Strategies to Enhance Technology-Based Learning Experiences in Older Adults: A Field Study

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Abstract. The aim of this study is to explore the main aspects that affect pre/during and post-learning experiences in later age. Specifically, the study examined the problems adult learners encountered in learning how to use digital technologies, accessibility in learning and strategies to enhance technology-based learning experiences that take into account the ageing process. Eighty-one learners from learning organizations in the North of Portugal (Community-dwelling older adults, Short-time Courses and Universities of Third Age) participated in this study. The participants attended a set of learning sessions related with the use of digital devices and data were collected from observation notes and group interviewing. Results suggest that there is a variety of prominent aspects that can affect pre-/during and post-learning experiences in later age that include the access to technology, time availability for learning and lack of on-demand learning instructions. A set of recommendations to design technology-based learning experience that takes the ageing process into account is proposed and lessons from the study are discussed.

Keywords: Technology-based learning · Learning experiences · Strategies · Older adults · Field study

1 Introduction

Over the past decade, much more information [1, 2] has become available on learning Technologies of Information and Communication in later adulthood. Indeed, the field of 'geragogy' or 'gerontagogy' used to define the science that studies the process of learning in later age [3–5] has become extremely relevant since the access to education

and training has been a priority of the older adult learner's rights, presented in the second World Assembly on Aging [6].

Similarly, the number of Universities of Third Age has risen dramatically, leading to the need of understanding the learners' context, needs and motivations, aiming at providing a positive learning experience and increasing the learners' sense of wellbeing and quality of life [7–9].

The advent of the Information and Communication Society also brings many challenges that can compromise learning, communication and daily-life routines that are mediated by digital devices. Indeed, there is a need to create inclusive learning environments that fosters info-inclusion and encourages critical thinking skills in the media ecology [9–12].

This paper, therefore, provides guidance for learning practitioners to address effective technology-based instructions that take the adult learners' context and ageing aspects into account. In specific, the research question is 'What strategies can be adopted to enhance pre-/during and post-learning experiences in later age?' and, subsequently, the aim of this paper is to explore the main aspects that can affect these learning experiences in later age, given the difficulties that can emerge and the participants' context.

2 Background

The demographic ageing in the European Union (EU) results from low birth rate, retirement of the post-war baby-boom generation and high life expectancy. The Portuguese case is also identical to the EU-28 and according with the Eurostat [13], the old-age dependency relative to the total population for the EU-28 was 29.9% whereas in Portugal was 32.5% in 2017. In 2080, this old-age dependency is estimated to grow to 52.3% [13].

Beyond this demographic scenario, the ageing process is an individual and complex process that involved physiological, social and psychological changes [14, 15]. For example, many of these changes involve the sensory system, in which the smell and taste can deteriorate, regardless of the ability to perceive the four basic tastes (sweet, sour, bitter and salt) [1, 14, 15].

In terms of older adults' cognition, a cognitive decline is often associated with the ageing process and it is generally characterized by a number of specific changes [1, 17]: (a) increasing difficulty in understanding long and/or complex messages and in recovering specific terms; (b) greater difficulty in reasoning activities involving a logical and organized analysis of abstract or unfamiliar material; (c) repetitive discourse; (d) difficulty in selecting information; (e) reducing the ability to perform new and rapid psychomotor tasks; (f) memory impairment, especially relative to the acquisition of new information and multi-tasking; and finally, (g) difficulties in inductive reasoning, spatial orientation, numerical and verbal skills and perceived speed.

Changes in motor skills due to ageing are also likely to occur and these include: slower response times; decrease in the ability to maintain continuous movements; coordination disorders; loss of flexibility; and less variability in movements [18]. Furthermore, the incidence of chronic conditions, such as arthritis, also affects movements and these changes also have a direct relevance to the use of computers [1].

According to some authors [1, 18], the older adult population embody different age cohorts and cannot be studied as a single target group owing to different changes that tend to appear at different life stages and, therefore, the age cohorts that are the most frequent are the following: young older adults (>65 to 75 years old) and old older adults (>75 years old).

