Universidade de Aveiro
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Sónia Cristina Sousa Machado

Co-design de um Toolkit de Experiência do Utilizador para Comunidades Online Sénior: Proposta para a Comunidade Online miOne.

Co-designing a User Experience Toolkit for Senior Online Communities: A Proposal for the miOne. Online Community

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Comunicação Multimédia, realizada sob a orientação científica do Doutor Óscar Emanuel Chaves Mealha, Professor Catedrático do Departamento de Comunicação e Arte da Universidade de Aveiro, e sob coorientação da Doutora Liliana Filipa Vale Costa, Investigadora do Departamento de Comunicação e Arte da Universidade de Aveiro.

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palavras-chave

Co-design, Experiência do Utilizador, *Toolkit*, Comunidades Online Sénior, miOne.

resumo

Nos últimos anos, assistiu-se a uma dependência crescente da utilização das Tecnologias da Informação e Comunicação e nunca foi tão importante a conceção de tecnologias adequadas ao cidadão sénior, dado o envelhecimento populacional. De facto, a maioria dos projetos de desenvolvimento de *software* destinados a seniores contam com as suposições dos designers em relação aos modelos cognitivos dos utilizadores, apresentando o risco de assentar em estereótipos e levar ao desenvolvimento de produtos que acabam por não serem utilizados, realçando a necessidade de envolver o utilizador no processo de design.

O objetivo desta investigação-ação é compreender como é que o co-design pode influenciar a experiência do cidadão sénior na utilização de comunidades online. Uma amostra por conveniência constituída por 40 alunos de cinco Universidades Seniores e dois coordenadores participou nas atividades de co-design de um *Toolkit* de Experiência do Utilizador para Comunidades Online Sénior, abrangendo um conjunto de 17 sessões no total e uma avaliação de eye-tracking. As atividades foram estruturadas da seguinte forma: Pesquisa sobre Co-Design, Desenvolvimento de um *Toolkit,* Aplicação, Avaliação e (Re)Design da Comunidade Online miOne.

Os resultados indicam que a aplicação do *toolkit UX* para comunidades online facilitou a identificação de "melhores práticas" ou diretrizes para envolver o utilizador no processo e permitir o *redesign* da comunidade online miOne. Esta investigação contribui para a área das Ciências da Tecnologia da Comunicação ao identificar e analisar as tendências mais recentes na aplicação das melhores práticas para desenvolver artefactos de informação e comunicação que reforcem a interação empática com os utilizadores, no contexto das comunidades *online*.

keywords

Co-design, User Experience, Toolkit, Senior Online Communities, miOne.

abstract

The past few years have seen an increasing dependence on the use of Information and Communication Technologies and never had the design of age-friendly technologies been so important as nowadays, given the ageing population. Indeed, most of the software development projects designed for older adults tend to rely on the designers' assumptions of the users' cognitive models, presenting the risk of falling into stereotypes and leading to products that end up not being used, which reinforces the need to involve older adults in the early stages of the design process.

The purpose of this action research method is to understand the way co-design can influence senior citizens' experience in online communities. A convenience sample of 40 adult learners at five Universities of the Third Age and 2 coordinators participated in the co-design activities of a User Experience Toolkit for Senior Online Communities, which encompassed a set of 17 sessions in total and an eye-tracking evaluation. The sessions were structured into the following: Co-Design Research, Toolkit Development, Application, Assessment, and (Re)Design of the Senior Online Community miOne.

The results indicate that the application of the co-design toolkit facilitated the identification of 'best practices' or guidelines for involving the user in the design process of online communities, enabling the re-design of the online community miOne. This study gives a noteworthy contribution to the field of Communication Sciences and Technologies by identifying and analyzing the most recent trends in the application of best practices to develop information and communication artefacts that reinforce empathic interactions with the users, within the context of online communities.

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List of Abbreviations and Acronyms

AR	Action Research
cont.	Continuation
e.g.	*Exempli gratia* – For example
EU	European Union
HCI	Human-Computer Interaction
i.e.	*Id est* – That is
ICT	Information and Communication Technologies
UI	User Interface
USA	United States of America
UX	User Experience
WHO	World Health Organization

Introduction

This dissertation was developed in the context of the SEDUCE 2.0[1] project POCI-01-0145-FEDER-031696 (SEDUCE 2.0 - Senior Citizen Use of Communication and Information in miOne community), in which the project's main goals are (Veloso, 2014): (a) to assess the impact of psychosocial variables and the sociability of senior citizens through the use of ICT in the context of the miOne[2] online community, and (b) contribute to the growing development of the miOne community with the participation of senior citizens. Currently, the miOne community enables the exploration of the following areas: communication – group participation and exchange of instant messages; online news - share, read, debate, and react to news; and content sharing relative to health information, tourism, and new forms of entertainment such as gamification.

This investigation is focused on co-designing user experiences by engaging adult learners with a designed toolkit. A set of best practices and guidelines for designing senior online communities were formulated and the miOne community is redesigned accordingly. Research on co-designing user's experiences has recently been receiving attention in such areas as marketing and tourism research (Mathis, Kim, Uysal, Sirgy, & Prebensen, 2016). Although many studies engage senior citizens in co-design activities (e.g. Ahmed et al., 2019, Maa & Buchmuller, 2018), few studies (*e.g.* Wikberg-Nilsson et al., 2018) use the approach of co-designing experiences and engagement in online platforms.

Given this lack of research in the area of Human-Computer Interaction (HCI), the aim of this dissertation is to understand the way co-design can influence the experience of senior citizens in online communities (*i.e.* Research Question: In what way can co-design influence the senior citizens' experience in an online community?), by engaging senior citizen participants of Universities of the Third Age with a toolkit of co-design activities, in order to test and enhance the user experience in the miOne online community.

The Research Problem

The proportion of the global population aged 60 and over has been growing faster than any other age segment throughout the years (WHO, 2003). People not only tend to live longer and actively in older age but also with higher physical and mental capabilities (Czaja, Boot, Charness, & Rogers, 2019). This increasing population age and recent advancements in Information and Communication Technologies (ICT) have also led to an overly dependence on the end-users' digitally-mediated interactions with the environment (Davison, Sia, & Dong, 2008). Furthermore, a considerable number of senior citizens are living alone (Czaja et al., 2019) and online communities are, therefore, very likely to foster meaningful social contact (Leist, 2013), reducing the effects of social isolation and loneliness (Findlay, 2003).

[1] Available at: http://www.seduce.pt/ (Date accessed: 21-04-2020)
[2] Available at: https://www.mione.altice.pt/ (Date accessed: 21-04-2020)

Despite its benefits, the gap between older and younger adults persists in terms of ICT use (Czaja et al., 2019) as well as a general disengagement with online activities from older generations (Neves, Franz, Munteanu, & Baecker, 2018). Possible reasons that were highlighted by Czaja and colleagues (2019) for this gap are Income disparities; perception of the needs to use the technology and difficulties in its use. Both physiologic and psychological impairments associated with the aging process can also make the technology harder to use (Czaja et al., 2019), and therefore the user's context should be prioritized over technology (Pearson, Walsh, Carter, Koskela, & Hurley, 2016). Most software development projects rely on the designers' assumptions of the users' cognitive models with the risk of homogenizing the aging experience and fall under stereotypes (Vines, Pritchard, Wright, Olivier, & Brittain, 2015). As a result, some of these projects end up not being used by the end-user either because senior citizens do not recognize themselves in these products or refuse the portrayal of negative social images in terms of old age (Brandt, Binder, Malmborg, & Sokoler, 2010).

A collaborative design approach could be, therefore, used in order to come up with products that senior citizens would use, *i.e.* the participation of senior citizens in the technology development process may facilitate the identification of their wishes, abilities, and resources (Pearson et al., 2016). Such experience results from vivid memories about activities and interactions with the product (Campos et al., 2016), and the end-users' engagement in co-design sessions are also very likely to impact their unique and added-value experiences (Wiklund, Cecilia, Åsa, Nilsson, & Normark, 2018) with the product use (Mathis et al., 2016).

The Research Question

A research question was formulated to meet the dissertation purpose, following the principles of clarity – *i.e.* the research question is precise, concise, and unambiguous; feasibility – *i.e.* the research question is realistic; and relevance – *i.e.* the perception of what already exists and the intention to understand the studied phenomena (Quivy, Campenhoudt, Marques, & Mendes, 1992). By following these principles, the research question of this dissertation is:

"In what way can co-design influence the senior citizens' experience with an online community?".

This research question will be fundamental to understand the possible influence of co-design in senior citizens' experience with online communities – in the specific case of the miOne online community and apply those experiences in the design and implementation phases of the miOne community.

A qualitative approach was chosen in order to answer the research question by reviewing the literature, applying the co-design techniques, administering questionnaires, and user experience evaluation tools such as eye-tracking. A systematic literature review

in co-designing with senior citizens was also conducted to gain further insights on the co-design techniques used with this target group in the last six years. The dissertation addresses the following sub-questions:

(a) What are the co-design techniques that have been used with senior citizens in the last six years?
(b) What are the co-design strategies that can engage senior citizens in the different phases of the user experience in an online community (pre-experience, experience, and post-experience)?
(c) What are the main difficulties that senior citizens have when interacting with the online community's interface?
(d) What are the best practices/guidelines for designing and developing Senior Online Communities? and
(e) How do the co-design strategies, the participants' self-reported experience with online communities, and the interaction of adult learners at the Universities of the Third Age with the miOne online community help to explain the influence of co-design in the senior citizens' experience with an online community?

The Purpose of the Study and Main Goals

As previously mentioned, the purpose of this Action Research is to address the way co-design can influence the senior citizens' experience with online communities by engaging the participants from Universities of the Third Age in the online community miOne.

The main goal of this research is to propose a set of 'Best Practices' or 'Guidelines' for designing and developing senior online communities. Moreover, the following sub-goals are defined:

The goals answered by the literature review are:

(a) Identify the co-design techniques that have been used with senior citizens in the last six years;
(b) Understand the senior citizens' motivations and preferences to use online communities;
(c) Explore the main guidelines to design and develop Senior Online Communities;
(d) Create a UX toolkit for co-designing Senior Online Communities;

The goals answered by the co-design sessions are:

(a) Formulate a framework relative to UX co-Design in Senior Online Communities;
(b) (Re) assess and refine the UX toolkit for co-designing Senior Online Communities;
(c) Involve the participants in the (re) design of the miOne online community.

The goals answered by the user experience evaluation, group discussions, and questionnaires are:

a) Understand the senior citizens' motivations and preferences to use online communities;
b) Apply the framework and toolkit in the Senior Online Community miOne;
c) Test and evaluate the online community miOne; and

The goals answered by the eye-tracking sessions are:
(a) Test the users' navigation and assess the main features of the online community miOne;

Based on the research question and the main goals established for this dissertation, the following subsection presents the Analysis Model.

The Analysis Model

The analysis model based on the research question "In what way can co-design influence the senior citizens' experience with an online community?" is shown in Table 1. It is divided into five main concepts - Co-design, User Experience, Influence, Senior Citizens, and Online Communities - further explained in the theoretical framework, as well as its dimensions and indicators.

Expected results

The main purpose of this dissertation is to develop a co-design toolkit for evaluating the user experience in online communities. In specific, the toolkit is applied in the context of the miOne online community, involving the participants of the Universities of the Third Age.

Based on the literature review, co-design is focused on understanding the user's needs to create a tailored, meaningful, and useful Human – Computer Interaction (Ahmed et al., 2019). By engaging adult learners in co-design activities, their expertise is brought to the design process and, consequently, there are more chances of creating a successful product (Jarke & Gerhard, 2018). Thus, the co-design of user experience activities is expected to positively influence the senior citizens' engagement in online communities. It is also expected that the developed toolkit generates meaningful experiences with the online community miOne so that users interact spontaneously with it outside the co-design sessions.

Table 1 – The Analysis Model based on Quivy and colleagues (1992)

Concept	Dimensions	Indicators
Co-design (*e.g.* Y. Lee, 2008b; Muller & Kuhn, 1993; Sanders & Stappers, 2014; Schuler & Namioka, 1993)	Techniques	Group number
		Design phase
	Participation modes	Community participation
		Public participation
		Design Participation
User Experience (*e.g.* Cooper et al., 2014; Nielsen, 1994; Preece et al., 2015)	Information Architecture Design	Organization
		Navigation
		Labeling
		Searching Systems
	Interaction Design	Conceptual principles
		Behavioral principles
		Interface-level principles
		Usability Heuristics
	Visual Design	Context
		Shape
		Size
		Color
		Orientation
		Texture
		Position
		Text and Typography

Table 1 - Analysis Model based on Quivy and colleagues (1992) (cont.).

Concept	Dimensions	Indicators
User Experience (*e.g.* - Cooper et al., 2014; Nielsen, 1994; Preece et al., 2015)	Visual Design	Information Hierarchy
		Motion and change over time
	Evaluation Methods	Self-reported measurement
		Observational measurement
		Physiological measurement
Influence (*e.g.*Cialdini, 2010; Kelman, 1958; Norman, 2005)	Principles	Reciprocity
		Consistency
		Social Proof
		Liking
		Authority
		Scarcity
	Social Influence Theory	Compliance
		Identification
		Internalization
	Emotional Design	Visceral
		Behavioral
		Reflexive
Senior Citizens (Coleman, Clarkson, & Cassim, 2003; Czaja et al., 2019; Neugarten, 1974)	Aging process	Psychologic effects
		Physiologic effects
		Social effects
		Demographic effects

Table 1 - Analysis Model based on (Quivy et al., 1992) (cont.).

Concept	Dimensions	Indicators
Senior Citizens (Coleman et al., 2003; Czaja et al., 2019; Neugarten, 1974)	'Domestication" of digital media	Information literacy
		Inclusive design
Online Communities (A. J. Kim, 2000; Nimrod, 2014; Preece, 2000)	Roles	Moderators
		Mediators
		Professionals
		Lurkers
		Participants
	Policies	Rules
		Rituals
		Protocols
	Shared Purpose	Interests
		Needs
		Information Exchange

Personal Motivations

In my bachelor's degree in New Communication Technologies, my final project was focused on intergenerational relationships between grandparents and grandchildren, in which the main goals were bringing young people closer to senior citizens and encouraging a positive attitude towards the aging process. Working with senior citizens made me realize that society should view Human aging as a natural process, and that is important to demystify stereotypes associated with senior citizens, which I had myself previously devised.

I chose this dissertation theme, not only because of my previous experience working with senior citizens but also from the belief that it is important to listen and work alongside the end-users to develop platforms that are inclusive and create memorable user experiences.

The Dissertation Proposal Structure

This dissertation is divided into six main chapters, including the Introduction and Conclusion. These are relative to the Literature Review and Related Work (Chapter 1, 2, 3, 4, and 5); Empirical Research (Chapter 6); Data analysis, Evaluation, and Discussion of Results (Chapter 7).

The Introduction presents the research theme and purpose. It consists of the research question and expected results, objectives of the study, the analysis model, and personal motivations for the dissertation theme.

In the literature review, the following topics are addressed:

- Chapter 1 entitled "Senior Citizens and the 'Domestication' of Digital Media" discusses the social and demographic changes in an aging society and physiological, psychological, and social effects of the aging process. Besides, this chapter addresses the use of technology by senior citizens and inclusive design;

- Chapter 2 entitled "Co-designing User Experiences" introduces the concepts of Co-design and User Experiences (UX) and its interrelatedness. Techniques and evaluation methods used for UX co-design are described as well as The Design Thinking Process;

- Chapter 3 entitled "Emotions in UX and Social Influence" addresses Emotions in UX Design, Influence Theories, the Design of Social Influence, Positive Computing and Persuasive Design;

- Chapter 4 entitled "Senior Online Communities" addresses the concept of online communities and their lifecycle. The difference between Online Communities and Social Networks Sites is further explained and some examples of Senior Online Communities are provided.

Finally, the related work and final thoughts on the literature review are also presented and the application of User Experience Research Toolkits is analyzed.

The sixth chapter, *i.e.* Empirical Research, presents the description of the method used, techniques, tools used for data collection, and the contextualization of the research, namely the conceptualization process, design, implementation and evaluation process, data coding, and analysis. The seventh chapter presents the results from the co-design sessions and guidelines to design Senior Online Communities, based on the user experience evaluation with the end-users. Finally, this dissertation ends with the conclusions, answering the research question, and presenting the research limitations, and future work.

1. Senior Citizens and the 'Domestication' of Digital Media

According to the World Health Organization (WHO) (WHO, 2017), the aging biological process results from the impact of gradual damages in Human molecules and cells that can originate biopsychosocial changes, diseases, and death. Additionally, age often involves other important changes such as shifts in roles (*e.g.* (grand) mother/father) and social positions (*e.g.* age-dependence condition). Alongside population aging, Information and Communication Technology (ICT) grows exponentially and ubiquitous in such social activities as work, education, healthcare, communication, and entertainment (Czaja & Lee, 2007).

The concept of 'Domestication', approached by Silverstone and Haddon (1996), is mainly concerned with the way Information and Communication Technologies (ICT) contribute to the formation of everyday routines, describing and analysing processes of media technology's appropriation, objectification and incorporation; as well as the societal consequences of the domestication of technology (de Reuver, Nikou, & Bouwman, 2016; Silverstone & Haddon, 1996).

Appropriation is concerned not only with the purchase of a technology but also with the socially assigned meaning that is presented before its acquisition and the personal meaning that is developed throughout its ownership (De Schutter, Brown, & Vanden Abeele, 2015). In the end of the appropriation process, the meanings of objects are transformed to fit the self-image of their users. In the conversion phase the personal meanings, acquired in the appropriation phase, can be incorporated and reinforced into an ever-evolving public meaning, as users display (or not) their ownership and expertise in a public context (De Schutter et al., 2015).

Then, the phase that follows is objectification, which refers to the spatial exhibition of an object within the home. It is defined by Silverstone (2005), as 'the location of information and communications technologies in the material, social and cultural spaces of the home' (Silverstone, 2006, p. 235). However, it is also possible for users to never objectify a newly domesticated technology (*i.e.* by only using the object outside of their home) (De Schutter et al., 2015). If objectification occurs, then the spatial display of such objects may reveal the 'incorporation' of how they are used, particularly concerning their integration within a routine (De Schutter et al., 2015).

