek the future direction of research on the intersection of learning of older adults and technology. The review results will inform educators, social workers, and policymakers about the current state of learning of older adults with technology and possible future research and social services for improved aging and independent and active living.

**Review Methodology**

Guided by systematic literature reviews (Moher et al., 2009), we searched for articles published in English between 2010 and July 2021 from the following databases: EbscoHost, Web of Science, IEEE Explore, ACM Library, and ProQuest Central. We used different combinations of terms which generated eight search strings. Further snowball searching generated more records for a total of 866. All search results were logged into the reference-management software Zotero, and after duplicates were removed, we had 614 records to screen. We performed two levels of screening and identified 66 studies by researchers in 28 countries/regions with sample populations of adult learners aged 50 years and older (Figure 1).
Research Questions

Three research questions guided this review to provide a comprehensive picture of the targeted research (2010-2021) on the learning of older adults with technology. Older Adults are defined by the United Nations (2017) as those individuals aged 60 years or over. In this review, however, some samples of older adults in the articles reviewed were 50 years and older.

1. What are the characteristics and themes of research on the learning of older adults with technology as reflected through peer-reviewed publications (2010-2021)?
2. What are the challenges and gaps in research on the learning of older adults with technology as reflected through peer-reviewed publications (2010-2021)?
3. What implications can be drawn from the review results for future research and practice?

Some sub-questions were also generated to guide and facilitate this systematic review:

- (RQ1) What journals publish research on the learning of older adults with technology?
- (RQ2) What are the countries/regions of authors researching the learning of older adults with technology?
- (RQ3) What are the most frequently published research topics on older adults learning with technology?
- (RQ4) In what ways have the topic trends of this research changed over time, as revealed by the keywords?
- (RQ5) What research methodologies are used in the research on the learning of older adults with technology?
• (RQ6) What types of technology are used in research on the learning of older adults with technology?
• (RQ7) What is the demographic information of participants in research on the learning of older adults with technology?
• (RQ8) What are the common limitations, challenges, and gaps in research on the learning of older adults with technology?

Data Extraction and Analysis

A template in Excel was used to guide the extraction process to retrieve the relevant data from each article matching the inclusion criteria. The template covered different aspects of the studies, including keywords, research questions or purpose of study, the sample (e.g., sample size, age range), methodology and design, data analysis, theoretical framework, key findings, recommendations for practice, future research, limitations, and suggestions for future research. The two researchers coded a few articles independently and then compared their results to ensure the instrument's reliability and validity. In the case of qualitative studies and data from mixed methods studies, themes were also coded; for quantitative data, we coded the variables into numbers for descriptive analysis. Thematic analysis was used to review each article's results and discussion sections to synthesize common ideas to identify gaps and potential areas for further research.

Results

We synthesized and summarized key findings from the selected articles, which presented results to answer research questions and the thematic analysis results from the selected research.

Characteristics and Themes of the Selected Research

(RQ1) What journals publish research on the learning of older adults with technology? Our systematic review included studies published in 66 journals. Table 2 shows the journals that were included more than once, the number of articles, the impact factor, the publisher, and the country of publication. Almost one-quarter of the articles (14 out of 66 or 21.2%) were published in Educational Gerontology, followed by Computers in Human Behavior in the United Kingdom. Out of 66 journal articles, 30 (45.45%) were published by the seven journals dispin Table 1.

(RQ2) What are the countries/regions of authors researching the learning of older adults with technology? Among the selected articles, most of the authors were from the United States (26), followed by Spain (6), Taiwan, China (5), and the United Kingdom (4), which reflects the authors’ locations and very likely, the locations where these studies were conducted. Four articles (Anikeeva et al., 2019; Blažun et al., 2012; Tsai et al., 2015; Tsai et al., 2019) were written by authors in two different countries.

(RQ3) What are the most frequently published research topics on older adults learning with technology? We analyzed the 474 keywords from 52 of our 66 articles to determine the most frequently published topics. It must also be mentioned that ICT, the acronym for “information communication technology,” is commonly used to describe various digital technologies to access information, such as the Internet, wireless networks, mobile devices, and other modes of communication. Table 2 lists the top ten keywords according to their frequency.
in the selected articles. The high frequency of these keywords reflects researchers' degree of interest in these topics.