Contradicting techno-ageism [20] and ageism [21], several studies also show that older people are interested in using Information and Communication Technologies (ICT) [1, 14, 19], regardless the limitations of the ageing process. The difficulty or non-existent relationship between older adults and ICT may be due to different aspects: the fear of using computers often associated with the fear of damaging the hardware and/or software; the equipment cost; and unfamiliarity with the language and interface conventions [19, 22] and certain difficulties associated with the ageing process, i.e. short-term memory, vision, motor skills and other physical or psychological changes.

In terms of the benefits of its use by the older adult target group, digitally-mediated learning is suggested to foster social support [24–27] improvements in cognition [21] and well-being [26, 28]; reinforcement of self-realization and self-esteem [23, 29], reduction of the feeling of loneliness [24], increase in quality of life (QL) [21, 23, 30, 31] and reinforcement of self-concept (SC) [21, 23].

Active ageing and healthy lifestyles are also suggested to keep the body and mind healthy, through good nutrition habits, involvement in interesting mind-challenging activities and reinforcement of the importance of social support and self-concept maintenance [23, 28, 32]. In this sense, facilitating access to social, cultural and leisure interaction is essential [28].

Concerning the motivation to learn digital technologies in later adulthood, the information is often contradictory. On the one hand, the older adults are seen as anxious in the use of computers and with little motivation to perform tasks involving technology [33, 34]. On the other hand, technologies are omnipresent in daily life and this target group seems to be interested in new opportunities and functionalities offered [35].

Given the aforementioned implications of the ageing process, the organization of tutorials and/or materials to support ICT's teaching-learning strategy for older adults may follow the fundamental principles of instructional design for meaningful learning [36, pp. 45–51]:

1. Learning occurs when students are involved in solving real-world problems. This principle focuses on the presentation of the problem, its deconstruction in tasks in order to solve it, followed by its operationalization and consequent action of making them feasible;

2. Learning proceeds when prior experiences and knowledge provide a basis for new knowledge. The development of this principle is to identify previous knowledge that can be valued in new learning and structure the way in which the new knowledge and apprenticeships can be used;

3. Learning occurs when students are presented with a set of demonstrative instructions instead of relying solely on information related with the learning goals. The focus of this principle is on demonstration in how to solve a problem and how the tasks can be performed. Different mental models and the generalization of knowledge into different situations should be considered in these demonstrations;

4. Learning is encouraged when learners are required to use new knowledge and problem-solving skills by using examples and real-world problems. Furthermore, feedback is crucial when solving these problems in order to understand, recover and avoid mistakes;

5. The process of learning also happens when there is a general encouragement to transfer and integrate new knowledge or/and skills into everyday life. This principle enables learners moving on different learning stages – i.e. integration, experimentation, creation and reflection until new knowledge is incorporated outside the learning environment and included in the daily routine.

In a nutshell, the design of instructional programs should consider the learner's cognition and in order to address meaningful learning experiences, one should take into account some general instructional strategies, namely, specific learning subtasks and/or tasks; supportive information strategies according with the tasks' difficulty level; the learner's pacing and feedback; timing exposure of the material in the training session; adaptive and simulation training; e-learning and performance assessment [15, pp. 93–106].

3   Method

As mentioned in the Introduction, the intent of this research is to explore the main aspects that can affect pre-/during and post-learning experiences in later age. A goal-oriented training method relying on step-by-step was used owing to the fact that it may be effective by telling participants which steps to perform and order and reducing working memory [37, 38].

Being a step-by-step self-pace learning process [38], such measured tasks as completion time and accuracy metrics are often used to assess the use of digital devices and help in self-judgements about the learning journey, enabling metacognition and adjusting the actual learning performance to the one that is expected. Furthermore, each participant is assigned to a certain goal and feedback is given towards the tasks and that way, fostering repetition and enactive mastery of the learning process and creating awareness towards errors.

Given the aforementioned procedures relative to a goal-oriented method [16, 17], information about the participants' learning context was needed through ongoing participant observation. Although the role of the researchers as primary data collection instrument can bring personal biases at the outset of the study as the relationship established between the participants and the institutions and researchers, our research team has practice on the field throughout at least five years and are aware and sensitive to the challenges and ethical concerns that may be brought to the field.