This subchapter provides further insight into the concept of aging and the definition of different senior age cohorts. Then, it explores the social and demographic changes of an aging society and the physiological and psychological effects of the aging process. Moreover, technological growth and the domestication of technology by senior citizens are analysed, as well as the adoption of inclusive design as a way to further engage senior citizens with modern technologies.

1.1. Social and Demographic changes

There has been a growth in the number of senior citizens over the world. One in nine people are aged over 60, and an estimated increase to five is expected by 2050 (Coleman et al., 2003; Helena, Asia, Asia, & Lucia, 2006). In 2006, 17% of the North Americans and 23% of Western European inhabitants were over 60. By 2050, this age segment will likely represent 32% of inhabitants in the most developed nations, including North America, the EU countries, and Australia (Helena et al., 2006).

According to PORDATA, a database of certified statistics on Portugal (PORDATA, n.d.), the aging index in the entire Europe has exponentially grown. The following chart (c.f. Figure 1) shows five European countries with a higher aging index – *i.e.,* the ratio of the number of senior citizens aged 65 and over to the number of young persons (from 0 to 14).

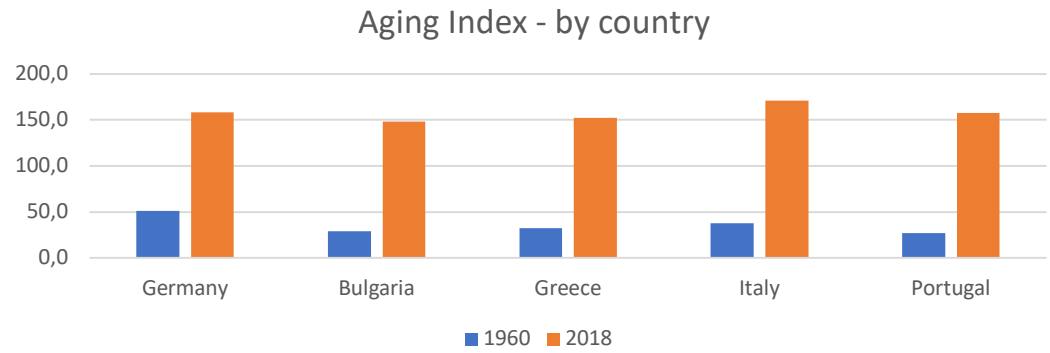


Figure 1 - European countries with the highest aging index. Adapted from PORDATA (n.d.)

As shown in Figure 1, Portugal was the third country in Europe with the highest aging rate (157,4) in 2018 whereas only Italy and Germany surpassed this number (171,0 and 158,5 respectively).

This aging trend can be explained by the increased longevity and low levels of fertility, especially observed in developed countries (WHO, 2003). While in most European countries the number of senior citizens has outnumbered children (United Nations, 2017), international migration has contributed to changing the population age structure since migrants tend to be concentrated in the working ages (United Nations, 2017).

The aging of a population has also been regarded as a form of social success and a reflection of a global cultural crisis (Restrepo & Rozental, 1994). Nowadays, many senior citizens take responsibility for household management and childcare so that younger adults can work outside home (WHO, 2003). Similarly, some of them act as volunteers increasing their social contacts and psychological wellbeing while making a significant contribution to communities and nations (WHO, 2003). In contrast, some senior citizens live without the quality of life, being poor, marginalized, dependent on others, and forced to compete

against experienced younger people in the labor market to ensure financial stability (Restrepo & Rozental, 1994).

As society is economically driven and the global population continues to age, the older age segments can't be overlooked. Efforts should be made instead to create incentives to incorporate this age group in the market, making them producers and consumers (Restrepo & Rozental, 1994).

The following section defines the concepts of "younger-old", "older-old" and "oldest-adult" to inform the reader about some considerations on the terminology used in this thesis.

1.2. **Definition of "Younger-Old", Older-Old" and "Oldest-Old"**

Senior citizens or older adults do not form a homogenous group given that age occurs on many levels and individual differences seem to prevail (Czaja et al., 2019). However, chronological age is still an indispensable marker to define this group (Neugarten, 1974).

Czaja and colleagues (2019) classify older adults in two groups: Younger-Old, consists of those aged between 60 to 75 years old; and Older-Old for the 75s and over. Lee and colleagues (2018) add a third to this age group classification – the Oldest-Old for those aged over 85 years old.

The young-old group (aged between 60 to 75 years old) is marked by the age of retirement (Neugarten, 1974), *i.e.* the mean of 65 years old in Europe ("Retirement Ages in Different Countries," 2020). This retirement phase may open up opportunities to have a vast diversity of lifestyles and a healthy, economically stable, and politically active life, sometimes contrasting with the portrayal of old age and eventual stereotypes (Neugarten, 1974).

Older-Old population (aged between 75 to 85 years old) generally still live independently. However, they are more likely to suffer from physical and mental deterioration, needing more social support and special physical environments to fully function as active members of society (Neugarten, 1974).

This latter group is formed by a higher percentage of women over men (Smith, Borchelt, Maier, & Jopp, 2002), being the fastest-growing demographic group - expected to reach 19% of the old adults' population by 2050 (Neves et al., 2018). This age group is especially vulnerable to social isolation and loneliness, due to higher levels of comorbidity and institutionalization, poor health, reduced social networks and social interactions and, unlike the older-old population, this age group cannot possibly function independently (Neves et al., 2018; Smith et al., 2002).

This Master thesis will be centered on the term "senior citizens", although it must be acknowledged that the discourse may change to "adult learners at the Universities of Third Age" given that +50 learners may be also involved in the empirical study, who usually share some of the concerns with physiological and psychological changes in Aging (covered in the next section).

1.3. Physiological and Psychological Changes in Aging

Although living longer and actively is possible in older age, many senior citizens are still affected by physiological or/and psychological impairments, being a natural condition of the aging process (Czaja et al., 2019; Huppert, 2003; Kanasi, Ayilavarapu, & Jones, 2016).

The following table (c.f. Table 2) provides a brief overview of some physiological and psychological effects of the aging process ascertained by Czaja and colleagues (2019).

Table 2 - Physiological and Psychological effects of the aging process.

Effects	Description
Haptics	Increasing variability in haptic control, perceived temperature, and vibration occur with the aging process. Balance and the control of body position and movements may deteriorate, making senior citizens vulnerable to postural instability, and fall risk.
Audition	Speech comprehension and the ability to detect tones and other sounds deteriorates with age, having implications on sound design.
Vision	Visual impairments also increase with age, namely the difficulty in eyes' adaption to darkness and sudden changes in illumination. Moreover, saccadic movements and reaction time are also slowed down.
Memory	Working memory, *i.e.* capability to store and retrieve temporary information when needed tends to be affected. Prospective memory or the capacity to remember to-do tasks in the future tends to be declined. Similarly, time-based prospective memory (*i.e.* doing something later) is more negatively affected than event-based memories, *i.e.* action after some event occurs. Senior Citizens have also difficulty in performing procedural memory (*i.e.* knowledge about how to perform activities).
Attention	More time is needed when processing different stimuli – *e.g.* flashing or high-intensity lights.

Table 2 - Physiological and Psychological effects of the aging process (cont.).

Effects	Description
Spatial Cognition	Senior citizens tend to lose the capacity to process spatial cognition – *i.e.* the capacity to process locative and spatial information.
Self-efficacy	Senior citizens' confidence relative to their abilities and sense of mastery tends to be lower.
Understanding written and spoken language	There is a general difficulty in language comprehension, processing, and production.

Based on these physiological and psychological effects, many authors (Czaja et al., 2019; Kurniawan & Zaphiris, 2005) present a set of interface design implications for websites that may impact technology acceptance, represented in the following table – c.f. Table 3.

Table 3- Implications on the design of websites for senior citizens.

Feature	Design Implication
Target Design	Provide larger clickable targets and create visual cues for the confirmation of the click; avoid double click.
Use of Graphics	Use relevant graphics without animation; icons should be simple and in accordance with their affordances.
Navigation	Minimize the steps and the number of controls needed; information and layouts should be consistent; extra and bold cues should be provided, as well as an indication of the current page. Avoid Pull down menus; Do not use a deep hierarchy; and group information into meaningful categories.
Browser Window Features	Avoid scrolling and multiple windows (*e.g.,* pop-ups).
Content Layout Design	Simplify the language used and remove irrelevant information. Highlight important information and put it at the centre.
Links	Differentiate visited and unvisited links with clear identification.
User Cognitive Design	Provide enough time to read information; support recognition instead of recalling; and provide fewer choices.
Use of Color	Achieve at least 50:1 contrast (*e.g.,* black text and white background). Blue and green tones should be avoided.

Table 3 - Implications on the design of websites for senior citizens (cont.).

Feature	Design Implication
Text Design	Use 12-point fonts and avoid decorative and cursive fonts, using serif or sans serif fonts instead. Avoid moving text and it should be left-justified. Text lines should be also short in length.
Search Engine	Cater for spelling errors.
User Feedback and Support	Provide a site map and an online help tutorial. Error messages should be displayed easily and simply to follow.

1.4. The 'Domestication' of Digital Media in an Aging Society

ICT use by senior citizens will continue to grow, as society is being continuously digitalized and tech-savvy people pass into older age (Eurostat, 2019a). In the Portuguese dataset PORDATA (PORDATA, 2016), it is noticeable a growing trend in the use of the Internet among Portuguese age groups, including older adults (64-74 years old) – c.f. Figure 2.

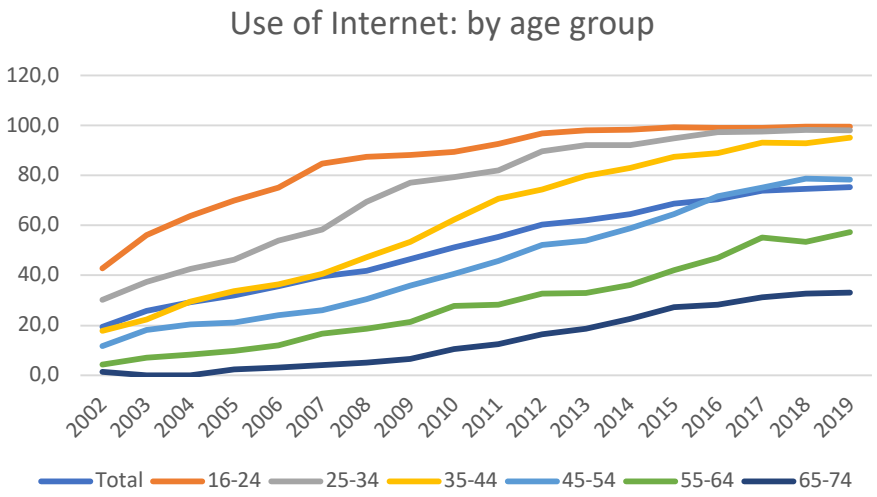


Figure 2 - Use of Internet by age group. Adapted from PORDATA (2016)

As illustrated in Figure 2, only 10,4% of individuals aged between 64 and 74 years old used the Internet in 2010, in comparison with 89,3% of a younger group aged between 16 and 24 years old. In 2019, 33,1% of the population aged between 64 to 74 years old were Internet users, showing a growth of 22,7%. However, there is still a "digital divide" between older and younger age groups (Czaja & Lee, 2007), being the percentage of Internet users aged between 16 and 24 years old of 99,5% in 2019.

It is a myth that older people want to avoid technology 'Domestication', yet they express more anxiety towards its usage and only want to use technology when they feel that it is necessary (Czaja et al., 2019). Also, the physiological and psychological limitations mentioned in chapter 1.3 may impact technology use, and so do senior citizens' attitudes and beliefs towards ICT (Leist, 2013). Lee and colleagues (2011) highlight that there are three perceived constraints for ICT usage: (1) Intrapersonal (*e.g.* I'm too old for this); (2) Functional (*e.g.* memory decline); (3) Structural (*e.g.* cost too much to own a computer) and (4) Interpersonal (*e.g.* no one teaches me how).

Regardless of these obstacles to the older adults' use of ICT, they can bring many benefits, such as enhancing self-image and self-confidence, increasing social connectivity and social support, decreasing loneliness and depression, and creating positive attitudes towards aging (Mitzner et al., 2010). Besides, Internet activities such as online banking, online shopping, and e-health can also contribute to active aging (Czaja & Lee, 2007). Still, the Internet presents a challenge for that population, being computer literacy (Choudrie, Ghinea, & Songonuga, 2013, p. 419) essential, which is further explained in the following sub-section.

1.4.1. Information literacy in a digitally mediated context

The concept of literacy refers to the capacity of being able to read and write, involving both a learning and teaching process whereas numeracy is relative to the capacity to calculate and operate basic math (Benavente, Rosa, Costa, & Ávila, 1996).

Information Literacy (IL) has been looked from three different perspectives: behavioral, relational, and socio-cultural (Linares Soler, 2019). In the behavioral perspective, IL is defined by Bruce (1997) as a set of abilities and capacity to recognize when information is needed and to be able to define, locate, and use it effectively. Bruce (1997) likewise establishes the relational perspective, describing IL as a complex way of experiencing information use, emphasizing the relationship between users and information, and the way they experience the world. Lastly, a social-cultural perspective of IL is concerned with information engagement when learning in different contexts to efficiently participate in social, professional, and personal activities of everyday life (Lloyd, 2006).

According to the UNESCO report on "Aspects of literacy assessment" (2005) "literacies" are in constant evolution and new perspectives are added since there should be a constant reflection on societal changes, language influences, culture, and identity, and communication and information technologies growth.

The access to ICT and the ability to use it has been impacting the socio-cultural and political integration of individuals into society (Zadražilová, 2018), and with the spreading use of computers and other forms of digital media (UNESCO, 2005), non-users or non-literate users in a digital context will be in a disadvantage as information and communication technologies are progressively becoming the exclusive infrastructure of

communication and information access (Zadražilová, 2018). Moreover, the Internet has enabled users to be also content producers, and, hence, the importance of knowing how to search for and filter good information (Pool, 1997). Based on those precepts, a person with information literacy can:

a) **Use** by having the skills and knowledge to access and use a variety of hardware devices and software applications;
b) **Understand** by having the skills to comprehend, contextualize, and critically evaluate digital media; and
c) **Create** by having the ability to create with digital technology and communicate with different media tools.

When compared to other age groups, senior citizens are still one of the most vulnerable groups to digital exclusion (Larsson, Larsson-Lund, & Nilsson, 2013) sometimes because they feel apprehensive about using ICTs since they do not have the perceived needed skills – a term called the *information literacy paradox* (Schreurs, Quan-Haase, & Martin, 2017).

To contradict this paradox, the Schreurs and colleagues' (2017) study emphasizes the need for peers and family to support older adults in gaining experience and enhancing their digital skills. The UNESCO report on "Creating and Sustaining Literate Environments" (2011, p. 17) is in accordance with those results affirming that "rich literate environments should be learner-friendly and have appropriate, adequate, and accessible materials, attractive and enticing physical settings and a learner-friendly socio-cultural atmosphere to engage learners to experience a transformative learning process." Examples of these environments can be "home, schools, community learning centers, libraries, and museums, among others."

In brief, creating 'literate environments' is important as well as training senior citizens to be information literate within a digital context and for that, the use of interactive activities are recommended (UNESCO, 2011) such as storytelling, role-playing, and game-based learning, which may develop new technical skills, incite discussions, and critical thinking. Beyond being literate, digital inclusion is also important, and the next subtopic will cover inclusive design as a contribution to Active Aging.

1.4.2. Inclusive Design as a contribution to Active Aging

According to the World Health Organization (2003, p. 12), Active Aging can be defined as "(…) the process of optimizing opportunities for health, participation and security in order to enhance the quality of life as people age." Design plays a role in optimizing these opportunities given that the products and services may facilitate and encourage the active enjoyment of older age (Coleman, 2003).

However, conventional product interfaces still present serious difficulties for senior citizens (Huppert, 2003). Initially, products were specifically designed for consumers with

functional impairments to overpass these difficulties, following a 'design for disability' approach (Keates & Clarkson, 2003). In market-oriented businesses, such approaches were regarded as expensive, inappropriate, or not useful considering the lack of knowledge towards the users' context and needed investment (Keates & Clarkson, 2003).

Bearing the previously mentioned problems in mind and the necessity to create a more rightful world through design, the term 'Inclusive Design' was born (Steinfeld & Maisel, 2012). Inclusive Design is defined by the British Standards Institute (2005), as cited by Persson and colleagues (2015, p. 5) as "the design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible ... without the need for special adaptation or specialized design." It is worth emphasizing, however, that inclusive design does not intend to be universal. It aims to reach as many users as possible, incorporating different user requirements (Keates & Clarkson, 2003). Inclusive design, thus, implies easy-to-use systems accessible either by older adults or other user groups and user knowledge to identify usability problems that may arise (Czaja et al., 2019).

A 7-level model relative to inclusive design adapted from Keates & Clarkson, (2003) can guide the process, which is summarized in Table 4.

Table 4 - Inclusive Design 7-level Approach. Adapted from Keates & Clarkson (2003).

Level	Problem Requirements	Stage
User Wants and Aspirations	Identification of the problem to be solved	Problem Definition
User Needs	Specify the functionality to be provided	
User Perception	Develop a minimal but sufficient representation of the system status	System Definition
User Cognition	Structure the interaction to match the user's expectations	
User motor function	Develop quality of control and user input	
User Practical Acceptability	Evaluate system functionality, usability, and accessibility	System Validation
User Social Acceptability	Evaluate social acceptability and match to user wants	

The different phases, presented in Table 4, enable designers to adopt the design tools or techniques they find most appropriate for each level and the designed product (Keates & Clarkson, 2003). Keates and Clarkson (2003) draw our attention to 7 levels of inclusive design:

- Level 1 – In the first level, users' needs are acknowledged as a social motivation for the product design.

