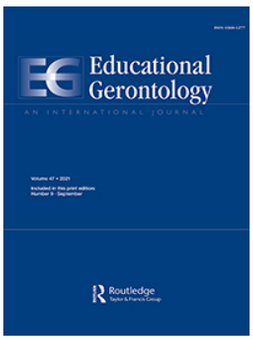

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Barriers and supportive factors for older adults learning about and using information and communication technologies for healthy aging in Costa Rica

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ABSTRACT

This study describes the barriers and supportive factors for learning about and using Information and Communication Technologies (ICT) present during a learning intervention designed to enable older adults to use ICT for fostering healthy aging in terms of promoting functional ability. Forty-one adults, older than 60 years, participated in a blended learning environment to learn how to use ICT for supporting cognitive performance and social interaction. The classrooms sessions were video recorded, and the data were analyzed using an inductive process of content analysis. The main observed barriers for learning about and using ICT were lack of experience with ICT, negative emotions such as fear, and shame related to the learning process and restrictions for individual support. On the other hand, the main supportive factors for ICT learning were a collaborative learning environment, the motivation for becoming efficient and independent ICT users, and using learning strategies focused on supporting cognitive abilities and overcoming lack of experience with ICT. The most observed factors for overcoming the identified barriers included peer support, the motivation for using ICT independently, and the opportunities for practising the learned skills. Based on the results, the paper discusses some opportunities for improving the design and implementation of this type of learning interventions.

What is known about this topic:

- Information and Communication Technologies have the potential to support healthy aging.
- Most older adults do not use digital technologies for everyday life or health-related activities. For example, during 2016, only 45% of people aged 65 to 74 used the internet in the 28 countries of the European Union (European Commission, 2017). In Costa Rica by 2017 only 27.4% of households with only people over 65 had internet access (Programa Institucional Sociedad de la Información y el Conocimiento [PROSIC], 2018).
- Most older adults faced age-related difficulties for learning about and using ICT in everyday life, such as 1) limitations in motor and cognitive functions, 2) resistance to learning about and using ICT, 3) negative stereotypes about older adults and/or ageingand/or ICT (De Palo et al., 2018; Morrison & McCutheon, 2019; Righi et al., 2017; Sayago et al., 2013). Which remarks the need for suitable ICT-learning opportunities aimed at older learners needs and interests.

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What this paper adds to the topic:

- The most important barriers were lack of experience with ICT, negative emotions fear and shame related to the learning process and social support, as relatives are busy or do not have time and/or patience to teach older adults to use ICT. Another barrier was restrictions for individual support.
- Main supportive factors were a collaborative learning environment, the motivation for becoming efficient and independent ICT-users, and learning strategies focused on supporting cognitive abilities and overcoming lack of experience with ICT.
- There is a need to move from learning approaches focused on individual relationships between learner/user – devices to more comprehensive approaches focused on the social ensemble involved in ICT learning and use by older adults.

Introduction

World Health Organization (WHO) defines healthy aging as 'the process of developing and maintaining the functional ability that enables wellbeing in older age' (World Health Organization [WHO], 2015, p. 28). Functional ability comprises *intrinsic capacity* understood as all the physical and mental capacities of an individual and *environment* which refers to all the extrinsic elements that are part of the individual´s context. Environment includes housing, communities and societies, people and their relationships, attitudes and values, health and social policies, support systems and access to services. From this perspective environments can foster healthy aging through building and maintaining intrinsic capacity (reducing risk, encouraging healthy behaviors, removing barriers, providing specific services) and enabling greater functional ability (assistive technologies and devices, accessible public transport, housing modifications, assistance for activity of daily living) (WHO, 2015).

From this view Information and Communication Technologies (ICT) have the potential to support healthy aging by fostering functional ability in terms of building and maintaining capacity and resilience, reverse, stop or slow the loss of capacity and compensate for loss of capacity (WHO, 2015).

Previous research has shown that ICT can support healthy aging through applications that support areas such as *health care* i.e. tracking systems, auto fall alerts, and personal alarms, health related information, and cognitive training (Halmdienst et al., 2019; Morrison & McCutheon, 2019; Ryd et al., 2018; Vroman et al., 2015); *entertainment and communication* (Halmdienst et al., 2019; Vulpe & Crăciun, 2020); *social networks* (Hasan & Linger, 2016; Righi et al., 2017; Vulpe & Crăciun, 2020) which includes intergenerational relationships i.e. in educational/formal, family and community settings (Sánchez Martínez et al., 2015). ICT can also support *overcoming limitations in instrumental activities of daily living* i.e. online shopping and banking (Halmdienst et al., 2019), *facilitating personal development* by mediating learning processes in different topics and civic participation (del Pilar Díaz-López et al., 2016; Mitzner et al., 2019; Morrison & McCutheon, 2019); *facilitated subjective wellbeing* i.e. fostering empowerment, agency, self-efficacy, and satisfaction (del Pilar Díaz-López et al., 2016; Hasan & Linger, 2016; Hur, 2016; Ryd et al., 2018); and *reducing social isolation* (Chen & Schulz, 2016).