3.1   Settings

The study was carried out on three places in the North of Portugal: Four community-dwelling centers (Group 1 – G1), University of Aveiro (short-time course Multimedia addressed to older adults) (Group 2 – G2) and two Universities of Third Age (Group 3 – G3). These different learning organizations were purposefully selected in order to focus on different learning contexts that can affect the perception and meaning associated with those experiences expressed by the participants.

3.2   Data Collection and Analysis Procedures

Data was collected from September 2011 to July 2013 at the four community-dwelling centers, from December 2012 to February 2013; University of Aveiro from October 2012 to May 2013; University of Third Age 1 from October 2012 to May 2013; and University of Third Age 2 from October 2015 to December 2016.

Multiple sources of data were gathered in the field (i.e. field notes, surveys, documents…) and participants were observed in the activities within their context. The researchers also lectured the subject 'Multimedia' that was part of the curriculum from the Learning Organizations.

In ensuring internal validity, the following strategies were used: Triangulation of data sources of information (field notes and literature); and Extension of the field work in time. Data were analyzed in terms of the codes: Learning strategies used; Difficulties observed and Learning experiences.

The research safeguards: (a) Participants' informed consent; (b) Voluntary participation; (c) Involvement of the research team in the process; and (d) that the risks of participating in the study do not outweigh the risks associated with the participants' daily lives.

3.3   Participants

Community-Dwelling Participants (Group 1 – G1)
The group of participants from four community-dwelling centers consisted of 22 older adults: 14 females and 8 males, aged between 66 and 90 (M = 81.1, SD = 6.5). Eleven participants opted for the day care center modality whereas 10 are in retirement homes and 1 opted for the home-support service. Furthermore, 16 participants have been in institutions and 1 opted for four years or less than four years. In terms of the reasons that led these participants to join the community-dwelling centers, the majority (11) were recommended by a family member, seven took the initiative, three had a friend's suggestion and one participant was suggested by the Social Portuguese Services.

Given the context of use of Information and Communication Technologies (ICT), 14 out of 22 participants had never used a computer. Seven out of eight older adults, who used a computer had assistance, either in the community-dwelling centers or in ICT sessions and such activities as transcribing information and surfing in the Internet, promoted by the Town Council.

Group of Short-Time Courses in Multimedia Addressed to Older Adults (Group 2 – G2)

The group of participants from the short-time course in Multimedia consisted of 14 older adult learners: 7 females and 7 males, aged between 54 and 78 years old (M = 64.9; SD = 7.97).

Two focus groups with older adults aged between 65–75 years old, who were not in community-dwelling centers and were literate in order to overcome the limitation of the sample size of older adults with low literacy in the use of ICT in daily activities. The added groups were from the following institutions: 'Universidade Sénior de Ermesinde' and a group of 'Encontros com a Ciência' at the University of Aveiro.

Most of the participants in the group of short-time courses in Multimedia addressed to older adults has between 9 years of schooling and a college degree. Given their context of use in ICT, all participants used personal computer for basic tasks (e.g. writing, information searching…).

Group of the Universities of Third Age 1 - UTA (Group 3 – G3a)

The group of participants from the University of Third Age 1 consisted of 12 participants aged between 60 and 83 years old (M = 67.33; SD = 7.33), divided into 5 males and 7 females. Their school qualifications varied between the 6th year of schooling and a college degree. Given their context of use in ICT, all participants had computer at home and similarly to G2, they used personal computer for basic tasks (e.g. writing, information searching…).

Group of the Universities of Third Age 2 - UTA (Group 3 – G3b)

The group of participants from the University of Third Age 2 consisted of 33 participants aged between 55 and 82 years old (M = 67.33; SD = 7.06), divided into 16 males and 17 females. Their school qualifications varied between 10 and 14 years of schooling.

4   Results

4.1   The Case of Community-Dwelling Participants (Group 1 – G1)

These participants (G1) initiated their contact with digital devices in these classes and did not have access to personal computers beyond those used in the classroom. Furthermore, the activities had to be carefully prepared in order to motivate and engage the older target group with no knowledge about the metaphors used, language used and interaction paradigms.