- Level 2 – Specifications of the required utility of the product are identified. Tools and techniques such as task analysis and user observation can be used in this phase to draw possible features.
- Level 3 – This level is relative to the perceived information about a product. Tools and techniques such as usability and accessibility testing and prototyping can be applied during this phase.
- Level 4 – The match of the product behavior to the user's mental model is assessed. Cognitive walkthroughs can be used in this phase to map the product behavior to what is expected by the user.
- Level 5 – Similarly to level 3, level 5 focuses on the user's input relative to the product.
- Level 6 – The final product is evaluated to ensure satisfactory practical acceptability. Usability and user experience evaluations can be used in this phase.
- Level 7 – In this last level, the resultant product is assessed in terms of the user's needs. Qualitative approaches are generally needed in this phase, such as surveys, interviews, and questionnaires.

According to Donahue (2009), the inclusive design should become embedded in every design practices, being acknowledged as 'thoughtful design', *i.e.* a design that is sensitive to people's needs, mindful of their individual and collective challenges, and well-considered in terms of the process and execution.

Overall, the appropriateness of digital media by senior citizens has (re)invented some of the design methods and workflows to match the products' features to their context. Given that user experience and acceptance of technology is highly dependent on the users' level of involvement in co-designing, the next Chapter covers 'Co-designing User Experiences.'

2. Co-designing User Experiences (UX)

User experience (UX) design involves multidisciplinary knowledge of how people interact with a product. For example, these may be (a) Visual and Tacit knowledge (Polanyi, 1966; Sherwin, Feigenson, & Spiesel, 2007) relative to the way the characteristics of the product are perceived and its affordance (D. A. Norman, 2013) – *e.g. "how it feels to touch*, *how it feels in their hands*, *how it fits into their context"* (Alben, 2001, p.12); (b) Contextual Knowledge and Semiotics (Bowcher, 2018) – *e.g.* "*how it makes sense"*; and (c) Emotional drivers and Behavior (Norman, 2004)– *e.g.* "*what the experience of using is like"* (Alben, 2001, p.12).

User experience has also been closely interrelated with co-design over the past decades (Wiklund et al., 2018). In this sense, user's experiences also contribute to the knowledge of product design, making the consumers experts on the matter as long as the designer aims to provide a good user experience and, therefore, involve the end-users in the design process (Kouprie & Visser, 2009). The designer's role, then, changes from being a mere translator of the virtual user's cognitive model to a facilitator of co-design processes that often rely on the development of toolkits in the end-users' ideation and expression (Sanders & Stappers, 2008).

Such experiences emerge from a number of activities and interactions with the products, platforms, or services, being rich and vivid memories part of their essence (Campos et al., 2016). In fact, co-designing user experiences is relative to the end-users' interaction with service providers, or a number of personalized settings (Mathis et al., 2016). Prahalad and Ramaswamy (2004) draw our attention to these co-designed experiences as the foundation for value and innovation-led products or services. Hence, organizations must foster an "experience network", enabling users to co-design and personalize their experiences (Prahalad & Ramaswamy, 2004, p.5). Similarly, Wiklund and colleagues (2018) point out that designers should move from explorations of current end-products to the co-design of future enjoyable experiences.

Given the importance of co-design to enhance the user experience and the challenges posed to UX designers, the following subsections will delve into different areas of Experience Design (*i.e.* Information Architecture Design, Interaction, and Visual Design), the techniques used in co-design, and the designer-user roles, the Design Thinking Process and different evaluation methods.

2.1. User Experience Design

The concept of User Experience (UX) has been adopted as a design goal, a philosophy, or/and methodology by many designers (Schifferstein & Hekkert, 2008). As a matter of fact, the increasing advances in Information and Communication Technologies and its omnipresence and ubiquity in the end-users' daily life have led to increased interest

in UX design and study through the lens of Graphic Design, Interaction design, Product Design, Marketing, among others (Kou & Gray, 2019).

User experience is defined in the International Organization for Standardization (ISO) standard (ISO 9241-210:2010) as "a person's perceptions and responses resulting from the use and/or anticipated use of a product, system, or service" ("ISO 9241-210:2010(En), Ergonomics of Human-System Interaction — Part 210: Human-Centred Design for Interactive Systems," n.d.).

Hassenzahl (2008, p. 2) adds that User Experience is a "momentary, primarily evaluative feeling (good-bad) while interacting with a product or service". This author also identifies two different UX dimensions of interactive artifacts: hedonic and pragmatic. Hedonic quality refers to the users' perception of the product's function to meet basic Human needs. In contrast, the pragmatic dimension embodies usability aspects, being related to the products' role to help the users to achieve their goals of use.

Moreover, (Schrepp, Hinderks, & Thomaschewski, 2017) establish six UX dimensions applied in a UEQ (User Experience Questionnaire), being: (a) Attractiveness - impression of the product; (b) Perspicuity – Familiarity with a product/Product easy and clear; (c) Efficiency – Users can do their tasks without much effort in a fast and, efficient and practical way; (d) Dependability – Users feel like they are in control; (e) Stimulation - s it exciting, fun and motivating to use the product; and (f) Novelty – The product is innovative and creative, capturing users attention. Out of those UX dimensions, dependability, perspicuity and efficiency belong to the pragmatic quality mentioned by Hassenzahl (2008), Whereas stimulation and novelty belong to the hedonic dimensions and attractiveness is a dimension of valency (Schrepp et al., 2017).

UX is also emotionally changeable (Hassenzahl, 2008) in a way that it combines visceral, behavioral, and reflective design (Norman, 2004). Whereas visceral design refers to the Human's sense to judge the product based on its appearance, the behavior is relative to the experience and pleasure in use, and reflective design refers to the self-conscious, memories, and satisfaction that are aroused while using the product. Therefore, product design should not only be evaluable after users' interaction with a product but also prior to and during the interaction. In addition, users' values are likely to affect their experiences when interacting with products and/or services, and, hence, they should be considered from the beginning of product design (Hussain et al., 2018).

There have been various attempts (e.g. Alben, 1996; Norman & Nielsen, n.d.) to define user experience, but a consensus of its meaning is still lacking (Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009). Tokkonen and Saariluoma (2013) point out that the difficulty to define UX precisely may be owed to the different backgrounds of researchers who give noteworthy contributions to the field – *e.g.* engineering, marketing, sociology, and psychology, which lead to different concepts and methods. Design researchers also acknowledge the fact that experiencing is a matter of subjective and individual or collective

perception without knowing exactly what occurs in another person's mindset and what their experience would be or feel like (Buchenau & Suri, 2000).

In order to achieve good user experiences, designers need to be aware and create empathy for sensory experiences, emotions and actions, values, and meaning towards products and inherit sociocultural contexts (Buchenau & Suri, 2000). For Cooper and colleagues (2014), a design project embodies a number of subjects focused on form, behavior, and content and the union of the three sets result in an appropriate user experience (Cooper et al., 2014). Figure 3 demonstrates the logical relations between the subjects of architecture design, interaction design, and visual design.

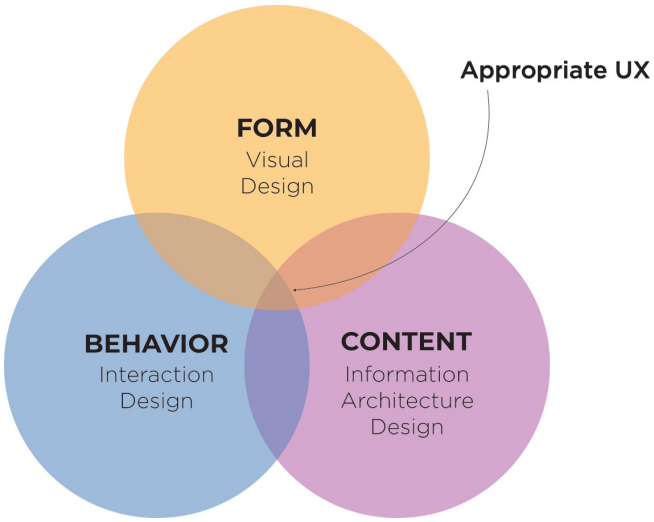


Figure 3 - Subjects of the User Experience - Adapted from "About Face - Fourth edition" (Cooper et al., 2014).

Each subject represented in the Venn diagram shown in Figure 3 will be described in the following sub-sections.

2.1.1. Information Architecture Design

According to Morville and colleagues (2014), organization systems can be divided into organization schemes and organization structures. In terms of an organization scheme, it refers to a set of common items that are grouped following either an exact "objective" or an ambiguous "subjective" scheme.

- Exact organization schemes refer to the way information is enlisted following a pre-determined order. Examples of frequently used orders are alphabetical, chronological, and geographical (*e.g.* Country names are usually listed in alphabetical order).
- Ambiguous or "subjective" organization schemes are based on categories. In other words, information is grouped accordingly with previous decisions made within the

system. Related items are grouped, following associative learning and reinforcing the users' self-made connections and interpretations.

Although ambiguous organization schemes rely mostly on subjectivity, they have shown to be more effective than exact schemes, when searching and retrieving the information. The benefits of using ambiguous organization schemes are provided in Table 5 (Morville, Rosenfeld, & Arango, 2015).

Table 5 - Ambiguous organization schemes.

Topical organization	The information is organized based on the subject or a related topic.
Task-oriented	The organization of the information is made through the use of the following classifiers: processes, functions, or tasks.
Audience-specific	The information on a website or other digital platform is divided into smaller units of data that are spreadable in audience-specific mini-websites. That way, webpages are clutter-free pages, showing only information to the users that interest them the most.
Metaphor-driven	Interface metaphors can ease the end-users' access to the information.
Hybrid	Many web pages combine both topics and tasks, having a global navigation user interface (UI).

As shown in Table 1, organization schemes are essential in Information Architecture, and they may include hierarchy, a database-oriented model, and hypertext (Morville et al., 2015). Hierarchies organize information simply through the use of indentation, proximity, and contrast. Databases are used to facilitate information retrieval and hypertext establishes interconnections between different pieces of information (Morville et al., 2015).

Labels categorize content, using easy-to-understand language, clarifications, and explanations. Two formats of labels are regularly found: textual and iconic.

Examples of textual labels include:

- Contextual links: Hyperlinks to chunks of information that can be used either as anchors within the same page or references to another webpage;
- Headings: Labels that categorize the content that follows, *e.g.* print headings;
- Navigation system choices: Labels representing options in navigation systems; and
- Index terms: Keywords, tags, and subject headings are used to facilitate content search or browse;

Icons can also be used to represent information, although they are highly dependent on the end-users' context, culture, and repertoire to understand its true meaning (Morville et al., 2015).

Beyond labeling, a navigation system plays a crucial role in shaping user experiences on the Web. Navigation may ease the access to information (findability) and understanding of the information while giving visibility to the brand and ensuring the overall credibility of a website (Kalbach, 2007). For Morville and colleagues (2015), navigation systems encompass the following sub-systems: (1) Global, local, and contextual navigation systems; (2) Supplemental navigation systems; and (3) Search systems.

(1) ***Global, local, and contextual navigation systems*** place the website pages or app information in context. In the case of global navigation systems, they are often shown on every single webpage *e.g.* a navigation bar. Local navigation systems are relative to a specific area, acting as complements to global navigation systems. Lastly, contextual navigation is a reference to specific pages, documents, or objects, *e.g.* "See also" hyperlink to a detailed page about a product or service (Morville et al., 2015).

(2) **S*upplemental navigation systems*** embody site maps, indexes, and guides (Morville et al., 2015). A site map represents the website's structure mostly divided into two to three levels, guiding the user to each webpage (Kalbach, 2007). Indexes do not provide entry points, presenting keywords or phrases alphabetically, whereas guides may include guided tours, tutorials, and walk-throughs directed towards a specific audience, topic, or task. They are often used on onboarding, guiding new users to the website's main features (Kalbach, 2007; Morville et al., 2015).

(3) Finally, a ***search system*** is essential for finding information. Content, time, and know-how are needed to optimize the search systems and ways of interaction (Morville et al., 2015).

In view of all that has been mentioned so far, information architecture is related to the way the end-user navigates, groups, and accesses the information. Considering that Information Architecture depends highly on the users' behavior about the information, the co-design card sorting technique is often employed to understand the way they group the information in different subsets and discuss its criteria. This co-design technique that intends to validate IA will be further explained in section 2.2.

2.1.2. Interaction Design

The developments in technology-driven products over the past years (*e.g.,* the use of Natural User Interfaces, Virtual Reality in game-playing) have been attracting a lot of interest. While in the earliest years of HCI studies the primary focus was on the product and work efficiency and productivity, interaction design is now challenged by designing products that provide the following characteristics: being satisfying, enjoyable, fun, entertaining, helpful, motivating aesthetically pleasing, supportive of creativity rewarding and emotionally fulfilling (Preece et al., 2015, p. 18).

From a holistic perspective, interaction design is centered on the relationship established between the end-users and the designed artifacts, within a sociocultural and business context (Löwgren, 2002). Interaction Design is also likely to affect end-users' everydayness and labor through the users' experiences and communication (Preece et al., 2015). It involves both creating product interfaces and considering different modes of interaction and dialogue structures between the end-users and the system (Preece et al., 2015). Many competencies such as graphic design, engineering, programming, or Human psychology (Lotz & Sharp, 2020) are, therefore, needed to succeed (Preece et al., 2015).

Nielsen (1994) introduces ten design heuristics to take into consideration while interaction designing, to improve usability:

1. Visibility of system status, *i.e.* always keep the users informed about what is going on by providing them appropriate feedback in a reasonable time.
2. Match between system and the real world, *i.e.* speak users' language by employing words, phrases, and concepts that are familiar to the users, rather than system-oriented terms.
3. User control and freedom, *i.e.* support undo and redo and provide ways of allowing users to exit places they unexpectedly find themselves in, by using marked 'emergency exits'.
4. Consistency and Standards, *i.e.* avoid making users wonder whether different words, situations, or actions mean the same thing.
5. Error prevention, *i.e.* prevent errors from occurring and present users with a confirmation option before they commit to the action to avoid errors.
6. Recognition rather than recall, *i.e.* make objects, actions, and options visible to minimize users' memory load.
7. Flexibility and efficiency of use, *i.e.* provide accelerators, invisible to novice users, that offer more experienced users to carry out tasks faster.
8. Aesthetic and minimalist design, *i.e.* Information irrelevant and not needed should be avoided.
9. Help users recognize, diagnose, and recover from errors, *i.e.* display error messages, in languages that users understand, indicating the problem and a solution.
10. Help and documentation, *i.e.* provide information that can be easily searched and help in a set of concrete small steps.

According to Dix and colleagues (2016), the process of Interaction Designing follows four phases: 1. Establishing Requirements, 2. Analysis, 3. Design, and 4.Implementation and Deploy. Figure 4 shows the design process focused on Interaction Design.

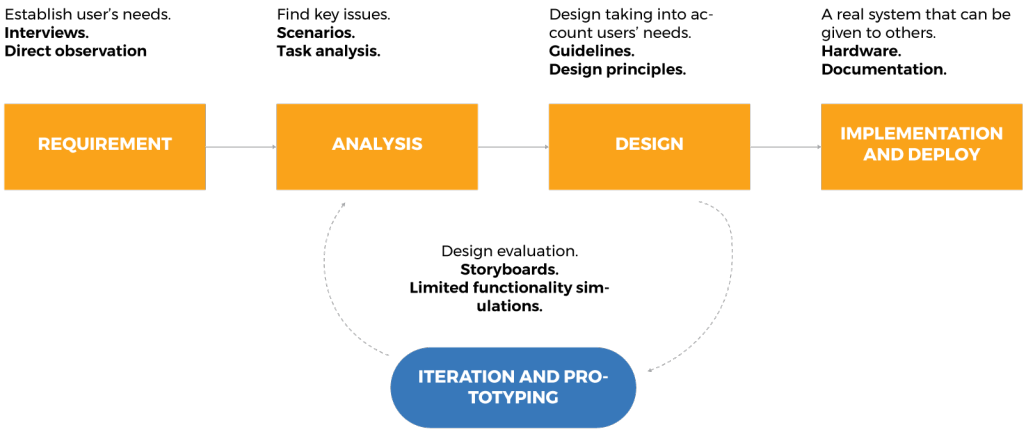


Figure 4 - Design process focused on interaction design. Adapted from Human–Computer Interaction - Third Edition (Dix et al., 2016).

As shown in Figure 4, a sequential linear process is followed by the requirement definition to the implementation and deployment. Both the analysis and design phases involve prototyping and evaluation before implementation and deployment can be performed through the use of storyboards and simulations (Dix et al., 2016).

In the Requirements phase (1), the users' needs are defined by, for example, interviewing the end-users and using direct observation. Analysis (2) of the results obtained during the Requirements phase unravel key behavior patterns that are later used in communication design. Such techniques as scenario-building and task analysis anticipate the Design phase (3), in which rules, guidelines, and design principles based on the users' needs are established. Finally, Implementation and deployment phase involves coding, hardware and documentation, and manuals.

Besides these phases, Dix and colleagues (2016) draw our attention to an iteration loop that will certainly occur during analysis and design, involving both iterative design (re) assessments and prototyping (c.f. Figure 4).

In the same vein, Cooper and colleagues (2014) highlight the following interaction design principles: (a) Conceptual principles, (b) Behavioral principles, and (c) Interface-level principles. Conceptual principles (a) help to define a set of characteristics of a product and the user requirements within a certain context of use. Behavioral principles (b) determine the behaviors associated with the use of a product in specific contexts and (c) Interface-level principles are allusive to the effectiveness of the user interface to communicate the organization's vision and meet the users' behavior.

Considering these phases and design principles, one may suppose that for deciding the most appropriate interaction for presenting certain pieces of information within different contexts, the following journey is necessary: (a) Do Desktop research for

determining the requirements to meet the product characteristics to the users' motivations, drivers and personality; (b) Communicate the design to all the stakeholders involving, for example, brainstorming and mockups; and (c) Publish and maintain the end-users' interactions with the product. Having presented the design process of the user's interaction with content, product features, and functionalities, the next section will focus on visual design.