Nevertheless, few people older than 65 use ICT (Castro Rojas et al., 2016; European Commission, 2017). Olsson et al. (2019) argue that for Swedes older people greater material resources such as income implies access to a greater number of ICT devices. While discursive skills such as English as a second language and greater social networks have a positive relationship with ICT literacy. Gender had no effect on access to devices but might influence ICT-literacy. Both access and ICT literacy decreased with age. Olsson et al. (2019) argue that because the material, discursive and social resources decrease with age we need to reflect on the abilities older people require to participate in a digitized everyday society. For this study, these required skills are related to appropriate ICT learning opportunities for older people.

In Costa Rica in 2017 just 18.6% of households only with people older than 65 had computers, 27, 4% had Internet access and 70,4% and had a mobile phone. In Costa Rica, the 'digital divide' by age is the bigger and most steady in the period between 2010 and 2017 (PROSIC, 2018). One of the main

reasons is the lack of suitable and enjoyable learning environments that enable older adults to include ICT in their daily lives (Castro Rojas et al., 2016, 2018; Morrison & McCutheon, 2019; De Palo et al., 2018; Righi et al., 2017; Vroman et al., 2015).

Regarding internet access by 2020 in Costa Rica, 82.08% of people aged 60 to 69, 67.96% of people aged 70 to 79 and, 61,64% of people older than 80 had access to the internet at their homes. Access decreases with age, but even so, at least 60% of people over 60 had access to the internet. On the other hand, only 64.4% of people aged 60 to 69, 40,88% of people aged 70 to 79, and 13,94% of those over 80 had used the internet in the last three months (INEC, 2020). Although access is a relevant variable in the use of ICT by older people, the figures show us that other variables need to consider. Previous research points to learning processes and social support to promote the use of ICT in the daily lives of older people.

There is little information about how older adults learn to use ICT, their learning processes, strategies, and motivations (Castro-Rojas, 2018; Chiu, 2019; Morrison & McCutheon, 2019; Vroman et al., 2015). Our knowledge is also limited on what kind of institutional and social support older people need to become an ICT active and independent user (Abad & Agregado, 2016; Schreurs et al., 2017; Shirahada et al., 2019).

To contribute to the creation of suitable ICT-learning interventions for people older than 60 years a Design-Based Research (DBR) approach was implemented for designing a learning intervention aimed at enabling older adults to use ICT for cognitive activity and social interaction – two of the determinant factors of healthy aging (WHO, 2015).

Grounded on inputs from theories on 1) healthy aging proposed by WHO (2015) focusing on determinant factors such as maintaining functional ability, cognitive performance and social interaction and approaches as reserved capacities, learning, exercise, and training to develop adaptive strategies during the old age; and, 2) ICT learning by older adults such as lifelong learning (Commission of the European Communities, 2001), ICT learning model based on the personal, the social and community dimensions and focused on a) learn to know, which includes knowledge about concrete challenges; b) learn to do, referring to learning to perform practical tasks, and c) learning as activity, referring to learning for personal development and fulfillment (Ala-Mutka, 2011; Ala-Mutka et al., 2008) and, Information and Communication Technology Social Networking Motivational Model for older adults which is a 'community-centered socio-ecological model' for ICT adoption that includes three different levels a) ICT for social networking with family and friends; b) ICT for practical tasks and, c) ICT for broader communities (Vroman et al., 2015). Along with inputs from older learners and their teachers, the study derived a set of design principles for guiding the design and implementation of the learning intervention. For detailed information about the design principles, see the work by Author et al. (2018).

Based on the proposed design principles, the study designed and implemented a six-week blended learning intervention focused on facilitating the use of ICT devices and applications in older adults' daily life to stimulate autobiographical memory (ABM), train executive functions (EF), and memory abilities, and enhance social interaction.

This paper presents the barriers and supportive factors that emerged during the implementation in practice of the designed learning intervention. Furthermore, it proposes some strategies to improve the design of ICT learning interventions aimed at older adults focused on aspects such as user-independence, collaborative learning, opportunities to enjoy the learning process; and discusses some challenges and suggestions to refine the design of this type of intervention in future efforts.