The activities were, therefore, divided into four units: Unit 1. Introduction to computers; Unit 2. Text writing and formatting; Unit 3. Internet browsing; and Unit 4. Communication services: email and instant messaging.

During the sessions related with Units 1 and 2, most of the participants demonstrated the following difficulties:

- Handling the mouse and understanding the pointer position on the screen [1, 29]. As soon as they had reduced hand motricity, they would get frustrated;

- Ongoing difficulty in using the 'Caps Lock' key and other keys simultaneously for punctuation marks and accents;
- Confusion when using the letters 'W' and 'M' or 'O' and '0' and persistent difficulty in distinguishing between the keys 'Enter', 'Space bar' and 'Delete';
- Difficulties in starting the Microsoft Word, opening an existing document and saving it. Such problems as memory and learning impairments are related with changes in the ageing process.

  Relative to the units 3 – Internet browsing, the following observations were noted:

- The participants were surprised with the amount and diversity of information provided, leading to difficulties in selecting the information that was provided. One of the changes inherent to the ageing process is the decline in the ability for divided attention, which interferes in Human-Computer Interaction when older adults need to activate selective attention or when many details are shown, and older adults are unable to pay attention to all of them. Moreover, their perception is diminished, i.e. their ability to recognize patterns [29];
- Older participants express their dislike about the way in which information is listed, declaring that it is often disorganized;
- The participants had difficulty in understanding which areas are clickable and lacked the confidence to perform some actions [1];
- In terms of information searching, the topics that were chosen were extremely diverse. They searched information about religion, travelling, crafting, and place in which they were born.

  The main findings of this study on older adults' use of communication tools (unit 4 – communication services: email and instant messaging) were the following:

- The participants were afraid of starting new activities, either because they lacked the knowledge or because they feared about making a mistake [29];
- The participants felt great joy in receiving messages from relatives and friends;
- The participants never left messages unanswered. They always answered to the messages, even if it was just to say 'thank you';
- The participants had difficulty in remembering their email address and password. This problem was related to changes in working memory and learning inherent to the ageing process [1, 29, 39];
- The participants had difficulty in completing tasks. For example, participants rarely clicked in 'Sending', after writing a message, whether on *Gmail* or *GTalk*;
- The participants rarely included the subject in the emails they send, justifying it by saying that they didn't understand what they had to write. In other cases, they started to write the message in the subject box;
- The participants were not aware that the messages had attachments;
- The participants found that message feedback was important;
- The participants learned on how to open and answer an email, but rarely did it without checking if they were doing it properly;
- The participants understood the purpose of synchronous communication services, but they expressed that it would be only useful if relatives or friends were available to communicate simultaneously, which does not happen very often.

Despite having only basic knowledge about Information and Communication Technologies, the participants have soon realized their advantages, e.g. enable the exchange of written messages with distant relatives. It became, therefore, clear how much older adults were motivated during the sessions and interested in using ICT in their daily lives.

4.2 The Case of Short-Time Courses in Multimedia Addressed to Older Adults (Group 2 – G2)

The short-time courses in Multimedia were held once a week. A total of 10 sessions were given and each one lasted 90 min, in which the participants (G2) were highly motivated to learn and engage with technological activities.

The strategies adopted for the ICT activities were challenge-based with real-world problems, as recommended in the previous literature [36, 39]. Relative to the activities that were carried out, these were divided into four units: (i) Fundamentals of Computing; (ii) Introduction to Multimedia: Text and Image; (iii) Internet: Information searching and processing; and (iv) Social networks and communication services.

Despite the differences in the participants' skills, age, and level schooling relative to the ones from the community-dwelling centers, the difficulties observed during ICT usage were a transversal to all groups.

After the course sessions, the participants assessed the training course, accordingly with the following criteria: (i) level of satisfaction; (ii) the influence of sessions on their lives; (iii) positive aspects; and (iv) negative aspects. It is important to highlight, however, that there were four withdrawals during the course owing to health reasons.

In terms of the participants' level of satisfaction with the training sessions, the participants were satisfied (42.9%, N = 6) or very satisfied (28.6%, N = 4). Similarly, they reported that these training sessions influenced (42.9%, N = 6) or greatly influenced (28.6%, N = 4) their lives, contributing to a greater computer knowledge, familiarity and computer skills.