2.1.3. Visual Design

In visual design, the basic visual properties — color, typography, form, and composition are in focus and the designer will balance them to effectively convey the message to be transmitted, arousing certain users' mood and visceral responses that may subsequently have an impact on users' decisions and behaviors (Cooper et al., 2014).

According to Cooper et al. (2014) and Krug (2017), a successful visual designed solution is dependent on several design decisions that contain the context of use, shapes, size, color, orientation, texture, position, text, and typography, information hierarchy, motion, and change over time. These elements are characterized in the following table – cf. Table 6.

Visual design is also determined by the understanding of how the Human eye and perception work beyond its implications on the organization of design elements (Hashimoto & Clayton, 2009). Watzman and Re (2020) identify three visual communication principles based on the Laws of Gestalt Theory: Harmony, Balance, and Simplicity. Harmony occurs when the sum of different parts is perceived as a single unit. Balance brings stability in the design by ensuring the harmony of various visual elements. Finally, Simplicity refers to the perceived easiness of use, making the design accessible and approachable.

Table 6 - Systematization of Visual Interface Design elements

Context	The context of use when interacting with a product has an impact on the visual guidelines to be adopted.
Shape	The shape is one of the most basic elements that materialize an idea and cognitive model into the representation of an artifact. Caution must be taken, however, when using shapes because that distinguishing different shapes demand a higher level of attention rather than distinguishing other properties, such as color or size.
Size	Size is often used to communicate hierarchy relations of different elements.
Color	Color is another element that is used to establish a mood and interconnection with the users' goals, environment, content, and define the product identity and brand.
Orientation	Orientation communicates the idea of the movement of different design elements.

Table 6 - Systematization of Visual Interface Design elements (cont.).

Texture	Texture may act as affordance visual cue and call to actions, *e.g.* saliency - bevel or drop shadow on a button makes it seem more clickable.
Position	Position can communicate different relations between elements – proximity, hierarchy, and depth
Text and typography	High contrast is used to ensure readability and it can be also used in typeface and size to establish, for example, hierarchy relationships. Sans-serif fonts often ensure readability and type sizes should be more than 10 pixels. Relative to the text messages, they should be concise, and abbreviations should be avoided.
Information hierarchy	Information scanning tends to be slower if there is no information hierarchy in the design in comparison with hierarchy used based on size, proximity, or typography contrast. Designing Information Hierarchy implies outlining: (1) important prominent information; (b) visually interconnected information; and (3) visually "nested" content.
Motion and change over time	The 10 mentioned characteristics can change over time either to convey information or the relationship established between different parts of information, guiding the user's attention through the additional use of animations, media, and effects.

As aforementioned, those principles can be explained by Gestalt Theory laws (Chang, Dooley, & Tuovinen, 2002), founded in 1910 by three German psychologists, Max Wertheimer, Kurt Koffka, and Wolfgang Köhler. Indeed, Gestalt Theory defends the idea that Humans try to find a pattern in the relation of isolated elements, always trying to group and interconnect different pieces of information (Hashimoto & Clayton, 2009). Chang and colleagues (2002) identify eleven Laws of Gestalt Theory, having significant implications for the design of user interfaces, as illustrated in the table below – cf. Table 7.

Table 7- Summary of eleven Laws of Gestalt Theory.

Law of Balance/Symmetry	An important visual technique is to ensure a balance between different elements that can be achieved by symmetry (formal balance) or a visual equilibrium with an asymmetrical composition (visual weight).
Law of Continuation	Considering that the Human brain tends to be addicted to patterns and establish connections, this law applies to the perceived capacity of grouping elements that are together as a single unit and determine a direction relative to the represented lines, curves, and shapes.

Table 7 - Summary of eleven Laws of Gestalt Theory (cont.)

Law of Closure	Based on the aforementioned addiction of the Human brains to detect patterns, conflict is likely to occur when a visual pattern is incomplete, and attempts are made to complete and closure.
Law of Figure-Ground	This law refers to the Human perception of a figure in comparison with its background. Size, contrast, and colors used are some of the elements that can affect this distinction or embeddedness of the elements in the background.
Law of Focal Point	In this law, the emphasis is given to different elements through the use of a visual predominant element – e.g. size, color, space, pattern… to capture the viewer's attention.
Law of Isomorphic Correspondence	The images and designed elements are perceived as a result of past experiences.
Law of Prägnanz (Good Form)	When presenting ambiguous elements, fewer elements and symmetrical compositions are perceived as the simplest instead of its complexity. That way, little cognitive effort is required.
Law of Proximity	The closer the elements are, the more they seem to be interrelated, whereas the further they are the more unrelated they are.
Law of Similarity	Similar elements are grouped and perceived as complete or belonging to each other.
Law of Simplicity	The Laws of Simplicity are evoked by John Maeda (2006) and these can be summarized as follows: 1.REDUCE elements/information; 2. ORGANIZE elements in order to be perceived as a single unit; 3. Save in TIME; 4. Ensure LEARNability; 5. Embrace DIFFERENCES (Simplicity and complexity are interdependent), 6. CONTEXT also influences simplicity; 7. EMOTION; 8.TRUST; 9. Inevitable FAILURE; and 10. THE ONE by intertwining simplicity and meaning.
Law of Unity/Harmony	In this law, the viewer perceives parts of visuals with the same forms as related whereas separated elements are perceived as not related.

These eleven Laws of Gestalt Theory are essential to facilitate communication and provide an aesthetically pleasing experience (Hashimoto & Clayton, 2009).

Overall, visual design interconnects interaction and information design, having an important role to provide visual cues, look and feel, and direct the attention of the end-users to certain features of the digital platforms. The Visual design integrates mood boards, pattern libraries, tones of voice and content, branding guidelines (e.g. Neumeier, 2005), usability heuristics (e.g. Nielsen, 1994), among others.

2.2. Co-design

Participatory Design (or co-design) dates back to the 1970s when Scandinavian workplace democracy movements took place (King, 2019; Muller & Kuhn, 1993; Ventura & Talamo, 2016a). In co-design, the expertise and daily-life practices of the end-users are considered as well as the role and meaning of technology to support them (Maa & Buchmuller, 2018).

The Co-Design method implies the involvement, active participation, and collaboration of researchers, designers, developers, potential customers, and users, among other stakeholders in the design process (Muller & Kuhn, 1993; Sanders & Stappers, 2008). Whereas product design and assessment are usually based on the users' cognitive model and the designer's assumption of their behaviors, co-design involves different stakeholders in the process from its beginning (Muller & Kuhn, 1993; Pejner, De Morais, Lundström, Laurell, & Skärsäter, 2019).

According to Reddy and colleagues (2019), there are three main reasons for involving the stakeholders and interfering with the design process:

1) Bring relevancy to the UX Research (Burns et al., 2016; Reddy et al., 2019): A match between the users' needs and the product or service features can be ensured by early focusing on the end-users' context and, subsequently, decrease the margin for failure and inherited efforts and costs (Steen, Manschot, & de Koning, 2011);
2) Provide a sense of ownership and accountability of the stakeholders relative to product design and development (Burns et al., 2016; Reddy et al., 2019); and
3) Strengthen social networks and community involvement through the contact and collaboration between organizations and all the stakeholders (Jagosh et al., 2012; Muller & Kuhn, 1993).

In addition, a co-design experience often helps to unravel the end-users' unmet or unrecognized needs that cannot be anticipated with previous assumptions of their behaviors and cognitive models (Yuk King, 2019).

Sanders (1999) highlights the importance of co-design in 'making' and reinforcing designers-users' partnership, instead of opting for design approaches that prioritize 'saying' and 'jump quickly into doing.' In User Interviews, users' "sayings" can be interpreted, and self-expression can be analyzed. User observation can also provide further insights into the users' interaction with products or services and such techniques as creative workshops can foster the stakeholders' connectedness with a product, exploring their needs and proposing solutions to a scenario-based challenge.

Given the considerable number of the co-design techniques that can be applied for different purposes, the following subsection (2.2.1. Co-design techniques used with senior citizens) provides an overview of a set of co-design techniques that have been adopted with the group of senior citizens that have been published in Scopus, Web of Science and

Google Scholar databases from Jan 2015 to March 2020. The Google Scholar database was searched in order to include "grey literature"- *i.e.* white papers with examples of market-oriented techniques that might fall out of the scope of commercial academic publishers (Haddaway, Collins, Coughlin, & Kirk, 2015).

The systematic literature review "Co-designing with Senior Citizens: A Systematic Literature Review" (Machado, Costa, & Mealha, 2021) was accepted to be published in the conference proceedings of the 23rd International Conference On Human-Computer Interaction (HCII2021).

The following search terms were used: "co-design" OR "Participatory design" OR "collaborative design" AND ("senior" OR "senior citizen" OR elder OR "older adult"). This search yielded potentially 534 eligible articles (see Appendix 1 – PRISMA Flow Diagram). The inclusion criteria used to select candidate articles were: (a) being peer-reviewed articles published between 2015 and 2020; (b) target the group of senior citizens and involve them in the design process. The search was limited to the last 5 years to understand the most recent developments in the field. From these articles, non-English or Portuguese, duplicated, and with no full access were excluded – yielding a sample of 146 articles. In addition, publications that only covered co-design with caregivers or were centered on attempts to construct personas based on the user's cognitive model were also excluded. Results were analyzed in terms of the aim, sample and methods/instruments used in each study. They are presented in Appendix 2 – Systematic Literature Review Summary.

Moreover, the designer and user roles in the co-design process are discussed in subsection 2.2.2., in which biases and subjectivity concerns may arise.

2.2.1. Co-design techniques used with senior citizens

As previously mentioned, the present chapter presents the results of a systematic literature review and the description of different techniques approached in those studies, as well as their results, in order to understand the most used co-design techniques in the last six years, and their effectiveness.

In the reviewed studies, co-design was conducted having senior citizens as the primary target group, however, some studies involved secondary users such as caregivers, health staff, and other family members (*e.g.* Chui et al., 2017; Raju, 2018; Sadler et al., 2017)). Since the aim of this research is to determine the co-design techniques applied with senior citizens, the activities conducted with other target groups were not taken into consideration. In addition, since the aging process is not the same for everyone and leads to different physiological, psychological, and social changes (see chapter 1.3) (Czaja et al., 2019), there are representations of senior citizens of diverse backgrounds, *i.e.* adult learners (e.g. Righi et al., 2018); adults living in care homes (e.g. Campos et al., 2015), or having some sort of health issue like cognitive impairments and hearing difficulties (e.g. Nielsen et al., 2018b), or having low income and limited education (e.g. Lee et al., 2017), among others.

The systematic literature review articles eligible for the study (summarized in Appendix 2 – Systematic Literature Review Summary) present several co-design techniques, being most of them qualitative. Most studies were conducted in the form of group workshops/co-design sessions (n = 64) (*e.g.* Kim & Fadem, 2018; Martin-Hammond et al., 2018; Tsekleves et al., 2020; Veloso & Costa, 2015), in which the future workshop technique is mentioned (see Çarçani & Mörtberg, 2018).

The following techniques are referred: interviews (n = 68) (*e.g.* Amado et al., 2019; Brookfield et al., 2020; Harrington et al., 2018; Malmborg et al., 2016); focus groups (n = 30) (*e.g.* Caravau et al., 2017; Doppler et al., 2018; Juel et al., 2020); questionnaire surveying (n = 18) (*e.g.* Kim & Fadem, 2018; Li, 2020; Mehrotra et al., 2016; Orzeszek et al., 2017) and questionnaires administration (n = 22) (*e.g.* Gomes et al., 2018; Silva et al., 2018; Volkmann et al., 2019); low-fidelity and paper prototyping (n = 21); and activities involving scenario building (n = 15), often combined with personas creation (n = 8) (*e.g.* Cahill et al., 2017); and storytelling (see Righi et al., 2018). Card sorting games (n = 13) (*e.g.* Tsekleves et al., 2020; Wiklund-Axelsson et al., 2017); and cultural probes (n = 10) (*e.g.* Wiklund Axelsson et al., 2016; Panek et al., 2017)) are the most cited as common.

Furthermore, several articles present multiple of the previously mentioned and other co-design techniques (*e.g.* Easton et al., 2019; Juel et al., 2020; Knowles et al., 2019; Maa & Buchmuller, 2018; Muriana & Hornung, 2017; Reddy et al., 2019; Tsekleves et al., 2020). For instance, Muriana and Hornung (2017) make use of different co-design techniques – collages, storytelling, interaction with a paper prototype and an interactive prototype, user evaluation - in order to better understand how to properly engage senior citizens, with or without cognitive impairment, on the construction of a low-fidelity prototype. On the same note, Maa & Buchmuller (2018) conducted four workshops aiming to apply cultural probes and discuss them, using for that matter, other co-design techniques like interviews, personas and storyboards, and paper and digital prototype evaluation.

The previously mentioned techniques can be used depending on the time of the development life cycle, the participants involved and purpose, and the appropriate group sizes for the practice (Yamauchi, 2012). Moreover, Sanders & Stappers (2014) mention four main phases of the design research process, in which those techniques were the most included: pre-design, generative, evaluative, and post-design. The purpose of pre- and post-design is to understand people's experiences in the context of their past, present, and future lives (*e.g.* survey and questionnaires; interviews and focus groups; cultural probes). During this design research phase, the designer/researcher prepares participants for the co-design activities while creating empathy with them. In the generative research phase, aiming for future scenarios of use and exploration of the design space, participants produce ideas, insights, and concepts to be designed and/or development (*e.g.* low-fidelity and paper prototyping, scenarios, card sorting). The evaluative phase allows assessing the effectiveness of products, spaces, systems, or services (*e.g.* use evaluation). In this phase, the identification of possible problems occurs.

Analyzing the literature review sample, most workshops and co-design sessions were conducted in group settings with small groups of participants (e.g. (Baker, Waycott, Carrasco, Hoang, & Vetere, 2019; A. P. King, 2020)), often dividing the study sample.

While most of the analyzed studies concentrate on one of the phases of product development, some studies engage the senior citizens throughout all the phases (e.g. (Hu & Dong, 2016). According to Merkel and Kucharski (2019) those studies can answer the question of whether co-designed technologies for older adults are superior to those who have been receiving only a few contributions or none.

This subsection presents an overview of the previously mentioned co-design techniques of the systematic literature review, describing the different phases of the design research process that those techniques were most applied, as well as different modes of participation, described in the previous section, that were used to engage senior citizens.

A. Focus Groups and Interviews

Focus groups reunite users in group settings to evaluate products in a group discussion format (Schuler & Namioka, 1993). Designers do not participate directly in the discussion but provide inputs for the topics to be covered by the participants (Schuler & Namioka, 1993).

According to Schuler & Namioka (1993) and based on the conducted systematic literature review, researchers have been exploring the use of other co-design techniques in focus groups (see (Coelho, Rito, Luz, & Duarte, 2015)) to elicit comments to their work, in order to provide an adequate understanding of a certain concept or technology (Schuler & Namioka, 1993).

In semi-structured interviews, the interviewer has a series of open guiding questions about the topics in the study and allows the participants to speak freely about them, directing the interview to its objectives each time the interviewees move away from them and ask questions at the right time (Quivy et al., 1992). In structured interviews, the interviewer has a closed-ended list of questions to follow in a rigorous way, and the same questions are asked to each interviewee in the same order (Quivy et al., 1992).

Analyzing the results of the systematic literature review, although some studies do not specify the type of interview there was conducted, most of the studies seem to have conducted semi-structured interviews (*e.g.* Huisman et al., 2020; Jaakola et al., 2015).

A. Questionnaires

According to Schuler and Namioka (1993), questionnaire surveying involves administering a standard questionnaire to potential or existing users with the intention of determining users' preferences. In a questionnaire, the researcher asks a series of questions – socio-demographic, level of knowledge of a given subject, expectations, and opinions about a certain topic, among others to a set of individuals, who usually represent the study population (Quivy et al., 1992).

Questionnaires allow the quantification of a large number of data and correlation analysis. It can be especially useful to carry out an analysis of social phenomena that are hardly quantified and underexplored (Quivy et al., 1992). Eighteen of the analyzed studies use surveys by questionnaires, either as the only technique (see Goeman, Conway, et al., 2016), or combined with other co-design techniques such as focus groups (see Mehrotra et al., 2016) and were mostly used at the early stages of co-design. An account of 22 studies uses questionnaires in the research (*e.g.* Doppler et al., 2018; Harrington et al., 2018; Orzeszek et al., 2017).

B. Low-fidelity and Paper-prototyping

Prototypes are physical manifestations of ideas or concepts (Sanders & Stappers, 2014). They represent a widespread design technique, particularly in software development, enabling designers and end-users to communicate and eventually agree about the features of a product (Ventura & Talamo, 2016a). They vary from rough (giving the overall idea - as paper prototypes) to finished (resembling the actual result) (Sanders & Stappers, 2014).

Paper prototyping is a method to brainstorm, design, create, test, and communicate user interfaces (Duh, Guna, Pogačnik, & Sodnik, 2016; Osman, Baharin, Ismail, & Jusoff, 2009; Snyder, 2003). End-users work with materials they are familiar with such as papers, pencils, and sticky notes (Duh et al., 2016; Osman et al., 2009; Snyder, 2003). This technique does not require high budgets and as much development time as computer prototyping (Duh et al., 2016; Osman et al., 2009). Therefore, developers are more willing to accept changes to the design (Osman et al., 2009).

However, based on the reviewed studies, according to Duh and colleagues (2016), Muriana and Horning (2017), and Ventura and Talamo (2016a) studies, paper-prototyping is difficult for senior citizens to engage with, as they cannot see it being a real application or service. Interactive prototypes are a better solution to solve that problem even though there can be fewer idea contributions and suggestions for changes (Duh et al., 2016).

C. Scenarios, Personas and Storyboards

A Persona refers to a fictional character who represents the target user and helps designers to consider the user's perspective in the development process

(Grudin & Pruitt, 2002). Most personas are often complemented with scenarios (Maa & Buchmuller, 2018). A scenario is a short story that communicates information from which the product/service requirements are drawn and a persona's goals, desires, and behavior in certain contexts and situations are highlighted (Saurer, Mueller-Gorchs, & Kunze, 2009; Valaitis et al., 2019).