Materials and methods

Design Based Research (DBR)

DBR is a flexible methodology aimed at improving educational practices through the analysis, design, development, and implementation of learning interventions based on collaboration among researchers, practitioners, and participants.

DBR is implemented in real educational settings and, consequently, leads to contextually-sensitive design principles and theories (Wang & Hannafin, 2005). These design principles have a theoretical base, are context-specific and context-dependent; but they also have the potential of being generalizable to interventions in different contexts (McKenney & Reeves, 2012; Oh & Reeves, 2010).

Based on a set of principles proposed by Author et al. (2018) a six-week blended learning intervention was designed and implemented. The DBR approach allowed the inclusion of older adults and their educators in the design process. Through the process of evaluation and refinement, DBR facilitated the understanding of how older people can include ICT in their daily life environments for having cognitive activity and social interaction. Evaluation and refinement of the designed learning intervention allowed exploring how the design fit the characteristics, needs, and interests of older adults, and identifying possible improvements to make the intervention more efficient.

In designing and refining the learning intervention the pragmatic approach of DBR allowed to combine theory and interests, experiences, and expectations of older adults and adult educators in defining contents, activities, resources and learning strategies. The inclusion of older adults in the design process allowed identifying their preferences for cognitive activity and social interaction mediated by ICT. The inclusion of daily life settings allowed participants to include ICT in everyday life environments. Finally, the context-sensitive local theory based on older people and adult educators' practices in Costa Rica has the potential to be applied in similar contexts.

General description of the learning intervention

The six-week learning intervention implemented some activities of a reminiscence protocol for creating empathy among the participants and stimulating Autobiographical Memory (ABM), which is associated with improvements in several cognitive abilities and general well-being (Salazar-Villanea, 2012; Westerhof et al., 2010). Participants created personal memories and shared them through Facebook® or Blogger® while reading and commenting on other participants' memories. Since cognitive games can improve the trained cognitive abilities (Anguera et al., 2013; Ballesteros et al., 2015, 2014; Nouch et al., 2016; Nouchi et al., 2012; Rebok et al., 2014); participants had access to Lumosity®, an online game platform for stimulating attention, flexibility, problem-solving, memory, and processing speed. The results of these activities on cognitive performance are reported in Author (2018). For social interaction and share about the learning process, participants used Skype®. Finally, there was an online classroom implemented by Moodle® that served as a repository of learning materials.

The activities were developed in three classroom weeks (face-to-face) and three online weeks; each classroom week was followed by an online week. During a classroom week, four groups of approx. 10 participants attended three 2.5-hour sessions. Classroom activities included: 1) step-by-step instruction of routinely procedures and cognitive procedures for solving problems; 2) repetitive practice of procedures and routines (McKenney & Reeves, 2012); 3) opportunities for collaboration, individual support, and creation of personal learning artifacts and, 4) contents related to cognitive age-related changes. During an online week, participants completed at least two assignments at their convenience and published their results in online platforms.

The intervention was implemented in the computer labs of the Omar Dengo Foundation, an education Non-Governmental Organization in Costa Rica.

The Institute of Clinical Research (ICIC) and the Ministry of Health approved the study, and all the participants gave their written consent before the study started.

Participants

The study recruited the participants through a general call in governmental and non-governmental organizations working with older adults. Inclusion criteria were: 1) being older than 60 years; 2) being able to write and read; 3) having little experience using ICT devices and applications; 4) having no

psychiatric, neurological, or neuropsychological disorders diagnoses; and 5) having a score of 25 points or above on the Mini Mental State Examination (MMSE) (for non-literate individuals, a score of 19 points could be accepted).

Participants were 41 adults older than 60 years (33 female) without cognitive impairment as measured by the MMSE M = 28.56, SD = 1.47, and an average age of approximately 67 years (M = 67.15, SD = 5.35. Six of them had completed or had some primary school education; 16 completed or had some high school; and 19 had completed or had some courses toward a university degree. participants were randomly assigned to one of the four learning groups.

Data collection

During the learning intervention, 36 classroom sessions (nine by group) of two and a half hours' length were video recorded for analysis, equaling 90 hours in total.

Data analysis

Following Mayring (2000), common topics were extracted from data, and a set of analytical categories was defined. After 30% of the material was reviewed, the categories were evaluated and some categories were subsumed, and new ones were created, this was done again after 60% of the material was reviewed. Finally, the analytical categories were grouped in two main categories presenting barriers and supportive aspects for older adults learning about and using ICT for cognitive activity and social interaction.

After the category system was created, one video of each session was randomly selected, and each group was observed twice across the process. In total, 22.5 hours of video data were coded and analyzed in depth by using the NVivo 11 software.