The main strengths of this course were the pedagogical capacity, diversified approach, support, contact, teachers' supervision and collaborators. Relative to its weaknesses, the participants mentioned the lack of time and reduced number of sessions.

4.3 Group of the Universities of Third Age 1 - UTA (Group 3 – G3a)

A 35-working session plan was taken over a period of 8 months (once a week), aiming at enhancing the participants' ICT skills and motivation. Indeed, these sessions had the purpose of training to ICT use in a context of information sharing, giving particular emphasis on the use of social networks. Although the first sessions were devoted to the Introduction of Computers and its interface, there was some familiarity with the interface conventions and some functionalities, increasing their motivation to become a regular or advanced user. The learning activities were, therefore, prepared in order to combine the participants' expectations, course goals and motivations to interlink the content to the daily life [7].

The activities that were carried out can be divided into five units: (i) Internet Security and Personal data protection; (ii) Social networks: Facebook; (iii) Image manipulation tools: *Picasa*; (iv) Creating a blog: *Blogger vs Tumblr*; and (v) Video editing tools: *Windows MovieMaker*.

The first module – Internet Security and Personal data protection (6 sessions) expected to clarify any of the participants' doubts relative to e-mail security, passwords, safe websites, *phishing* messages, antivirus and *Malware*. This module aimed at reducing participants' anxiety towards their doubts about security issues, namely in terms of their reported difficulties: (a) Memorizing passwords; and (b) Identifying safe websites through web addresses. In a nutshell, the participants find it hard to trust in the unknown and start using a different tool.

The second module – Social networks: *Facebook* (10 sessions) is one of the most popular and it embodies the following tasks: Learning how to create a User Profile; Adjusting the users' privacy policies; Finding friends; Publishing posts; Commenting on friends' profile; Sending private messages; Sharing photographs and videos; and Playing games. Relative to the difficulties that were found in this module, these were: (a) The insecurity and fear of trying new activities [29, 40], without having to ask someone with more experience; and (b) The inability to concentrate on a specific activity due to information overload and multimodality [1]. In general, the participants seem to not like to reveal their private life and they have shown their concerns on avoiding the expose of private information in a context of sharing.

Relative to the third module – Image manipulation tools – *Picasa* (4 sessions), the participants were taught on how to solve minor problems on manipulating images, organizing them on the computer, sharing images, and identifying the file formats. More specifically, participants found it difficult to:

- Switching between multiple computer applications, particularly when the application they were working on forced them to interact with the operating system;
- Using the cursor and understanding its functionality and accuracy caused frustration in some participants, who had physical limitations [1, 29, 31];

The fourth module – Creating a blog – *Blogger vs Tumblr* (8 sessions) aimed at teaching the participants how to create a blog, using two existing market-oriented platforms. The activities were: (i) Defining the blog theme; (ii) Formatting text (inserting hyperlinks, images and videos) and writing messages. In this module, the participants also explored the notion of *following someone* and defined privacy policies. Moving from *Blogger* to *Tumblr*, the following observations were made:

- There were some difficulties in selecting the information as the ability to recognize disorganized and unmatched patterns and elements without hierarchy affected the participants' whole experience [29];
- The participants had some difficulties in completing certain tasks, for e.g. they wrote the comment but did not publish it [41];
- When using *Tumblr,* the decrease in the number of configuration options and the reasonable amount of information shown in the screen facilitated the participants' interaction with the information provided.

Similarly, the most experienced participants had less difficulties and these were related to the configurations of the digital platforms.

Finally, the fifth module – Video editing tools – *Windows Movie Maker* (7 sessions) had the ultimate goal of capturing and editing videos to be uploaded on *Youtube*. The main subjects covered in this module were: The concept of frames per second, video subtitling, transition effects, different video formats, uploading and sharing videos on Youtube, and publishing the video on a created channel. The main difficulties in this module were: The quantity of steps that were demanded to upload a video on *Youtube* [41] and dual tasking, particularly when inserting images and/or audio files.