Rosson and Carroll (2002) described four kinds of scenarios that designers can use in the development of a software application in different design phases: Analysis phase - designers study the current practices of stakeholders (1), and perform field studies to generate problem scenarios (2); and Design phase - designers use activity scenarios to introduce concrete ideas about how the user's requirements can be met (3), and create information design scenarios (4), which specify the representations of task's objects and actions that will help users perceive, interpret and make sense of the proposed functionalities.

A storyboard is a series of drawings or images that represent envisioned scenarios on how an interface would be used to accomplish a particular task (Snyder, 2003). According to Gruen (2000), stories and storyboards can anchor design in the end-use; promote innovation by capturing real problems; convey the functionality of a proposed solution, product, or service; help people to understand how they could incorporate new technology in their working practices; among others (Valaitis et al., 2019).

By engaging senior citizens in scenario activities in order to gain insights on how senior citizens plan their budget, Maqbool and Munteanu (2018) results showed that participants had difficulties envisioning a scenario they thought would be unrealistic.

D. Card Sorting Games

Card sorting consists in giving co-design sessions participants' a pack of cards with a concept associated to each card. It is often conducted in groups as it has the advantage of being quicker to carry out and allow more elaborated results gained through the group dynamics (Pazart et al., 2011). By carrying out card sorting activities, the concepts are tangible for the co-design sessions, and participants interact with and create discussion around these concepts (S. Kim & Fadem, 2018).

Different card sorting games were spotted in the analyzed studies. Harrington and colleagues (2019) use card sorting to label images on given cards. Nevay and Lim (2015), use a card sorting exercise to understand the participants preferences. Also, Nevay and Lim (2015), and Harrington and colleagues (2019) draw attention that card sorting games can contain blank cards, in order to encourage participants to prompt ideas and personalize the cards. For transforming a card sorting activity in wearables prototypes, Nevay and Lim (2015, p. 3), noted that "participants commented that the incorporation of blank cards was useful to capture any 'missing' items or design components."

E. Cultural Probes

Cultural Probes consist of self-documentation materials, created by Designers and sent to the end-users with the task of documenting their everyday life or aspects of it (Jarke & Gerhard, 2018; Sanders & Stappers, 2014). Cultural Probes are sent as an individual task, often with little or no guidance, and after completed, they are returned to who sent them out (Sanders & Stappers, 2014). Materials given in Cultural probes are diverse, such as diaries, cameras, packages of maps, and games (Gaver, 1999; Jarke & Gerhard, 2018; Sanders & Stappers, 2014). Those materials were originally designed to provoke inspirational responses from senior citizens in diverse communities, as part of a strategy of pursuing experimental design, on an urge to design for unfamiliar groups (Gaver et al., 1999).

As an example. Shore and colleagues (2018) makes use of a cultural probe pack, constituted by a large wallet with the following materials: mood board and stickers to quickly indicate positive/negative experiences for each day; a scrapbook and glue sticks to do a collage activity of the articles read or noticed; a disposable camera to capture storytelling, and lastly, a notebook for senior citizens to express their thoughts. The authors state that raw data such as photos and videos of users in their homes and individual stories and quotes can be a good way to create empathy and personal connections to the users' experiences. However, according to Nicol and colleagues (2016)' results, in such activities that postcards were given to the participants as cultural probes material, senior citizens were less comfortable with showing their photos and were more likely to show their postcards.

Throughout the studies analyzed, some participants had difficulties with creative activities, such as paper-prototypes, concerned with new technology adoption. Since senior citizens might not be familiar with technologies, it is important to explain the concept of the type of technology we are testing or creating in order for the users to better perceive it and to be able to fully collaborate in it. Some studies included a technology introduction before the co-design activities (e.g. Randall et al., 2018; Vácha & Kandusová, 2018). Clear guidance and explanation of the activities' goals can also help the participants' engagement and interest.

Moreover, despite the techniques conducted, researchers should spend a lot of time creating an informal relationship with senior citizens (see Hornung et al., 2017), building a non-hierarchical relationship with them in order to build a sense of trust (see (Raber et al., 2019)). Likewise, categorization of the participants 'older', 'elder', etc. should be avoided.

Kopeć and colleagues (2018), for example, engage senior citizens in a hackathon, working together with designers. The results of the study showed that senior citizens felt isolated and deserted by the designers and that only one group received the senior citizens in a proper way and involved them in every stage of the product development, leading to a successful product and win the hackathon.

The designer and user roles

Co-design stands in contrast to the cult of the specialist (Schuler & Namioka, 1993). Specialists are likely to lose full power and authority and end-users are given the position of 'expert of his/her experience', playing a large role in knowledge development, idea generation, and concept development (Sanders & Stappers, 2008; Schuler & Namioka, 1993). But in order for them to take on this role, they must be given appropriate tools for expressing themselves (Sanders & Stappers, 2008).

Y. Lee (2008) highlights three participation modes which can be applied to action research projects:

1. Community Participation (CP): Users take control over the design process and designers have the role to give professional pieces of advice;
2. Public Participation (PP): Users only have partial involvement in the design process and designers collect people's opinions for the development of policy or strategies;
3. Design Participation (DP): Users and designers have equal involvement in the design process. Designers aim to develop an innovative design or better design to improve people's lives.

2.3. The Design Thinking Process

Design Thinking (DT) is a cognitive process that aims to create problem-based solutions, in which innovation-led products and services, humanistic user-driven businesses, iterative problem reframing, prototyping, and interdisciplinary teamwork are involved (Combelles, 2020; Hehn, Mendez, Uebernickel, Brenner, & Broy, 2020).

A change from a rational to an analytical paradigm in Design has been witnessed in the 1980s, and since then, a much more solution-focused holistic paradigm has emerged (Tschimmel, 2012) with the purpose of facilitating project task planning, production, and scheduled activities.

Tim Brown, the chair of IDEO, draws attention to a series of actions to be undertaken in the design thinking process in his 2009 Ted Talk.[3] These are 1. Start with Humans; 2. Prioritize Culture and Context-awareness over Ergonomics; 3. Build to Think and Prototype to speed the process; and 4. Evolve from Consumption to Participation. These courses of action encompass dealing with change and new ideas, problem questioning and reframing, divergent thinking and alternatives, rapid prototyping, collaboration, and participation.

[3] Designers – Think Big! https://www.youtube.com/watch?v=UAinLaT42xY&feature=youtu.be (Date accessed 03/05/2020).

According to Brown, Design thinking can be defined as:

> *"Human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success"*
>
> ("IDEO Design Thinking | IDEO | Design Thinking," n.d.).

Considering that understanding problems' complexity and current reality is one of the hallmarks of Design Thinking as suggested in this definition, this is a step-based process. Figure 3 shows the Stanford Design School Design Thinking process (Figure 5).

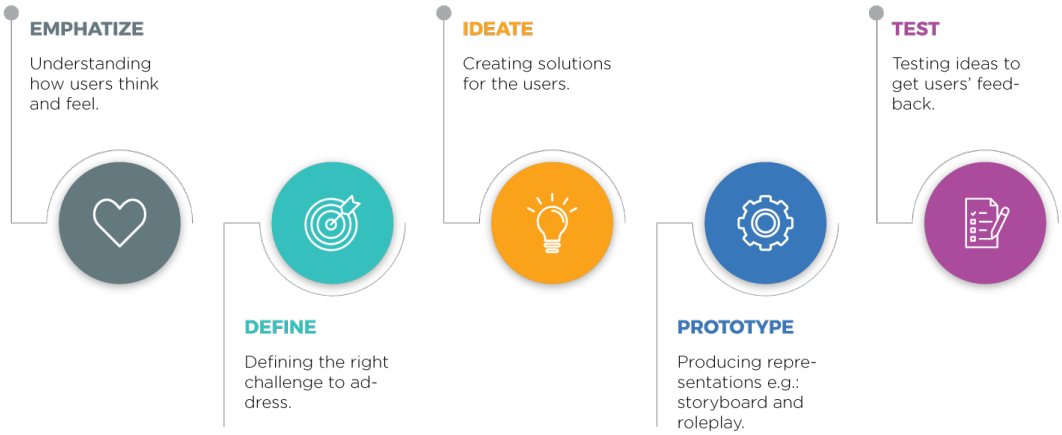


Figure 5 - Stanford Design School Design Thinking process. Adapted from Stanford d.school (n.d.).

Drawing on the Stanford model shown in Figure 5, five stages are proposed (Henriksen, Richardson, & Mehta, 2017):

1. Empathize – Empathic relationships are the basis of Human-centered design, being a start in a design project. In this stage, user needs are assessed through the use of interviews or direct observation;
2. Define – Based on the insights from the Empathize stage, the problem is framed and defined, coming up with ideas and solutions in the Ideation phase;
3. Ideate - In this phase, such techniques as brainstorming, mind-mapping, and sketching are used for developing ideas;
4. Prototype – Prototypes materialize ideas, bringing them to life; and
5. Test – Testing is a way to get feedback from users before releasing a product to the market, through observation or interviews, in order to refine the solutions.

It is worth noting, however, that these stages are not always sequential and can occur iteratively thought the process (Henriksen et al., 2017).

According to Brown & Kātz (2009), the design process often starts with discovering which constraints are important and establishing a framework for evaluating them. Figure 6 illustrates the interrelationship between different constraints for successful ideas.

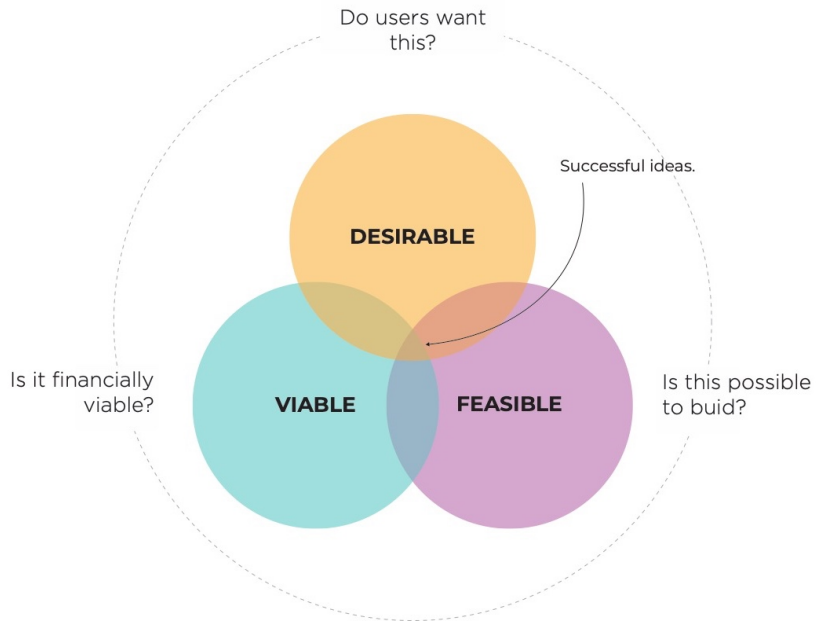


Figure 6 - Constraints for successful ideas - Adapted from "Change By Design" (Brown, 2009).

From the figure above constraints can be best visualized in terms of three overlapping criteria for successful ideas: 1) Feasibility - assessing possible solutions within a foreseeable future; 2) Viability – the added-value of a solution in a sustainable business model; and 3) Desirability - sense-making of a product to people. The design thinker's goal is to balance harmoniously those concepts (Brown, 2009).

Some USA based companies, specialized in technology and innovation, such as IDEO and International Business Machines Corporation (IBM) adopted the concept of Design Thinking into their working practices (Lucena, Braz, Chicoria, & Tizzei, 2017; Sándorová, Repáňová, Palenčíková, & Beták, 2020).

In 2001, IDEO introduced the 3 I's Model (Inspiration, Ideation, Implementation) for the Design Thinking process (Brown, 2009; Tschimmel, 2012). This model is presented in Figure 7.

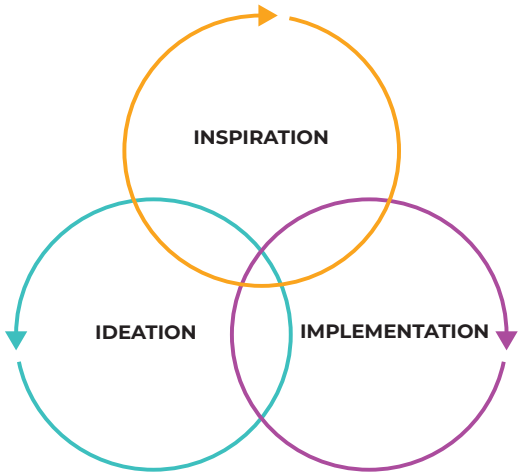


Figure 7. - 3 I's Model - Inspiration, Ideation and Implementation. Adapted from IDEO Design Thinking | IDEO | Design Thinking (n.d.).

The 3 I's – Inspiration, Ideation, and Implementation are interdependent and occur iteratively, as shown in Figure 7. In the Inspiration phase, further insights on a problem are obtained from different sources (Brown, 2009) and the design problems and opportunities are registered in a design brief, combined with direct observation of user behaviors (Tschimmel, 2012).

In Ideation, previous insights are translated into ideas (Brown, 2009). During this phase, complexity is demounted through the use of visual representations of concepts (Tschimmel, 2012), whereas in the last phase of the Design Thinking process, Implementation, the ideas are selected and materialized, designing a plan of action (Brown, 2009).

Similarly, IBM has also been adopting Design Thinking in its practices. The IBM Design Thinking Software Development Framework (Figure 8) is an example that extends Design Thinking principles applied to software development, meeting the user's needs.

The framework in Figure 8 provides the interrelatedness of three principles (*i.e.* Focus on users, Restless reinventions, and Multidisciplinary teams), sharing some similarities with other Design Thinking methods with a few modifications: Hills, Playbacks, and Sponsor Users (Lucena et al., 2017).

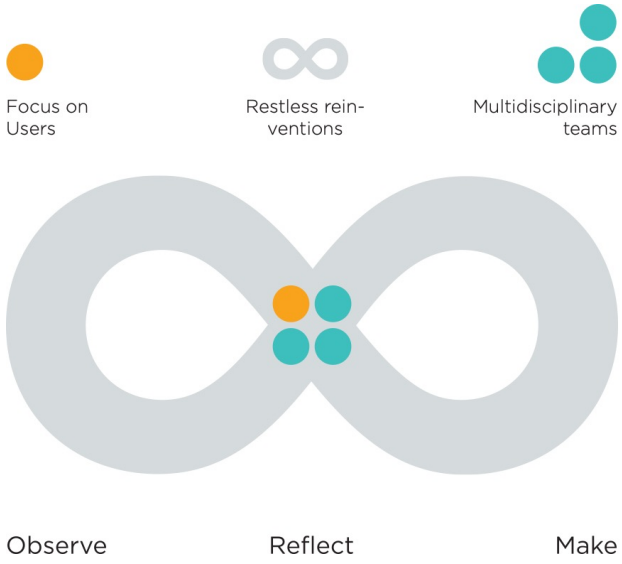


Figure 8 - IBM Design Thinking Development Framework. Adapted from Learn the Enterprise Design Thinking Framework - Enterprise Design Thinking (n.d.).

In specific, Hills are registered statements relative to the user's intent - Who, What, and Wow. Playbacks are relative to the exchange of insights, ideas, and updates in story-based user experiences. Finally, Sponsor users refer to external clients, future clients, or end-users, representing target users ("Learn the Enterprise Design Thinking Framework - Enterprise Design Thinking," n.d.).

Both the IDEO agency (*The Field Guide for Human Center Design - IDEO*, 2015) and IBM ("Design Thinking Activities and Tools - Enterprise Design Thinking," n.d.) provide Design Thinking toolkits, further explained in chapter 5, in which the following activities can lie the foundation for the co-design activities:

(A) Co-creation sessions: By integrating co-creation in the design process, people are being empowered and that is a way to get immediate feedback on ideas. In these sessions, the following materials are used: Pens, Post-its, and Paper. A set of conversation starters are planned, and role-playing can be used;
(B) Role-Playing: This activity can be used to test an idea and scenario for using a product. This technique is usually pre-tested with the design team and check whether the design system meets the users' roles;
(C) Integrate Feedback and Iterate: Take into account the users' feedback on a system by learning from their behaviors (direct observation and listening). Based on this feedback, user stories are shared with the development team and brainstorming, rapid prototyping, or idea refinement can occur;
(D) Generate Empathy Maps: Empathy maps are a way to systemize what the user may Say, Does, Thinks, and Feels based on a persona.

These aforementioned activities can be combined with some of the following techniques (Hanington & Martin, 2017):

(A) Concept Mapping: Organizing ideas, objects, and events in a visual framework. Concept Maps are used to map the interrelationships between general domains that aggregate ideas, objects, or events that share similar meanings;
(B) Affinity Diagramming: Field observations and insights are categorized into themes, synthesizing the users' stories. Color-coded post-its are often used as classifiers of users, tasks, or events;
(C) AEIOU Registration: AEIOU is a framework that aims to facilitate the registry of field observations. AEIOU stands for Activities, Environments, Interactions, Objects, and Users, and these elements are taken into account in the field notes;
(D) Creative toolkits: A set of activities, exercises, and materials can be used to encourage users' interactions with the artifacts and express their thoughts, feelings, and emotions. These can be: Interface kits (represent design features and device interactions), Collage kits (Integrate images and symbols to be subject of interpretation and design inquiry) or drawing kits (Containing papers, cards, writing tools, and exercises);
(E) Cultural Probes: These probes facilitate the communication with the end-users, by gathering users' insights from their everydayness and daily objects. These can be postcards, journals, photos, text combined with observation, interviews, and site visits;
(F) User Journey Maps: These maps represent the journey that results from the users' interaction with a product or service, registering their actions, feelings, perceptions, and mindset in the different stages of their journey and experience.

In sum, co-designing and Design Thinking techniques are important to bring a Humanistic User-design approach to the information, interaction, and visual design of a system. Beyond User Research and Design, Testing is also important. The next subsection covers some of the evaluation methods (2.4. Evaluation Methods) that can be an added value to the User Experience (UX).