Results

Barriers for using ICT for cognitive activity and social interaction

Table 1 presents a summary of the coding process of barriers observed during the classroom sessions.

Lack of experience with ICT

Even though most of the participants reported using ICT devices and applications before the intervention, they presented lower levels of familiarity with ICT than expected. ICT-user participants evidenced *gaps in ICT literacy*, like recognizing basic icons and functions such as the on/off, enter, and help buttons. They also experienced problems with usernames and passwords mainly because they did not know them, did not remember them, and/or they made typing mistakes. *Problems transferring knowledge across devices and platforms* refer to difficulties distinguishing the functions and purposes of

Table 1. Barriers for learning and using ICT for cognitive activity and social interaction.

Categories	Subcategories	References
Lack of experience with ICT	Gaps in ICT literacy	72
	Problems with usernames and passwords	36
	Problems transferring knowledge across devices and platforms	18
	Facing technical problems and requirements	13
	Total	**139**
Negative emotions related to the learning process		**8**
Restrictions for individual support		**3**
	Total	**150**

the different platforms and/or transferring the skills to use them. *Facing technical problems and requirements* denotes difficulties with managing technical hitches such as updating software or cleaning internal storage.

These difficulties showed that most of the participants who identified themselves as ICT-users were non-independent users and that ICT-use had a particular meaning for this group of older adults. Facing these problems, participants experienced stress and negative emotions, and some of them were left behind for a period while solving different issues. The following examples portray participants' experiences during the sessions. First, there is a narrative account of the data and then there are some excerpts from the transcripts and complementary descriptions to illustrate specific aspects.

Example 1 – Lack of experience with ICT. Narrative account (Session 6, Group 2): JM who reported having ICT devices for personal use and previous experience using Facebook (FB) and e-mail, wanted to use his laptop for practising basic functions of FB, but the laptop was updating the operating system. Then, he moved to work with another participant (MHA). As he wanted to work independently, he moved again to work in a lab´s desktop. JM was waiting for his laptop to finish updating all the time. MHA helped JM to start the desktop and she reminded him of the procedure to log in into FB. JM had problems remembering his e-mail username. When he found his username in his notebook, there was a spelling mistake, and he could not log into FB. There was just one facilitator (F) during this process, and she was conducting the group activities. Three times, F went next to JM and helped him, reminded him of his username. Finally, F went to JM, reminded him his username, and pointed out the spelling mistake in his notes. When JM logged in FB, F reinforces JM efforts and achievement. It took 38 minutes for JM to log in into FB.

JM faced technical hitches, problems transferring knowledge from laptop to desktop, and difficulties with his username and password. Waiting for his laptop to start, he referred to the laptop in a derogative way evidencing that he was stressed by the situation.

> "This thing (in a very derogative manner) never finished restarting. It (his laptop) does not want to start" JM, male,65

Despite the difficulties, JM tried to solve the issues and work independently. He received peer support (this will be shown in another analytical category) and continued working.

Difficulties with usernames reflected that knowing this information was not relevant for participants because: 1) their children created their accounts and installed applications and updates, 2) they did not use the applications often; and 3) they used shortcuts to the applications, all of which limits the ownership of their accounts.

Participants who reported using FB, did not use basic features, such as writing comments and/or posting pictures or videos. Others were able to log into and read e-mails but were not able to reply, forward or delete them. Then, although participants were, identified at the first level of ICT adoption according to Vroman et al. (2015), which includes using ICT for social relationships and support systems more efforts must be conducted to identify properly the participants´ 'ICT-user profile' and their learning needs.

Negative emotional status related to the learning process

These emotions related to lack of experience. Making mistakes and failures provoked stress (as in Example 1), negative perceptions about themselves, and fear.

Example 2 (Session 4, Group 3). After solving issues during a practice, F announced a new learning activity. The participants reacted anxiously, and the facilitator pointed this out, allowing them to talk about it, and then attempted to restore a positive environment for learning.

> "Ow! You are going to have nightmares with us! I do not know why, but I am afraid; there is something that I am afraid of; I do not know why! LMV, female, 61.

Participants were afraid and ashamed of making mistakes and being slow learners. Some of them reacted to their mistakes negatively i.e., 'I am stupid,' 'I can do nothing,' or by adopting a dependent behavior i.e. 'I'm going to do nothing until F helps me.' Being learners and having self-perceptions of their limited skills to interact with ICT made some participants feel vulnerable, see (Castro Rojas et al, 2018) for more details about this aspect.