**Table 1. Journals Included More than One Time in the Review and Their Information**

<table>
<thead>
<tr>
<th>Journals in Review</th>
<th>Number of Articles</th>
<th>Impact Factor</th>
<th>Publisher</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Gerontology</td>
<td>14</td>
<td>0.490</td>
<td>Routledge</td>
<td>UK</td>
</tr>
<tr>
<td>Computers in Human Behavior</td>
<td>4</td>
<td>6.829</td>
<td>Elsevier</td>
<td>U.K.</td>
</tr>
<tr>
<td>Gerontology &amp; Geriatrics Education</td>
<td>3</td>
<td>1.170</td>
<td>Routledge</td>
<td>US</td>
</tr>
<tr>
<td>International Journal of Lifelong Education</td>
<td>3</td>
<td>0.620</td>
<td>Routledge</td>
<td>UK</td>
</tr>
<tr>
<td>Computers &amp; Education</td>
<td>2</td>
<td>8.538</td>
<td>Elsevier</td>
<td>U.K.</td>
</tr>
<tr>
<td>Journal of Extension</td>
<td>2</td>
<td>0.240</td>
<td>Extension Journal, Inc.</td>
<td>U.S.</td>
</tr>
<tr>
<td>New Media &amp; Society</td>
<td>2</td>
<td>8.061</td>
<td>Sage</td>
<td>UK</td>
</tr>
</tbody>
</table>

**Table 2. Frequency of Key Words from the Reviewed Studies**

<table>
<thead>
<tr>
<th>Key Word</th>
<th>Frequency</th>
</tr>
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<tbody>
<tr>
<td>older adults</td>
<td>18</td>
</tr>
<tr>
<td>technology</td>
<td>15</td>
</tr>
<tr>
<td>learning</td>
<td>15</td>
</tr>
<tr>
<td>digital</td>
<td>12</td>
</tr>
<tr>
<td>social</td>
<td>12</td>
</tr>
<tr>
<td>internet</td>
<td>7</td>
</tr>
<tr>
<td>ICT</td>
<td>5</td>
</tr>
<tr>
<td>lifelong</td>
<td>5</td>
</tr>
<tr>
<td>computer</td>
<td>4</td>
</tr>
<tr>
<td>divide</td>
<td>4</td>
</tr>
</tbody>
</table>

(RQ4) In what ways have the topic trends of this research changed over time, as revealed by the keywords? VOSviewer (Van Eck & Waltman, 2010), a software package for visualizing the connection between terms and creating and exploring maps based on network data, was used for analysis. We input the title and abstract data from all 66 articles and opted for the co-occurrence of keywords, resulting in 114 items grouped into 6 clusters, with 1430 links between them. Links indicate the number of publications in which two terms occur together. The network visualization (Figure 2) shows terms with a greater weight with more prominent labels and circles, such as "older adults," "lifelong learning," and "computer attitudes." The color coding indicates publication dates, and it is apparent that in more recent years, there has been an emphasis on topics such as digital inclusion, loneliness, and social participation.
Figure 2. Network Visualization of Keyword Co-occurrence

Figure 3 reveals the top ten most persistent research topics over time, including "ICT," "lifelong learning," "digital," "inclusion/divide," "training/education," and "community." The increasing interest in “distance learning” (2021) in publications reflects a global learner transition to remote and distance learning during the COVID-19 pandemic.

Figure 3. Topic Trends by Year (2010 -2021)

(RQ5) What research methodologies are used in the research on the learning of older adults with technology? According to the authors, this systematic review includes 28 quantitative research studies, 21 qualitative studies, and 17 mixed-methods studies. A total of 17 research studies (25.8%) did not specify their research design. The most frequently employed designs were quantitative with descriptive statistical analysis (9 studies, or 14% of total) and
experimental ones (7 studies, or 11% of total) with both descriptive and inferential statistical data analysis methods.

(RQ6) What types of technology are used in research on the learning of older adults with technology? In many studies, older adults were enrolled in technology learning courses and were surveyed and observed as they learned new applications. Those applications, when specified, most frequently addressed the use of the Internet and navigation of various websites (10 of 66 studies, or 15.2%). Other researchers studied older adults' use of computer software such as word processing or spreadsheets, followed by tablets, e-learning, and assistive technology. In many cases, the term "ICT" was used broadly without reference to the exact applications with which the participants were engaged. Findings from these studies focused on methods to engage older learners, types of training materials they prefer, and how ICT can impact their well-being.