2.4. Evaluation Methods

Many approaches have been proposed to assess User Experience Evaluation. Hussain and colleagues (2018) divide these User Experience Evaluation Methods (UXEMs) into three categories: (A) Self-reported measurement, (B) Observational measurement, and (C) Physiological measurement.

A. Self-reported Measurement

In Self-reported Measurement (A), participants report their feelings and thoughts without expert intervention. Emocards and Emofaces (A1) (Desmet et al.,

2001) and the AttrackDiff2 Questionnaire (A2) (Schrepp, Held, & Laugwitz, 2006) are some examples of self-reported measurements (Hussain et al., 2018).

A1. Emocards and Emofaces

Emotions can be difficult to verbalize and describe, being emotional responses often biased by attempts to recognize, recall, and represent them. The authors Desmet and colleagues (2001) present sixteen Emocards cartoon faces with eight distinct emotional expressions to solve that problem, varying from 'pleasantness' to 'arousal.' Each participant can select a card that best expresses their response to the product or put the cards in order of relevancy. That way, cards can be used both as an aid to the expression of emotions and act as conversation-starters.

A2. AttrackDiff2 Questionnaire

AttrackDiff2 is used to assess rapidly the user's expressed feelings, impressions, and attitudes after post-interaction and experience with a product (Hussain et al., 2018). The pleasure of using an interactive product (described in a following section – cf Chapter 3.

User Experience Design may be measured with the semantic deferential AttrakDiff2 questionnaire. This 28-item questionnaire uses a 7-point scale, encompassing such aspects as attractiveness, pragmatic quality, and hedonic quality-stimulation and identity (Schrepp et al., 2006).

Moreover, surveying the end-users, expert reviewing and thinking-aloud protocols can be used for assessing their perceived expectations towards a product (*e.g.* a pre-experience questionnaire about their motivations, reasons) thoughts (*e.g. in situ* think-aloud protocol), and satisfaction (*e.g.* Post-experience Interviews). In specific, these self-report evaluation methods can refer to the Tasks-performed; Interface and Usability issues; Background; Personality; Motivations and Satisfaction or Technology Acceptance.

In the light of the advancements of positive computing (Calvo, 2015), these self-report evaluations have also extended to Psychologically Oriented Experimental Studies, embodying the following aspects: between-subject (*e.g.* experimental and control group) and within-subject tests (*e.g.* pre- and post-evaluation), an independent variable that can be manipulated (*e.g.* using and not using an online community) and dependent measurable variables in order to check whether changes have occurred or not with such experiments (Budiu, 2018).In this type of research design, a randomly selected and large sample is needed in order to ensure a substantial power effect. Nevertheless, control biasing factors such as isolating other factors that may affect the changes obtained or ensuring the same participants in different assessment moments are some of the practical challenges with the adoption of this method.

Beyond User Testing and Expert Reviews, Heuristic Evaluation (Dix et al., 2016) is also relevant in order to assess an interface accordingly with some consensual best recommendations and practices – *e.g.* Shneiderman's Eight Golden Rules of Interface Design (Interaction Design Foundation, 2018) or Nielsen's Ten Heuristics of User Interface (Nielsen, 1994).

B. Observational Measurement

Emotion cues can be also communicated through the use of non-verbal communication (*i.e.* movements of facial muscles) and voice tone. Indeed, observational measurements (B) can be used to register the user's interaction with products, systems, or services (Hussain et al., 2018). FaceReader (B1) (Uyl & Kuilenburg, 2005) is an example of an observational measurement that uses facial expression analysis.

B1. FaceReader

FaceReader tracks facial expression in real-time, enabling the analysis of the user's emotions while interacting with products or software. This analysis is based on gaze direction, head orientation, and person characteristics in order to identify seven emotions: happy, angry, sad, surprised, scared, disgust, and neutral (Uyl & Kuilenburg, 2005).

Observational measurement can also be based on observational analysis frameworks (*e.g.* AEIOU – see 2.3. The Design Thinking Process) or previously established protocols adopted for recording design sessions (B2) – *e.g.* registering place and time, activity goals, description of the activity, and references to the materials used.

C. Physiological Measurement

In physiological measurement, sensors are used to track the user's body physical information (Hussain et al., 2018). Eye Tracking (C1) is mentioned by Ehmke and Wilson (2007) and Hussain and colleagues (2018) as being a powerful technology for physiological measurement (C):

C1. Eye Tracking

In Eye Tracking, eye movement is recorded while stimuli are presented (Ehmke & Wilson, 2007). In an eye-tracking experiment, the light corneal reflection and pupil dilation are tracked in order to recognize eye and gaze moments (c.f. Figure 9) overpassing possible limitations with self-reported or observational data in assessing user's visual attention (locating user's eye positions) and distraction (Hussain et al., 2018).

Duchowski (2017), presents a bottom-up model of the concept of visual attention, stating that vision behaves in a cyclical process composed of the following steps:

1. The user receives a stimulus (*e.g.* an image) and sees the entire scene in parallel through peripherical vision and mostly in low resolution. In this step, interesting features may "pop out".
2. Attention is turned off or disengaged from the foveal location and the eyes are quickly repositioned to the first region that attracted attention.
3. In this step, the eyes have completed their movement and the fovea is directed at the region of interest, and attention is engaged to perceive the feature at high resolution.

Although the interest in eye-tracking dates back to the 1800s, it was in 1947 that eye-tracking became relevant to the area of Human-computer interaction, namely when Paul Fitts started to use eye-tracking in order to study the cockpits interface (Jacob & Karn, 2003). Figure 9 presents a scheme on how eye-tracking monitors eye movements.

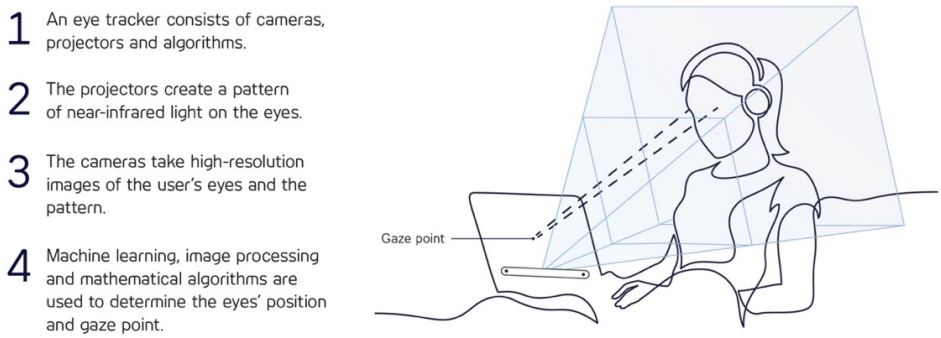


Figure 9 - Eye tracker process. Retrieved from Tobii (2015).

As shown in the scheme, the eye-tracker emits infrared light, recording the light reflection in the retina and, therefore, helping to find the pupil center. This pupil center is tracked in relation to the corneal reflection. Hence, the following data may be monitored with eye-tracking: Saccades (rapid eye movements used in repositioning the fovea to a new location in the visual environment (Duchowski, 2017)) and eye fixations (staring).

Whereas gaze plots may be used to show successive eye fixations and saccades on a webpage, heat maps reveal the looking duration at a screen (Ehmke & Wilson, 2007). Hence, Eye Tracking may unravel scenarios of confusion, attention, reading, and scanning behaviors (Ehmke & Wilson, 2007).

Other physiological measurements can be performed through electrodermal activity (*e.g.* galvanic skin response) with changes in the activity of sweat glands and an indication of moments of excitement (Ehmke & Wilson, 2007). However, these are limited in the way that many factors may be related to those changes, and not necessarily an observed interrelationship with an emotional state of arousal.

The following lessons from evaluation methods emerge from the studies discussed so far: (a) UX Evaluation is fundamental to ensure that the design fits the purpose and users' needs; (b) Expert Evaluation is commonly applied to the initial stages of the development cycle whereas Usability Testing serves to validate interface decisions or refine the design; and (c) The triangulation of different UX evaluation methods (UXEMs) (Self-reported measurement, Observational measurement, and Physiological measurement) strengthens the decisions made towards an interface.

3. Emotions in UX and Social Influence

Emotions and their role in user experience design have been getting attention, originating an increasing amount of scientific papers (e.g. Heerdink et al., 2013; Um et al., 2012) and the adoption of this design strategy by major brands such as Nike[4] and Philips[5] (Desmet et al., n.d.).

As people are emotional beings, products can address their emotions in multiple ways (Desmet et al., n.d.) and even influence the behaviour of other individuals or groups (Heerdink et al., 2013). The following chapter presents the role of emotions in user experience design, as well as social influence.

3.1. Emotions in User Experience Design

Cacioppo and colleagues (2000, p. 173) state that "emotions guide, enrich and ennoble life; they provide meaning to everyday existence; they render the valuation placed on life and property". According to Damásio (2004), emotions are actions or movements, mostly public, occurring in the face, voice, or specific behaviours. The author distinguishes three categories of emotions: background emotions, primary emotions, and social emotions. Damásio (2004) understands background emotions as combinations of simpler regulatory reactions (bodily changes) such as homeostatic processes, pain, and pleasure behaviours. These are not prominent in one's behavior and include emotions subsume states such as enthusiasm, wellness, excitement, tension, and relaxation. Primary emotions are easily identified, including the emotions that first come to mind when thinking about what emotions are *e.g.* fear, anger, surprise, happiness. Social emotional expression and communication can be also socially and culturally influenced *e.g.* sympathy, embarrassment, pride, admiration, envy.

In general, emotions present a strong influence on people's perceived experience of well-being *e.g.* people's evaluation of their own lives. Moreover, emotions can be triggered by a stimulus or 'cultural artifacts' such as clothing, art, and products (Desmet, 2002).

To understand why a product evokes emotions to its users, what particular emotions are evoked, and support designers in the design for emotional responses, Desmet (2002), presents a theory of product emotions - appraisal theory, consisting on three parameters: (1) appraisal - involving an assessment of how an object may harm or benefit a person; (2) concern – it can be regarded as the points of reference of the appraisal process. Finally, products will only evoke emotions if they match or mismatch a concern - (3) a stimulus.

[4] Available at: https://www.nike.com/ (Date accessed: 30-8-2020)
[5] Available at: https://www.philips.pt/ (Date accessed: 30-8-2020)

Despite the subjectivity of emotions, they are universal and people who share concerns and appraisals will experience similar emotions to a product (Desmet et al., 2007). Frijda and Mesquita (1998) argue that when people appraise a stimulus as beneficial to their concerns, they will experience positive emotions and try to approach this particular stimulus. Likewise, when people appraise a stimulus as colliding with their concerns, they will experience negative emotions and try to avoid them.

Moreover, in order to explain and predict emotions, it is crucial to understand the concerns that are relevant to a particular product (Desmet et al., 2007). Ortony and colleagues (1988), developed a typology of human concerns being divided into three types of emotional concerns: goals, standards, and attitudes. Goals, relevant for people's well-being, are event-related concerns and they are often assumed to be structured in a hierarchy ranging between abstract goals or aspirations (*e.g.* the goal to have a successful life or the goal to catch the train). Standards are relevant for our social structures, and consequent well-being, which consist of people's beliefs, norms, or conventions on how they should behave and correspond to states of affairs they believe ought to be (*e.g.* we expect a car to drive). Lastly, attitudes are object-related concerns, representing people's liking or disliking of a certain object or its attributes. Emotional responses related to attitudes are elicited by the appearance of the 'object as such' and not by its usage or by its behavior or functioning.

Furthermore, Donald Norman (2004), a prominent academic in the field of cognitive science, design, and usability engineering, in the book "*Emotional Design: Why we love (or hate) everyday things"* describes the term Emotional Design as a design approach concerned with creating designs that evoke emotions, resulting in positive user experiences.

In "*Emotional Design: Why we love (or hate) everyday things*" Donald Norman (2004) distinguishes 3 cognitive processing levels - visceral, behavioral, and reflective – that designers should approach in order to reach their users' emotions (Norman, 2004).

The visceral level is an unconscious behavior that manages the basic mechanics of the human system. Generally, this level deals with beauty and distinguishes quality from look and feel, and sensory involvement. It involves strong and immediate reactions and a result of an initial sensory scan of the experience (Norman, 2004). On a website, it can be the rapid judgment of the aesthetics of a system, whether it is good or bad, safe or dangerous and whether to approach or avoid (Pengnate & Sarathy, 2017). A positive visceral reaction can set a positive context for subsequent interactions; make users more likely to forgive faults as the initial experience was positive and encourage positive socialization of the product.

The behavioral level, also mostly unconsciously, is concerned with learned behaviors and actions. In specific, behavior design is concerned with the usability of a product, users' perception of how well it functions, and how user-friendly it is (Norman, 2004). On a website, it involves active and task-driven usage (Pengnate & Sarathy, 2017).

A positive behavioral reaction can allow users to feel empowered; cultivate trust and reliability; and encourage repeat actions (D. A. Norman, 2004).

Lastly, the reflective level, conscious, involves higher cognitive functions with complex planning and problem-solving (Norman, 2004). In this level, users can evaluate website informativeness or usefulness (Pengnate & Sarathy, 2017). This level is the most important for the designer, as emotions and memories of longer duration are produced at this level and reflection is what makes users recommend a product (Norman, 2004). A positive reflective reaction can encourage users to share their experiences with others and evoke a sense of pride and identity.

Furthermore, (Norman, 2004) indicates a set of design principles that can be used to create products with emotional impact:

- Personalization and Customization: Offer products users can personalize so they can feel a sense of ownership. Allow users to tailor the experience as an extension and manifestation of themselves.
- Expressive imagery: Use images, illustrations, and animations that users can relate to.
- Positive surprise: evoke emotional reactions by surprising the users.
- Relatable voice: use a tone and voice that speaks with users more humanly and express emotion, empathy, and encouragement through conversational UI.
- Humor: Alleviate fear and uncertainty while evoking a sense of joy;
- Storytelling: Helps people understand the journey of the experience, frame their interactions, and recall their experiences;
- Micro-interactions: Subtle affordances and indicators make interfaces feel more alive and fun, encouraging interaction.

The design of a product, using a set of design principles, and the correct use of interaction design components further explained in chapter 2.1 can not only help induce positive emotions on a visceral level but also affect users' performance and their cognitive process on behavioral and reflective level (Um et al., 2012). According to Um and colleagues (2012), color combination, for example, can help generate positive feelings and arousals of emotions such as pleasure and excitement. Warm colors elicit greater feelings of arousal than cold colors while higher levels of saturation and value influence feelings of excitement and relaxation (Um et al., 2012). Moreover, visual shapes are strongly associated with emotions (Abegaz, 2014). Rounder shapes tend to be associated with a positive effect while angular shapes tend to incite negative effects (Abegaz, 2014).

According to Desmet and colleagues (2001), designers must communicate with users to understand if the product satisfies the users' emotional needs. Emotions can be difficult to verbalize and asking users to describe their emotional response will require cognitive involvement, which might influence the response. Therefore, assessing the users' emotions is better through indirect communication, by using user experiences evaluation methods, such as Emocards and Emofaces – explained in chapter 2.4.

Furthermore, emotions expressed by individuals or groups may influence the behavior of other individuals or groups via the affective process (*e.g.* emotional contagion) or inferential process (*i.e.* individuals use others' emotional expressions to infer information about their motives and intentions) (Heerdink et al., 2013). The following sub-chapter further explains what influence is and the way social influence can impact on individuals.

3.2. Social Influence Theory

Influence is defined by the Oxford dictionary (n.d.) as "the capacity to have an effect on the character, development, or behaviour of someone or something, or the effect itself". Cialdini (2010), states that influence is based on six principles:

1. Reciprocation: people should give to others what they would like to receive. By doing good to others, they are more likely to retribute the favor.
2. Consistency: a high level of consistency is usually associated with personal and intellectual strength. It consists of the power of active, public, and voluntary commitments, resulting in people sticking to their word.
3. Social proof: people rely on social cues from peers on how to think, feel, and act.
4. Liking: people like those who like them or who they perceive as friends. This principle can be used by finding common hobbies or interests with people we want to influence.
5. Authority: if someone is an expert in a certain area, others are more likely to defer to them.
6. Scarcity: as things become scarcer, they become more valuable to others. This can be created by making limited offers or one-time deals.

Social influence, a constituent part of influence, according to (Kelman, 1974, p. 128) "can be said to have occurred whenever a person changes his behaviour as a result of induction by another person or group". Induction occurs whenever a person or a group, deliberately or intentionally, tries to persuade, order, threaten, express expectations, or provide guidelines to someone, originating changes in a person's behaviour (Kelman, 1974). Latané (1981, p. 343), defines social impact (or social influence) as a "great variety of changes in physiological states and subjective feelings, motives and emotions, cognitions and beliefs, values and behavior, that occur in an individual, human or animal, as a result of the real, implied, or imagined presence or actions of other individuals".

Kelman (1974) distinguishes three different processes of influence: compliance, identification, and internalization. Compliance occurs when an individual accepts influence because he/she hopes to achieve a favourable reaction from another person or group, expecting to gain specific rewards or approval and avoid punishments or disapproval. Identification occurs when an individual accepts influence because he/she wants to establish or maintain a satisfying self-defining relationship with another person or group. Finally, internalization occurs when an individual accepts influence because the content of

the induced behaviour is intrinsically rewarding, and the individual considers it useful or in accordance with his/her needs.

In brief, three things should be considered in order to generate a positive influence: (1) an important goal to a person must be activated so that he/she will be responsive to the induction and self-exposition; (2) a person must perceive the influencing agent as relevant for the goal achievement that has been activated so that he/she will be positively oriented to an induction coming from the influencing agent; and (3) the specific behaviour induced has to constitute a sufficiently "distinguished path" so that the person will select it in preference to other available response alternatives (Kelman, 1974).