Restrictions for individual support

There were two facilitators, one leading the activities and another one supported individual requirements. Due to multiple demands, sometimes participants had to wait for individual help. Example 1 illustrated this: Only in the fourth attempt and after 38 minutes F had time to help JM. This reinforces the need for accurate ICT-user profiles so facilitators can anticipate adequate support resources. Even though these situations were not common during the intervention, they must be avoided as they might influence participants´ mood and motivation to learn. Peer support was a positive alternative for this limitation (this will be discussed later).

Summarizing, the main challenge for the learning intervention was lack of experience with ICT which demanded the adjustment of designed activities, the inclusion of unplanned contents and activities; and investing more time and support resources than anticipated. In addition, the lack of experience with ICT related to participants' negative emotions which also presented a challenge to keep them calm and motivated.

Supportive factors for using ICT for cognitive activity and social interaction

Despite the difficulties, the participants encountered supportive factors to learn about and using ICT. Table 2 presents a summary of the coding process for supporting factors observed during the classroom activities.

Collaborative learning environment

Peer support was the most evident supporting factor for learning, and it refers to the willingness to help each other spontaneously when facing difficulties. In Example 1, MHA tried to help JM by asking him how it was going, suggesting solutions, and helping JM to perform some actions.

In total, MHA made 11 attempts to help JM. Support behavior reflected an active interest in helping the other one to cope with the difficulties and was common among participants independently of their ICT-knowledge and effectivity for solving the problems which means that beginners helped more experienced users and vice-versa, according to the circumstances.

Table 2. Supportive factors for learning about and using ICT for cognitive activity and social interaction.

Categories	Subcategories	References
Collaborative learning environment	Peer support	48
	Opportunities for individual support	32
	Social interaction based on learning tasks	5
Total		**85**
Motivation for becoming efficient and independent ICT-users	Using ICT independently in daily life	42
	Satisfaction and achievement	25
	Ownership	15
Total		**82**
Learning strategies focused on supporting cognitive abilities and overcoming lack of experience with ICT	Repetition and practice	41
	Contents focused on age-related changes	24
	Memory aids (notebook notes)	11
Total		**76**

Opportunities for individual support also helped participants to accomplish the learning activities. Providing support facilitators focused on reinforced personal achievements, regardless of the fulfillment of learning activities. Participants found this reinforcement as a motivation for continuing learning.

Other factor that made participants feel comfortable asking for help was that the facilitators were not experts on ICT and sometimes they asked help from more experienced colleagues.

Example 3 (Session 4, Group 3) JZC said he could not record videos with his phone since the phone ´s memory was full. F was not able to find the memory card and asked help. Then, LMV exclaimed 'Wow! Imagine that!,' Here, LMV implies that even F cannot solve some issues with ICT, so it is fine not to know how to solve all the issues. This challenged the belief that to use ICT you must be an expert.

Finally, *social interaction based on learning tasks* refers to sharing opinions of the learning intervention, difficulties using ICT, and strategies to overcome them. Participants celebrated together new learnings and achievements and shared emotions related to the learning process.

Motivation for becoming efficient and independent ICT-users

This aspect is related to the participants´ perception that the support from their family and friends was not adequate for learning about and use ICT. They reported that their children pushed them for learning fast and did not have patience or time to teach them. Participants were embarrassed to ask the same questions many times, making the same mistakes several times, and/or being perceived as slow or stupid learners by their children or relatives. This is also reported in (Castro Rojas et al., 2018).

Most of the time, children help older people to solve issues with ICT, but they do it very quickly or sometimes they solve the issues for them without giving older adults the opportunity to learn. Sometimes children and relatives are not available to support older adults to solve issues with ICT:
Example 4 (Session 1, Group 1)

> I use ICT, but there are some things that I do not know. When I have a problem, I call my children; but they do solve it for me! They do not explain to me how to do it. Then I ask them, 'How did you do it?' You are left without knowing how to solve the problem. They just solve it to stop you from bothering them. GLC, female, 65.

Therefore, they wanted to learn to *use their devices independently*. To achieve this goal, participants were using their own devices during the classroom activities to facilitate the transition to their daily environments. Previous work has identified social support as a key factor in older adults learning about and using ICT (Sayago et al., 2013; Vroman et al., 2015). However, this aspect has not been described in depth and research on how societies, communities and families can support such learning is needed.This is a challenge that must be addressed considering the key role of societies in supporting adaptation during the ageingprocess (WHO, 2015)

In this study the desire to learn how to use their own devices, solve problems, and to not depend on their children motivated participants to keep learning despite the difficulties. Exploring new content, developing new skills, and the realization of personal progress gave the participants *satisfaction and a sense of achievement* that helped them to perceive themselves as able to learn; this balanced the negative emotional status mentioned in the barriers section.