(RQ7) What is the demographic information of participants in research on the learning of older adults with technology? Many studies (54 out of 66, or 82%) reported the age group of their study participants. It is generally accepted that "older adults" in the selected studies refer to individuals aged 55 or older. There are gaps in research for the upper age range participants, such as 65 and older. Additionally, there were more female participants than male ones. Participants were most frequently recruited from ICT courses in senior centers, lifelong learning centers, universities of the third age, public libraries, and assisted living facilities.

(RQ8) What are the common limitations in research on the learning of older adults with technology? Frequently cited limitations in the selected studies (25 of 66, or 37.8%) were related to homogeneous participants with similar characteristics such as age group or ethnicity, an imbalanced gender ratio, use of one or limited locations, and the self-identified nature of technology users to the exclusion of non-users. In 15 of 66 studies (22.7%), researchers cited a small sample size and the use of convenience sampling as limitations. Other limitations (6 of 66, or 9%) included a study time that was too short; the translated text may not have conveyed the intended meaning of the original questionnaires; or incomplete data sets. We found it unusual that 20 of 66 studies (30.3%) did not include a limitations section or report any possible limitations in their studies. The common limitations reflect the challenges of researching older adults' learning with technology.

Thematic Analysis Results

Promoting Digital Inclusion of Older Adults. The selected publications also reveal the passion certain researchers had to promote the digital inclusion of older adults as they engaged in their studies. For example, Pinzon-Pulido et al. (2019) studied how the “En buena edad” (e.g., at a good age) web platform in Spain focuses on the World Health Organization’s four pillars on active and healthy aging. They incorporated feedback from multiple stakeholders to improve the functionality of their platform and noted in their findings that older people are essential advocates of their health interests and concerns; they need to be recognized with respect and given a voice when developing policies and plans (Pinzon-Pulido et al., 2019). Another example was Reneland-Forsman (2018), who discussed digital exclusion as an obstacle to seniors in Sweden as they struggled to interact independently in social, cultural, political, and commercial contexts using digital interfaces. Reneland-Forsman (2018) equated their lack of digital use to a loss of independence and civic participation, and Munoz et al. (2020) suggested a sustainable adult education program for effective digital inclusion. These studies advocate for and promote the digital inclusion of older adults in their social contexts.
Formal and Informal Learning. The review revealed that most of the selected studies were implemented in formal learning situations, which are very different from those of informal learning occurring at home or even during travel. Organizations that cater specifically to lifelong learning, such as the Road Scholar Lifelong Learning Institute Network and the UNESCO Institute for Lifelong Learning (UIL), take a holistic and integrated approach to lifelong learning as the guiding paradigm for 21st-century education. They support lifelong learning and educational equity, focusing on literacy and non-formal basic education. Nygren et al. (2019) found that non-formal learning skills were positively associated with problem-solving skills in technology-rich environments, indicating that adults' learning ecologies combine formal, non-formal, and informal learning. Walcutt and Malone (2019) contend that while we have primarily documented and valued only formal learning experiences, "informal and experiential learning can have as much, or even more, impact on individuals' abilities to acquire, assimilate, and apply knowledge" (p. 77).

Barriers to ICT Usage Among Older Adults and Recommendations. Our review has identified several critical barriers to older adults' ICT usage and recommendations from selected studies. For instance, due to age-related functional and cognitive declines, many older adults expressed fear, anxiety, discomfort, lack of confidence, or lack of general interest in learning, especially when ICT education programs or the use of new devices required a large amount of memorization and complicated steps (Heaggans, 2012; Hill et al., 2015; Morin et al., 2021). Perhaps more importantly, the causes of older adults' digital divide stem from contextual factors, particularly the lack of appropriate educational resources, information, and opportunities to develop and practice ICT skills (Anikeeva et al., 2019). These contextual constraints further decrease older adults' confidence in and motivation to learn with technologies.

In response to the COVID-19 pandemic, many researchers have made practical recommendations for effective learning for older adults, including considering seniors' characteristics, needs, and constraints. Researchers have suggested prolonged learning periods, sufficient practice time, scaffolded tasks, attention to ergonomic issues, and clearly written printed training materials and visual aids when assisting older adults in learning with technology (Calvo et al., 2017; Huber et al., 2014; Wood et al., 2010; Zheng et al., 2016). Many have also advocated for more learner-centered approaches and increased time to collaborate with peers (Lin et al., 2012; Prodromou et al., 2019; Sayago et al., 2013). In addition, peer mentoring with an intergenerational approach was recommended (Sanders et al., 2013; Stanley et al., 2019).