4.4 Group of the Universities of Third Age 2 - UTA (Group 3 – G3b)

A total of 34 session course was held at the University of Third Age 2, once a week with an average duration of 2 h per session (1 h per group of 15). There was also some familiarity with the interface conventions and some functionalities by these participants and their motivation to the use of computer-mediated communication and image and video digitalization and editing had implications on the topics that were selected to the course.

Although a module of 'Computer fundamentals' has been given in the first session, these learners wanted the tutor to adopt an 'on-demand' strategy and focus on image and video editing, and social networks. Hence, the modules were: (i) Image and video digitalization and editing; (ii) Internet browsing and bookmarking; and (iii) Communication tools, social networks and privacy.

In the module '(i) Image and video digitalization and editing', the participants learned to transfer their images and videos from their devices (i.e. mobile phone, camera…) to the computer. Furthermore, they learned how to edit their photos with the online photo editor pixlr.com and the videos with the video editor of *Youtube*. The 'bring-your-own device' approach seemed to best strategy to motivate these learners to interlink the information provided with daily-life challenges [7]. By contrast, this approach also brings many challenges to the tutor in order to meet every need and problem encountered in different devices. The tutor had also to find alternative solutions to downloadable content as the majority of the learners in order to express a strong suspicion towards downloadable content [7], regardless of the source's reliability.

Mouse precision was one of the most reported difficulties when editing image and adding transitions to the video, as it was also observed with University of Third Age 1.

In the module '(ii) Internet browsing and bookmarking', the participants learned to browse, filter images by using rights, colour and size, and add the search results to their Favourites. Although the participants were familiar with internet browsing, they were surprised with the options of filtering the information (*e.g.* use of quotation marks to refine their search).

Finally, the module '(iii) Communication tools, social networks and privacy' enabled the participants to learner how to configure their privacy settings in *Facebook*, manage their publications in terms of visibility and videochat. The same difficulties observed in the participants of the University of Third Age 1 were replicated in these participants. Moreover, these participants expected that the social network *Facebook*

would work as an online community in the way that it enabled to filter the friends' publications accordingly with their interests and ignoring the posts that are from their friends but do not share the same interests.

It is also worth to notice that co-challenges and co-exercises were not successful as thought in this team because each participant had different, individual and very straightforward needs.

5   Discussion

There is a variety of prominent aspects that can affect pre-/during and post- learning experiences in later age that include the access to technology, time availability for learning and lack of on-demand learning instructions.

Based on the aforementioned cases in the use of technology-based learning experiences and in response to the research question, one may suppose that the following strategies to design such experiences that take into account the ageing process are: (a) facilitate the discourse between learning agents; (b) divide problems and abstract concepts into specific and concrete ones; (c) provide age-friendly learning and non-downloadable services or products; (d) provide step-based feedback; (e) simulate and offer a potential solution to a learning exercise; (f) deliver the learning service on demand and at the learner's pace; and meet the adult learner's previous experience, concrete needs and everyday context.

Relative to the difficulties that technology-based learning may bring and affect the whole experience, these are: (a) Precision in house handling and understanding the pointer position on the screen; (b) Simultaneous actions (e.g. using 'Caps Lock' key and punctuation marks; switching between multiple computer applications; (c) Lack of time and reduced number of sessions to learn and dealing with insecurity and fear of trying new activities, information overload, multimodality and exposition of private information; and (d) difficulties in selecting the information and recognize disorganized and unmatched patterns.

The aspects that may affect pre-learning experiences tend to be the learners' expectations towards the content; their motivations; pre-defined goals and access to technology. The learning experience that occurs *in loco* may be affected by changes in the sensory system and implications in terms of multimodality in learning; changes in cognition and repetitive step by step tasks, discourse and metaphors used, demonstrative instructions and a learning service on demand and at the learner's pace. Finally, the post-learning experience is likely to be affected to the perceived interlink between the learning content and daily tasks and self-judgements about the learning journey and enactive mastery of the learning process. The major limitation of this study is that it relies too heavily on observation and experience of authors in the field. Large randomized controlled trials could provide more evidence of the observed aspects and future work needs to be carried out in order to understand in what way digitally-mediated learning could be embedded and have an impact on daily life decisions and subsequent actions.

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