Participants also displayed a desire for *appropriation* of their ICT devices and applications. MHA, female, 67 expressed during Session 6: 'I also installed Skype in my mobile phone in case the day we have the meeting, we are not at home.' She wanted to use the application at any time and place. At the beginning of the intervention, they wanted to stay at home for the Skype meetings to have some support and being in controlled conditions; but, in later sessions, they wanted to include ICT in their daily activities and trusted their abilities to manage issues in different environments.

Learning strategies focused on support cognitive abilities and overcoming lack of experience with ICT

Learning by doing, *repetition and practice* allowed participants to learn at their own pace and gradually improve their performance.

Example 5 (Session 6, Group 2) In Session 4, LCR, Female 68, could not include pictures in her FB post, so she was happy practicing it again. In Session 5, she could not include pictures in the post, but she could include them as comments. Finally, in Session 6: she exclaimed I did it! I did it myself! Practicing and practicing, finally, I could do it!

Participants welcomed repetition and practice during the classroom sessions, so they felt more confident during the online sessions.

Contents focused on aging and age-related changes in cognition engaged participants by making questions about their own aging process and linking the learning activities to changes in cognition and strategies to cope with them.

Example 6 (Session 6, Group 2) *M*emory practices were incorporated into the ICT learning:

> ‘I want to practice on the laptop, because I am forced to remember the username and password, whereas in the mobile phone I log in directly. By remembering my username and password I am exercising my memory.’ MHA, Female, 71.

The course did not provide specific memory aids but invited the participants to create their own artifacts for learning. Participants wrote down notes to remember contents and preferred to use their notebooks instead of the manuals and tutorials available in the online classroom. However, sometimes their notes were disorganized; they could not find the needed information, or there were mistakes in their notes. Thus, it might be useful to provide some structure for creating customized learning resources and memory aids.

Summarizing, collaborative learning environment was a key factor for learning, and peer support contributed to overcoming lack of experience with ICT, negative emotions, and restrictions for individual support. Motivation to become independent ICT-users interest in preventing cognitive decline supported participants´ disposition to overcome barriers for learning.

Relationships between barriers and supportive factors for learning and using ICT

Of the 393 coded references, supportive factors subsumed the 62% of coverage, and barriers 38%. Figure 1 shows a coding map of the project.

The most coded subcategory was lack of experience with ICT – corresponding to the 35% of all the coded material and the 92% of data coded as barriers. Each supportive factor subsumed similar coverage of all the coded data: collaborative environment, 22%; motivation for becoming independent ICT users, 21%; and learning strategies focused on supporting cognitive abilities and overcoming lack of experience with ICT 19%. The three most coded subcategories of supportive factors were: peer support 12.2%, using ICT independently in daily life 10.7%, and repetition and practice 10.4% and the most coded barriers were gaps in ICT literacy 8.3% percent, and problems with usernames and passwords 9.16%.

The balanced distribution might reflect that the main three supportive factors contributed to face the most important barriers. Motivation for using ICT independently in daily life was the only supportive factor present during all the observed sessions in which gaps in ICT literacy were present. Thus, it is key to consider this motivation in designing this kind of learning interventions.

Discussion

The study has shown that a supportive, non-threatening environment is a key factor in learning interventions mediated by ICT aimed at to promote healthy aging. Participants were willing and able to engage in using ICT for cognitive activity, social interaction, and personal development key factors of healthy aging (Castro-Rojas, 2018; WHO, 2015). The results of the learning intervention on