Moreover, the social influence theory states that people respond to social influence depending on the number (number of people in a group), strength (importance of the group member for the influenced agent), and immediacy (closeness of the group member to the influenced agent) of the actors in a social group (Latané, 1981). Regarding strength, in some cases, closer friends and family may be more important and in others, it might be the collective norm. As for immediacy, family and friends are typically closer than other social network members. However, it is possible that users feel closer to their social network members and identify more with them (Latané, 1981; Osatuyi & Turel, 2019). Yet, according to Latané (1981), strength and influence can be attenuated by the number of people exerting a force on the user. That is, the individual is more likely to be persuaded by the larger source of influence, even if the smaller group of people are important to the individual.

Butler (2001), suggests that communication activities create online social structures that facilitate information exchange, influence social behavior, and reach new users. Individuals use sociability in group settings in order to get information and build relationships. Influencer leaders also tend to occupy more central positions in their surrounding networks and are highly connected with many members of a community or organization.

As people tend to adopt activities that are familiar to the people they are currently interacting with and simultaneously form new interactions as a result of their existing activities (Crandall, Cosley, Huttenlocher, Kleinberg, & Suri, 2008), people in a group setting have the ability to influence the group by, for instance, sparking online dialog and shaping discussions (Huffaker, 2010):

a) The more frequently someone posts messages in a group; the more frequently someone replies to other group members; the longer the time period between someone's earliest and most recent messages:
    - the more replies he/she receives from other members;
    - the longer the chain of conversation of that message;
    - the more words he/she uses will be repeated by other group members.

The next chapter discusses online group social structures in the context of online communities, targeting senior citizens.

4. Senior Online Communities

To understand the importance of online communities to senior citizens, the following chapter begins to explain the senior-community mediated interactions and how they impact senior citizens' quality of life. Then, the concept of online communities is introduced, its lifecycle, and its members. Moreover, a distinction between online communities and social network sites is made and some examples of Senior Online Communities are presented in the last subchapter.

4.1. Senior-Community mediated interactions

Physiological and psychological changes (explained in chapter 1.3), and such factors as retirement and relocation can have several effects on older adults' social relationships (Nimrod, 2010a). Yet, a social and active lifestyle is fundamental for older adults' quality of life as those aspects can reduce the levels of social isolation and mortality, and increase the likelihood of surviving an illness (Due, Holstein, Lund, Modvig, & Avlund, 1999).

In senior communities, interactions have been associated with well-being and negatively related to loneliness (Nezlek, Richardson, Green, & Schatten-Jones, 2002) since communities are described as collectivities of people who share common experiences, interests, or convictions. The community members also tend to experience positive esteems for other members, establishing and nourishing social relationships (Nimrod, 2010b; Sproull & Arriaga, 2012).

States and colleagues (2015) describe a set of best practices to engage senior citizens in senior communities and help to reduce the previously mentioned social problems, being: (1) originality of the idea – the way a community differentiates from others; (2) importance in the context of successful aging of society; (3) financial impact; and (4) experience adoption – activities are transferrable as a new practice in other municipality or community.

Moreover, Internet usage can bring several benefits to older adults, as explained in chapter 1.4. Seniors' online communities are growing and can be beneficial by increasing communication and expanding their social networks, exchanging information, and giving and receiving emotional support (Nimrod, 2010a).

The concept of online communities is further described in the following subsection, as well as its life cycle and member roles (c.f. chapter 4.2).

4.2. Introduction to Online Communities

Before advancements in telecommunications, factors such as birth and location determined the sense of belonging to a community, and its interactions were primarily face-to-face (Preece & Maloney-Krichmar, 2005). With technological growth, low-cost

access to the Internet, and the World Wide Web, there has now increased personal mobility and low costs of communication across distances and, therefore, the previously mentioned factors are no longer determinant to the formation of a community (Plant, 2004; Preece & Maloney-Krichmar, 2005). Given the reasons previously mentioned, and people's desire for connection, knowledge, and information, online communities were formed (Plant, 2004).

According to Preece (2000), online communities consist of: (a) social interaction to satisfy personal needs or preform special roles; (b) a shared purpose that provides a reason for the community such as interest, need, information exchange and service; (c) implicit policies, rituals, protocols, rules, and laws that guide people's interactions; and (d) computer systems to support and mediate social interaction, enabling a sense of togetherness. Online communities imply computer-mediated communication (CMC), defined as a set of human behaviors that are maintained or altered in the exchange of interpersonal information through technological mediation (Wood & Smith, 2004). They may operate through diverse modes of computer-mediated communication such as email lists, newsgroups, interactive sites, social networking sites, or forums/message boards (Nimrod, 2014). Xie (2008) investigated the relationship of the use of three modes of computer-mediated communication – voice chat, forum, and instant messages - and the different types of support exchanged in the senior online community Lao Xiaohai. Whereas the conversation through voice is mostly used as a way to get company, forum messages are mostly used to offer information support and instant messages are used as a way to get emotional support (Xie, 2008).

Besides the "elimination" of the distance between its members (Kim, 2000), online communities may offer many advantages, including accessibility, anonymity, invisibility and status neutralization, greater individual control over time and pace of interactions, an opportunity for multi-conversing, and opportunity for archival search (Nimrod, 2014). Nimrod (2014) presents several personal benefits of the participation of older adults in online communities, summarized in the following table (c.f. Table 8).

Table 8- Benefits of the participation of older adults in online communities.

Service	Benefits that resulted from being able to serve or help others, occupy leadership charges, and have a sense of recognized authority, and skills acquired during the use of a community.
Self-Expression	Benefits associated with a sense of growth and change, as well as a high level of openness and self-disclosure.
Companionship	Benefits such as a chance to make friends quickly depend on other participants for useful information and emotional supports and being considerate of others.
Joyfulness	Benefits that reflected general good feelings and have an easy-going humorous attitude towards life.
Stimulation	Reflected a high level of intellectual and experiential excitement.

Table 8 - Benefits of the participation of older adults in online communities (cont.).

Standing out	Performing, showing off in front of a group, and/or being authentic.
Autonomy	Reflection of the sense of achievement as a result of meeting the challenges of new technology.

Moreover, Nimrod (2010a) quantitative content analysis of 14 leading online communities identifies the main topics discussed in senior online communities being the thirteen main topics, respectively: fun, retirement, family, health, work and studies, recreation, finances, religion, and spirituality, technology, aging, civic and social issues, shopping and travel. Examples of senior online communities and topics discussed are presented in chapter 4.4.

Furthermore, it is important to understand what motivates older adults to use online communities. Abraham Maslow's (1954) hierarchy of needs emphasizes that people are motivated by the urge to satisfy their needs (Bowman & Willis, 2003).

According to Maslow (1954), there are five different levels of needs:

- Physiological needs: food, water, clothes, shelter…
- Safety needs: personal security, employment, finances…
- Social needs: friendship, intimacy, family, connections…
- Esteem: respect, self-esteem, and esteem for others, status, respect…
- Self-actualization: full potential in life is achieved.

These needs are represented in a pyramid, in which at the bottom of the pyramid are the physiological levels and at the top are the psychological and motivational needs. A person can only achieve the highest level in the hierarchy (self-actualization) if the lower levels are fulfilled (Maslow, 1954).

Kim (2000) adapts Maslow's hierarchy to understand the goals and needs of online community members (c.f. Figure 10), using the same levels of needs:

- Physiological system access: the ability to obtain and maintain an identity as part of an online community.
- Safety needs: Protection from hacking and personal attacks; the sense of having a 'level playing field': the ability to maintain varying levels of privacy.
- Social needs: Sense of belonging to a community and its subgroups.
- Esteem: Contribution to the community and recognition by those contributions.
- Self-actualization: Take on a community role that develops skills and opens up new opportunities.

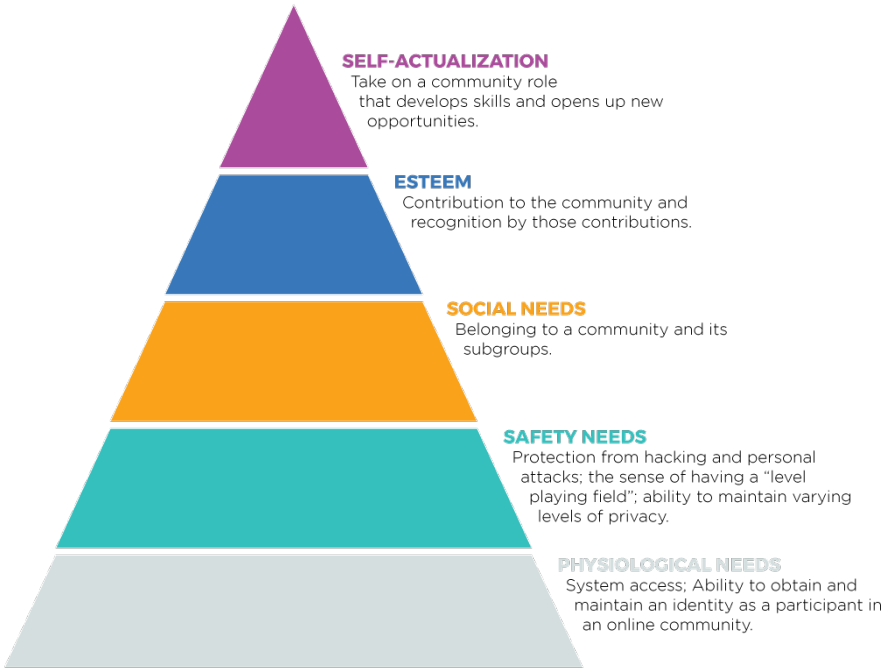


Figure 10 - Motivations and needs of online community users (Kim, 2000). *Adapted from* Bowman & Willis(2003).

4.2.1. The life cycle of Online Communities and members

Online communities evolve in stages, in which developers should work with community members to plan and guide the community's social evolution (Preece, 2000). Iriberri and Leroy (2009) define five stages of the online communities' life cycle:

1. Inception: The vision of the online community is formed according to the type of needs, interests, recreation, and relationship of its members and operators.
2. Creation: The technological components of the online community are developed, and members can start to interact with it.
3. Growth: Enough members have joined the community and their member roles are defined. Moreover, culture and identity for the community begin to develop.
4. Maturity: As the online community matures, there is a need for an explicit and formal organization with regulation, rewards, subgroups, and discussion topics. For some online communities, new members join bringing new ideas, the community is strengthened, and relationships begin to emerge.
5. Death: Some online communities thrive in the Maturity phase, staying in that phase for long periods. However, some online communities' members start to lose interest, resulting in almost no participation, lack of quality content, unorganized contributions, and brief membership.

As explained above, the life cycle of an online community often leads to the abandonment of the community members. Therefore, it is important to know the users and connect the community with its users' needs, goals, and rewards (A. J. Kim, 2000).

Online communities' users often share a set of characteristics such as (Preece & Maloney-Krichmar, 2003): a shared common goal or activity; interaction and bonding with each other; information shared reciprocally; and shared social conventions, language, and protocols.

Additionally, Kim (2000). distinguishes the life cycle of a new member in five main phases: visitor, novice, regular, leader, and elder. The 'visitor' is the new member of the community, who is still not familiarized with it. After the registration, the visitor becomes a 'novice', having to learn what they can do in the community and how to behave. After learning the basics, the novices become 'regular' users, comfortably participating in the community as they already know the environment and perceive its opportunities. The 'leader' is not a cycle that every member will likely reach, they keep the community working, helping new members to learn how to use it. Lastly, the 'elder' function can be reached when leaders stop exerting their function.

Similarly, Preece (2000), identifies six different member roles in communities: moderators, mediators, professional commentators, provocateurs, general participants, and lurkers. Moderators and mediators take important roles in a community (generally mediators take a less active role than moderators) performing activities such as: facilitating the group, managing the list of subscribers, filtering the messages and deciding what to post, answering questions about the community, helping people with general needs and settling disputes amongst participants in the community. Professional commentators bring their expertise to the community, offering opinions and orienting discussions. Participants are users that participate in the discussions. Finally, lurkers never post on a community, usually because they don't understand it, for personal factors, they don't feel the need to post, or it requires too much time.

According to Nielsen (2006), approximately 90% of the users of an online community are lurkers, 9% are participants, who occasionally contribute to the community and only 1% are active users. However, the same member can assume different roles through the life cycle of the community and its interactions (Preece, 2000).

Nielsen (2006) also states that it is unlikely to overcome participation inequality in online communities, but he explains ways to balance it, including making it easy to contribute; make participation a side effect of something people do; let users edit content instead of creating from scratch; reward the users for participating, but not too much, and promote quality contributions.

4.3. Online Communities and Social Network Sites

According to Buss and Strauss (2009), an online community is a website where users develop social relationships, and in that sense, social network sites are also online communities. However, according to Howard (2010), the authors are limiting online communities to the online world, nor recognizing that online communities often take place outside the web, in software games for example. Moreover, Buss and Strauss (2009) do not recognize that the structure of online relationships is different in online communities and social network sites. In social network sites, the user is in the center of the network whereas online communities are not focused on the individual user but in the common interests, values, and communication practices of all users.

In the EU Member States, in 2018, 56% of people aged between 16 and 74 years old used social network sites, a number that is expected to increase. Among senior citizens, aged 65 to 74 years old, 19% participated in social networks (Eurostat, 2019b).

In the United States of America, more senior citizens use social network sites, representing 35% of people aged 65 or older. There is also a growing trend in social network site usage among American adults of all age groups. Although younger adults still use more social media than older adults, social media usage among people aged 65 years old and older, for example, has grown exponentially, registering 11% in 2010 and 35% in 2015 (Perrin, 2015).

Figure 11 presents the American adults' social network site usage by age, from 2005 to 2015.

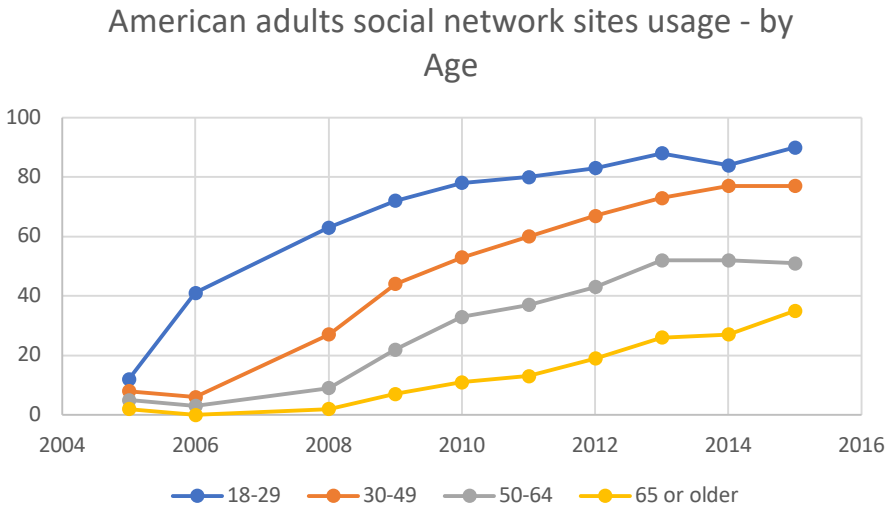


Figure 11 - American adults social media usage by Age. Adapted from Perrin (2015).

Furthermore, in the report "Online Communities: Networks that nurture long-distance relationships and local ties", Pew Internet & American Life Project found that 84%

of American Internet users have participated in online groups and used the Internet to deepen their ties to their local communities and get to know new people with different racial, ethnic, or economic backgrounds (Bowman & Willis, 2003).[6]

Despite their differences, online communities and social network sites both support existing strong ties and the conversion of weak ties to strong ones, requiring long periods of frequent social contact and a strong sense of commitment (Rheingold, 2000). They also foster strong norms of reciprocity, social trust, reputation and social dilemmas to be resolved (Preece, 2000). However, for Howard (2010), since online communities are more well-structured and organized, with social rules and rituals, and its members tend to have more in common, social relationships might be more complex.

4.4. Examples of Senior Online Communities

The following subchapter demonstrates examples of online communities that target senior citizens. The following online communities were mentioned in the literature review (*e.g.* Ferreira, 2013; Nimrod, 2014) and selected according to their designation, homepages, and posts. Each online community was revised in terms of the number of members, and recent posts to ensure there was a recent activity of its members.

Early Retirement

Early Retirement [7] (c.f. Figure 12) is an online forum from the USA, directed for early retired older adults, that allows users to post text and images on forum messages about financial independence, early retirement, and other related issues. This online community allows the customization of the users' profile, the publication of images, and allows the creation and access to social groups. The community also displays a section with important links, frequently asked questions about early retirement, a calendar where events such as the birthday of its members are displayed, and a section of "Today's Posts", where members can see the most recent forum threads.

[6] Statistics on the EU members states of the use of online communities were not found to establish a comparison.

[7] Available at: https://www.early-retirement.org/ (Date accessed: 19/06/2020)

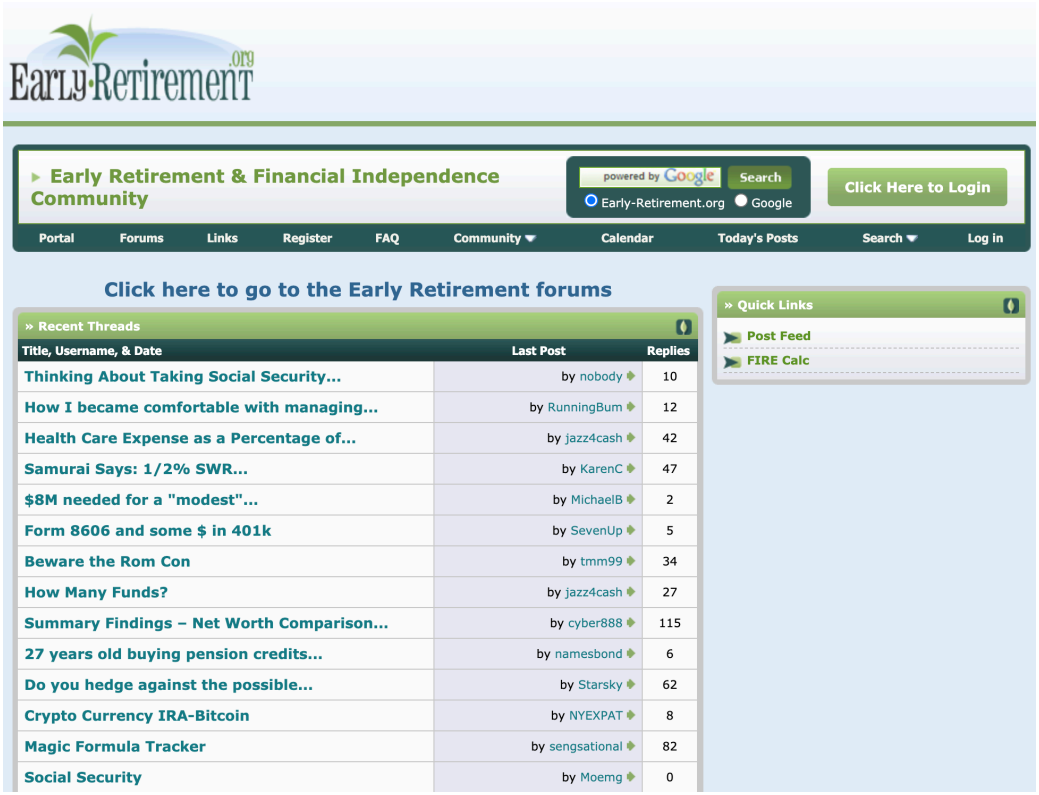


Figure 12 - Early Retirement forum main page.