Discussion

In the review, we found that a limited variety of technologies were studied. Only two studies (Hermann et al., 2012; Parker et al., 2011) addressed the use of assistive technology to empower older adults, in both cases to independently grocery shop and prepare food. We believe the learning needs of older adults are diverse, and research to help them with their learning needs should include the functionality of more technologies such as wearable technology, learning with home robots, and other assistive technology tools. As Pihlainen et al. (2021) pointed out, digital literacy is a relatively narrow definition that covers a range of technology skills; however, socio-emotional aspects of technology use are even more critical for older adults. The technical, socio-emotional, and cognitive aspects of older adults learning with technology should be considered if active aging is the ultimate driving force behind these learning efforts.
Most selected studies were conducted in formal learning environments with established learning objectives and outcomes. In reality, learning of older adults with technology occurs in formal and informal situations. LIFE Center (2005) indicated that more than 80% of learning during our life span occurs in informal learning environments. Our review indicates a clear need for more research to explore the informal learning of older adults with technology. We hope to see more research investigations in this area in the future.

With the rapid development of smartphones, learning how to use them best should not be limited to communication and social connectivity. As more services in society transition to a digital format, older adults must be digitally included. Research is very much needed to explore practical ways to assist older adults in using smartphones for daily activities and routine services, such as managing social benefits, e-health platforms, food-ordering services, and transportation. More research on the learning of older adults with smartphones and other digital devices is needed to align research with current social efforts to promote active aging through lifelong and life-wide learning (LIFE Center, 2005). We also want to draw readers' attention to the demographic information of study participants, which is quite skewed in terms of gender and age representation among the selected studies. There were 703 million persons aged 65 years or over in the world in 2019, projected to double to 1.5 billion in 2050 (United Nations, 2019). As such, more research is needed on participants in this upper age group with a balance in genders if researchers want to theorize the learning with this particular group of people and provide evidence-informed guidance to improve active aging through lifelong and life-wide learning.

Our review paints a picture of the research on the learning of older adults with technology for future research and practice. Accordingly, we offer the following suggestions:

• Agreeing with numerous researchers (Demirbilek, 2010; Ihm & Hsieh, 2015; Kuo et al., 2013; Munoz-Rodriguez et al., 2020; Seifert et al., 2017; Winstead et al., 2013), we recommend longitudinal studies for future research of active aging through learning to measure changes in confidence, competence, and participation accurately.

• Future research should pay more attention to clarity in methodology to increase the study's validity and assist other researchers in replicating these studies at their own sites. Researchers must address the imbalanced gender ratio among participants, with significantly fewer male subjects, to fully explore gender as a variable. The same issue with age groups of participants should also be addressed.

• Future research should expand digital access with devices that individuals already own and could use for greater functionality, such as smartphones or smartwatches, home robots, and other assistive technology. We sincerely hope to see future studies explore the learning of older adults with various technologies in informal situations. The results of such research can help promote lifelong and life-wide learning with evidence-based principles.

• We suggest researchers and practitioners in social service, gerontology, and educational technology engage in more collaborations to conduct field-needed and field-based research. This collaboration can tap into modern technologies that support education about health, independence, safety, and social engagement, which are critical aspects of active aging through learning.

• Educators, who provide learning opportunities for older adults, should consider not only the principles of adult learning but also the unique needs and special characteristics of this age group, being sensitive to ergonomic issues, leveraging the benefits of peer
learning, and drawing on their immense life experience, knowledge, and skills for learning.

Conclusion

After applying our selection criteria discussed in the research methods section above, we significantly narrowed the available studies to capture the research on the learning of older adults with technology. Despite our use of a thorough search strategy, some empirical studies may not have been identified (e.g., gray literature such as unpublished documents and reports) since we only included papers published in peer-reviewed journals. As we coded our articles and charted them based on categories for quality assessment, we realized that the lack of thorough study reporting in many instances and the heterogeneity of technology applications and research questions prevented us from conducting a meta-analysis. Another limitation is that only articles written in English were included in our review. This decision stemmed from the practical inability to survey all studies in all languages; however, we could still incorporate the results of studies from many different national contexts rather than focus solely on studies dealing with English-speaking countries.

The findings presented here provide helpful guidance and direction to other scholars similarly interested in the intersection of learning for older adults and technology. It is our hope and aspiration to promote field-needed and field-based research and, at the same time, research-informed and evidence-based practice when it comes to the learning of older adults with technology. With continual advancements and innovations in technology, much more needs to be done in research and practice to provide older adults with effective lifelong learning opportunities and, thus, enhanced well-being in all aspects of their life.

References