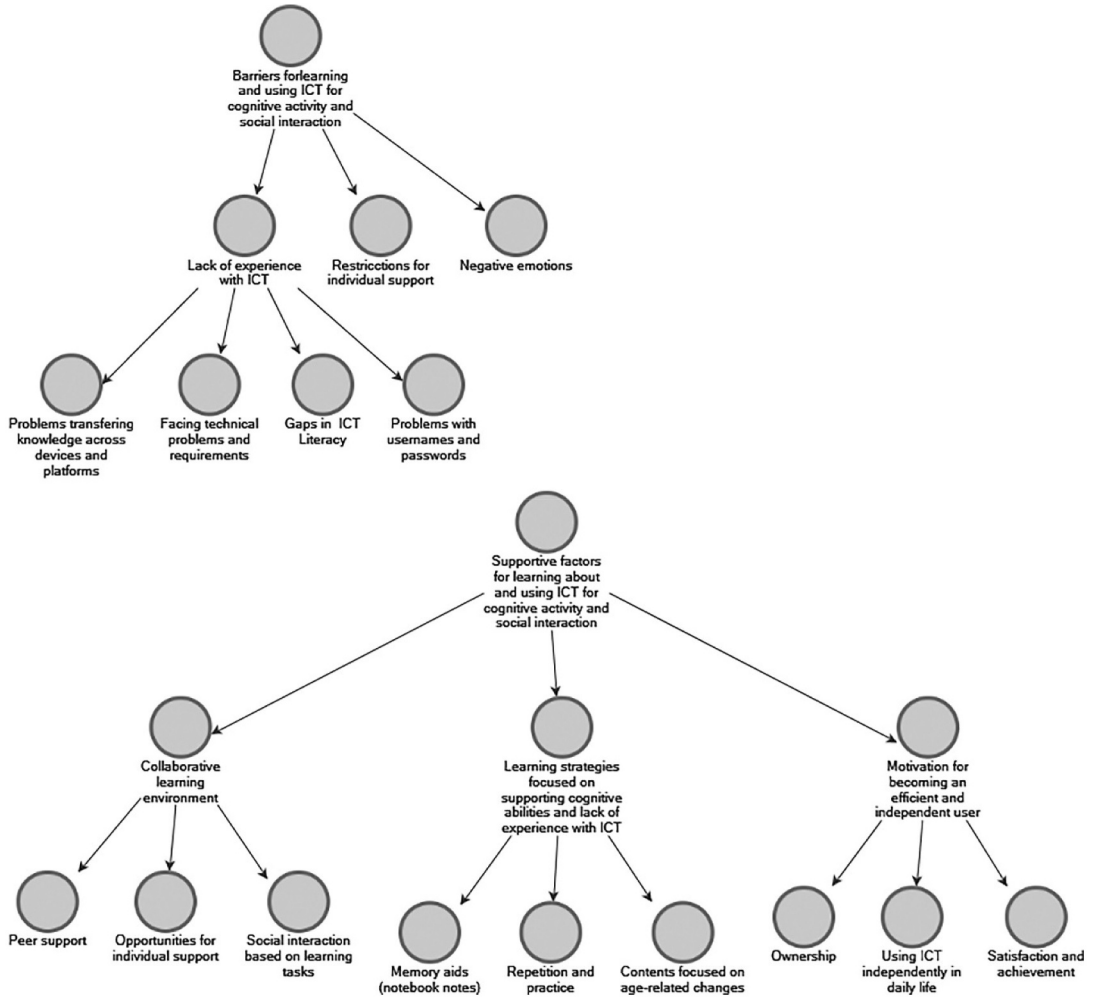

Figure 1. Map of analytical categories and subcategories.

cognitive performance are reported in Castro-Rojas (2018). Even though ICT use seems to decrease with age, the use of ICT for supporting health does not decrease (Halmdienst et al., 2019) in fact promoting healthy aging by strategies mediated with ICT can be a way to benefit more older adults, reduce the risk of health issues i.e., cognitive impairment and depression, support the digital inclusion of older adults, and promote which WHO (2015) call age-friendly environments.

The findings contribute to overcome the research gap on how older adults learn about and use ICT (Chiu, 2019; Morrison & McCutheon, 2019; Vroman et al., 2015) by bringing concrete examples of barriers and supporting factors for learning and pointing out aspects that might be included in the design of ICT-learning interventions for older adults in any context.

The lack of experience with ICT of those participants initially categorized as ICT-users pointed out the need for methods, beyond self-reporting, for creating accurate ICT-user profile of older adults. This profile must include information on at least: 1) the level of ICT literacy; 2) purposes for using CT; 3) specific applications and devices´ features they can manage independently, and their level of mastery on them, 4) required support for learning. This will allow planning learning activities and support resources adequate for each profile.

Participants present basic uses of ICT, were not independent users and seemed to be dissatisfied with their ICT-user level, as they wanted participating in online learning or interacting with broader social networks. Future research is needed to identify possible satisfactory ICT-user profiles for older adults, which meet their characteristics and interests.

Another suggestion for overcoming lack of experience with ICT could be including pre-intervention sessions to set up all the information and requirements (usernames, passwords, and personal devices configuration) needed for accomplishing the learning process, help older adults to get ready, and reach similar level of ICT-use before the actual intervention.

It must be noticed that, in the case of ICT-learning, the associations, age- knowledge/wisdom and age-experience (Reker et al., 2012; Tornstam, 2005; Westerhof et al., 2010) are reversed. This role change, previous negative learning experiences, and inadequate support from family and friends contribute to negative emotional statements that must be addressed. Furthermore, learning interventions aimed at facilitating older adults using ICT should be designed to satisfied needs and interests of the communities to which they belong to (Righi et al., 2017) and include caregivers, teachers, communities, and societies in the creation of opportunities to ensure that the benefits of technology can be realized by older adults (Righi et al., 2017; Schreurs et al., 2017).

Including other social groups in researching older people and ICT could expand the scope and contribute to the advance in the scientific knowledge to create societal conditions for supporting healthy aging and independent living which means to move from learning approaches focused on individual relationships between user – devices to more comprehensive approaches focused on the social ensemble involved in ICT use by older adults (Beimborn et al., 2016).

The implemented DBR strategy seems appropriate for including different groups and perspectives in creating suitable learning interventions to enable older people to use ICT for healthy aging. The proposed design principles (Castro Rojas et al., 2018) guided design propositions, learning contents, learning tasks, and resources that fitted older adults´ needs and interests. DBR approach also allowed the learning intervention to be responsive and be adjusted daily (Sandoval, 2004) according to participants´ performance and emotional status.

It was not possible to distinguish issues related to lack of experience with ICT from memory problems as both can be confused (Sayago et al., 2013). Nevertheless, in contrast with previous research (Mitzner et al., 2019; Sayago et al., 2013), the participants did not perceived memory problems or cognitive decline as main barriers for learning. Further research is relevant to find methods that allow to differentiate both factors properly, and to identify adequate strategies to support each aspect. Opportunities to enhance efficacy and positive experiences with ICT may also play a critical role in ICT adoption by older adults (Mitzner et al., 2019).

Peer support was frequent among participants, regardless of their level of familiarity with ICT and it became an important motivation for learning. Designing strategies to properly address peer support is needed to maximize its potential in supporting learning. Those strategies require knowing participants´ capabilities in supporting others and designing activities and learners' roles accordingly. However, there must also be room for flexible and spontaneous peer support.

Motivation for becoming efficient and independent ICT-users was always present when barriers related to lack of experience were present. This motivation includes adapting ICT to daily life needs, being capable of operating ICT and solving problems without external support. Understanding this motivation and its role in the learning process might require scholars to analyze its relationship with self-efficacy beliefs (Bandura & Adams, 1977; Hur, 2016; Wong et al., 2014) and identity formation during old age, as it seems that ICT-learning was not only driven by instrumental but also by self realization goals.

Repetition and practice allowed participants to get familiar with ICT devices and applications and become more efficient using ICT showing that this type of intervention must provide plenty of time and opportunities for practicing the learned skills. Including learning strategies and resources addressed to different stages of memory – sensory memory, working memory and long-term memory – (McKenney & Reeves, 2012; Mitzner et al., 2019) helped participants to find their personal way of remembering procedures and information. However, leaving to the participants the responsibility for creating their

learning artifacts was not a successful strategy. It might be useful to provide older learners with some scaffolding to guide the process of creation while still offering space and strategies to customize the learning resources according to individual needs. Further research is needed to identify ways to support older learners in the creation, co-creation and sharing of effective learning artifacts.

Finally, discussing about age-related changes, and ways to compensate them helped the learners to understand their own processes. Learning interventions must offer resources to empower older adults to recognize their potential for learning, to overcome difficulties and to dismantle stereotypes on older adults and ICT-learning.

Limitations of the study are that it only included older adults who were interested in learning and using ICT which limits the generalization of the research findings to similar learners. In addition, due to limited resources, the study did not include an inter-rater reliability measure for the coding process.

Conclusions

By bringing concrete examples, the study contributes to pointing out aspects that might be included in the design of ICT-learning interventions for older adults.

Thus, the most important barrier was lack of experience with ICT and some concrete issues of it were gaps in ICT literacy, problems with usernames and passwords, problems transferring knowledge across devices and platforms, and facing technical problems and requirements. Other barriers were negative emotions related to the learning process and restrictions for individual support during the classroom sessions.

Main supportive factors were a collaborative learning environment, the motivation for becoming efficient and independent ICT-users, and the implementation of learning strategies focused on supporting cognitive abilities and overcoming lack of experience with ICT. Specific supportive factors that helped participants to overcome difficulties were motivation for becoming effective and independent ICT-users, peer support, and repetition and practice.

Participants perceived that the social support from their families for learning about and using ICT was inappropriate, and this was related to negative emotions during the learning process; but at the same time, it motivated them to become efficient and independent ICT-users. This highlights the necessity for expanding the research about ICT-learning by older adults, to include social networks and social environments for older adults learning about and using ICT. Including these aspects will contribute to enhance the role of societies for enabling older adults to realize the benefits of ICT in their daily lives and to create age friendly environments (WHO, 2015).

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