Pensioners Forum

The Pensioners Forum[8] (c.f. Figure 13) is an online forum from the UK and, similar to Early Retirement, allows users to post in forums, in-text form. This community also displays a calendar to announce events, holidays, and members' birthdays, and profile customization.

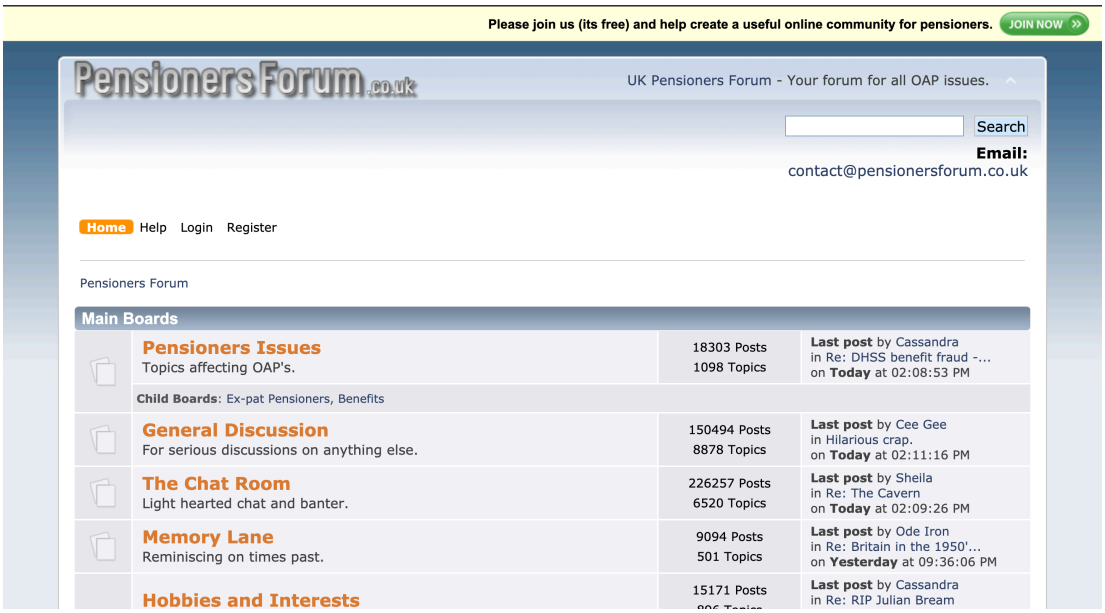


Figure 13 - Pensioners Forum main page.

SeniorNet

The online community SeniorNet[9] (c.f. Figure 14) is concerned with providing informatic classes, for people aged 50 or more, by connecting them with each other and providing a platform for them to share their wisdom on the subject. The platform allows the publication of photos, text, and files, where other users can comment. Users can join groups and search for information through an 'All Topics' section where the technological subjects are divided into categories. Moreover, the platform includes a 'Reputation' status that users will gain by engaging with the community.

[8] Available at: http://www.pensionersforum.co.uk/ (Date accessed: 19/06/2020)
[9] Available at: https://community.seniornet.org/ (Date accessed: 19/06/2020)

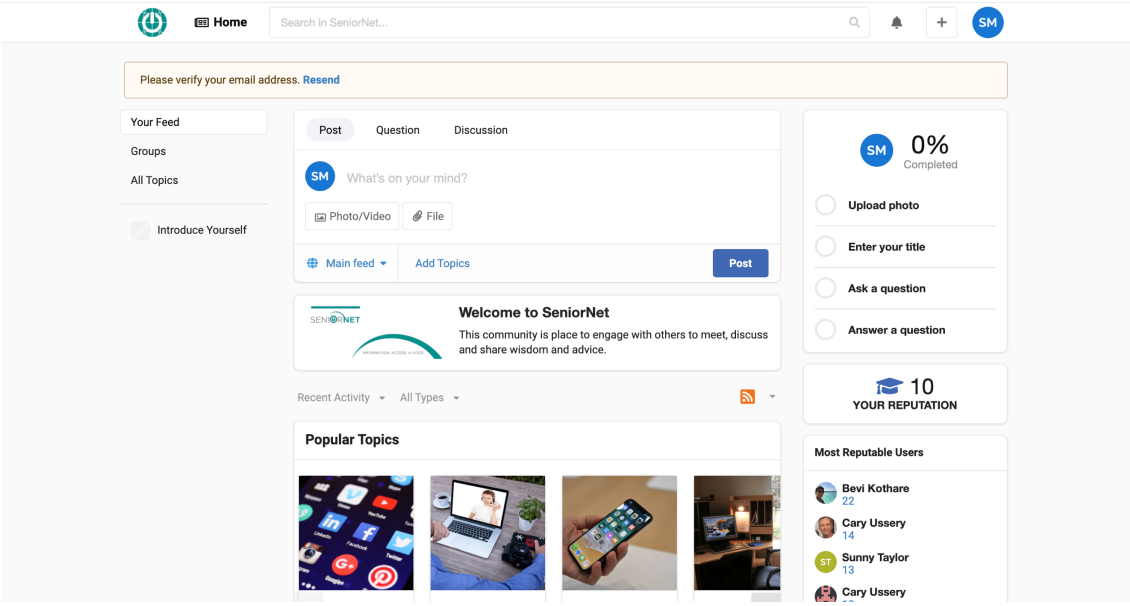


Figure 14 - SeniorNet main page.

Although the three examples are very similar and have the same mode of computer-mediated communication – forum; the community that is showing more engagement and presents a higher number of features is 'Early Retirement'.

The next chapter presents the related work, showing toolkits of co-design that can be relevant to evaluate the user experience of the online community miOne.

5. Related Work

Based on the keywords of this dissertation (Co-design, User Experience, Toolkit, Senior Online Communities), the literature review was performing using the databases of Scopus, Web of Science, Google Scholar, current industry/market-oriented platforms; and a google search on August 20th, 2020. Several co-design toolkits were identified and studied in terms of their relevance and application to the online community miOne's end-users.

BESiDE MAKE (k)IT

The BESiDE[10] project was composed of a multidisciplinary research group, including the fields of computing, design, and healthcare from both the University of Dundee and the University of Newcastle. The project was carried out in care homes aiming to help to create environments that support older adults in maintaining their quality of life, long after transitioning to a care home environment.

One of the activities conducted within the BESiDE project consisted of an open-source toolkit named MAKE (k)IT[11]. MAKE (k)it makes available a guide for a researcher/designer that explains how to engage older adults in a co-design process. The final product is a wearable pouch, customized to the personality and needs of each older adult. Moreover, the project aims to create memorable experiences and create empathy and connection within a community. The kit includes a guidance document, where the process is explained and fabric ideas are given, worksheets, and a process map.

The toolkit is divided into three phases – introduction, gathering insights, and making. In the introduction phase, casual conversations are advised, followed by an introduction of the project and lastly a crafting activity. In the gathering insights phase, participants will create a storyboard with the fabrics, intended style, and clothing, personality, and stories. The designer will then design a first version of the product and receive feedback from the older adults, repeating the process if necessary. In the last phase – making - and after making sure the participants are pleased with the product design, the wearable pouch should be created, whether by sending the design to a professional tailor or do it with the participants.

[10] Available at: https://www.beside.ac.uk/ (Date accessed: 20/08/2020)

[11] Available at: https://leannefischler.co.uk/?nor-portfolio=make-kit (Date accessed: 20/08/2020)

Figure 15 - BESiDE MAKE (k)IT toolkit. Retrieved August 2020 from (Fischler, n.d.).

Figure 16 - BESiDE MAKE (k)IT toolkit results. Retrieved August 2020 from (Fischler, n.d.).

Co-Design Toolbox

The Co-Design Toolbox[12] is a collection of co-design tools that allow designers to work with a group of non-designers during a brainstorm, following the design thinking process, further explained in chapter 3.

The toolkit includes a card game named "Word Cards". "Word Cards" are used to identify existing problems and discovering new ones. The game consists of verbs on one side and on the other side words that are associated with the verb. The participants have blank spaces to fill the cards with more words and can associate any word from the cards. After being filled, the verbs are placed in a brainstorm map next to the related words. Participants are then encouraged to create ideas and make connections with other participants' concepts. The toolkit also gives to the participants a set of drawing images of people in a variety of positions and tracing paper with guidelines in order to help them with the brainstorming process.

Figure 17 - Co-design Toolbox toolkit. Retrieved August 2020 from Sarmiento (2010)

Lastly, the toolkit includes a prototyping kit that consists of connectors and several pieces of polystyrene foam pre-cut into geometric shapes. It gives users the ability to quickly construct and personalize models they envisioned in the brainstorming phase.

Design Buffet

[12] Available at: https://www.coroflot.com/mipe19/co-design-toolbox (Date accessed: 20/08/2020)

Design Buffet[13] is a toolkit of a set of cards with different activities aiming to generate and influence ideas in a group design setting. Each card displays the "ingredients" (materials) for the activity, the estimated time, the creative style of the activity (Reality or Fantasy), and the game rules. Researchers can choose the games randomly or choose the right game for what they are investigating.

Figure 18 - Design Buffet toolkit. Retrived August 2020 from (Yang, 2010).

IDEO - "The Field Guide to Human-Centered Design" Design Toolkit

In 2009, IDEO launched a book entitled "The Field Guide to Human-Centered Design", an HCD toolkit, presenting different methods to unleash creativity, putting people at the center of the design process. Some of those methods are available online at the Design Kit website[14] as well as IDEO's team mindsets on Human-centered design, case studies, and other resources.

Following the 3 I's Model (Inspiration, Ideation, Implementation), further explained in chapter 3, IDEO sets different methods for each phase. In the inspiration phase methods such as card sort activities and "The Five Whys" can be conducted to better understand the target users and design according to their wishes and needs. In the ideation phase, Co-creation sessions and role-plays are methods indicated to understand and improve the users' experience. Lastly, in the implementation phase methods such as "Roadmap for Success" is helpful for teams to find the "next steps." The following activities are described below (IDEO, 2009):

[13] Available at: https://www.coroflot.com/ybl99/Co-design-Toolkit1 (Date accessed: 20/08/2020)
[14] Available at: www.designkit.org/methods (Date accessed: 10/05/2020)

IDEO presents “Card Sort” activities giving as an example presenting a deck of cards with one word or image and asking users to rank them according to their preferences. The activity is expected to last for 30 minutes and help to start a conversation between designers and users to gather insights into users’ preferences.

“The Five Ways” method is a simple method, estimated to last for only 15 minutes, that consists of starting a conversation by asking a broad question such as “Do you save much money” and then ask “why?” for five times, and writing all the answers to further analyze.

As explained in chapter 0, co-creation sessions can summon a group of target users and bring them into the design process. IDEO sets a time range of 1 to 3 hours per session and indicates activities such as conversation starters, brainstorm, role plays, and rapid prototyping.

Role-plays are an easy way to test the experience of a product. The activity should take about 30 minutes and it is crucial to previously determine the necessary roles, who will play them, and what to test. Testing the role plays with the team first is a good practice and props and costumes can help the users to better understand their character.

“Roadmap for Success” can help the project team to define milestones and human resources to work on the project. This planning activity should last for 120 minutes and consists of printing a calendar for the next year or 18 months and use it to map important events.

IBM Enterprise Design Thinking Toolkit

The IBM Design Thinking framework is made for multi-disciplined teams to understand the target users, prioritizing them over business concerns, and deliver solutions. As previously explained in chapter 3, IBM Design Thinking follows a continuous cycle of observing, reflecting, and making – called Loop. To help following the cycle and apply the design thinking framework, IBM offers a toolkit of different activities indicated to use during the reflection and making cycle phases.

In the Reflection phase, activities such as “As-is Scenario Map” “Empathy Map” and “Assumptions and Questions” can be conducted to better understand what the users need and what they want. In the Making phase, activities such as “Storyboards” and “Experience-based Roadmap” can be used, both aiming to improve the users’ experience with a product or service. The following activities will be further explained below (“Design Thinking Activities and Tools - Enterprise Design Thinking,” n.d.):

“As-is Scenario Maps” allows gathering a better understanding of the users’ experience to explore new ideas and create opportunities for improvement. The activity incites brainstorming, and it is stipulated to last for 30 minutes. To begin the activity, the

team should draw four rows and label them: Phases, Doing, Thinking, and Feeling. As an individual brainstorm, team members should ask themselves - what are users doing? what are they thinking? what are they feeling? – and fill the corresponding rows using one sticky note per answer. The team should then cluster similar stickie notes, refine the order and fill the row "Phases" with the different experience phases of an interaction with a product/service. Afterward, areas that are particularly positive or negative for the user should be circled and blank areas should be noted as a sign to learn more about them. In the end, one or two team members should prepare a presentation on the results and gaps in the team's knowledge.

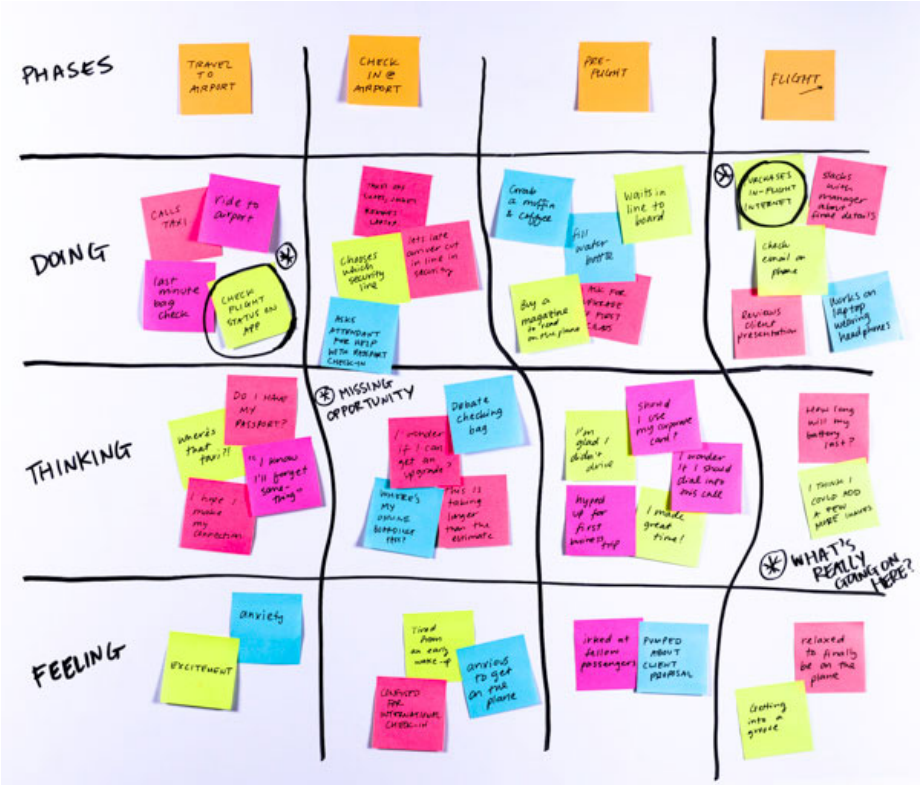


Figure 19 - "As-is Scenario Maps" activity. Retrieved August 2020 from ("Design Thinking Activities and Tools - Enterprise Design Thinking," n.d.).

"Empathy Map" helps to understand who the users are by synthesizing the team's collective knowledge about them. Sarah Gibbons, Nielsen Norman group designer (Gibbons, 2018) defines an empathy map as a "collaborative visualization used to articulate what we know about a particular type of user. It externalizes knowledge about users in order to 1) create a shared understanding of user needs, and 2) aid in decision-making.

This activity is stipulated to last for 30 minutes and should be conducted before making important decisions or after a direct observation session. Similar to As-is Scenario Maps, to start the activity the team should draw a grid and label four quadrants with Says, Does, Thinks, and Feels, sketching the user or stakeholder in the center of the grid and giving them a name and a description. Then the team should write in a sticky note, one per

observation, everything they remember about the user/stakeholder and place it on the respective quadrant.

Figure 20 - "Empathy Map" activity. Retrieved August 2020 from Design thinking activities and tools - Enterprise Design Thinking, *(n.d.).*

"Assumptions and Questions" is another activity to be conducted in the reflection phase, helping the team to reflect on their work – what they know and still need to learn. The activity is stipulated to last 30 minutes and allows the team to recognize and evaluate their assumptions and questions and the best way to address them. To start the activity, each team member should write one assumption or question per sticky note. The team should draw a two-by-two grid with the labels High-risk on the top, Low-risk on the bottom, Certain on the left, and Uncertain on the right. Then the team, individually, must evaluate each idea and plot them on the grid where they make more sense. A discussion should be started with the teammates and sticky notes can be re-positioned. The high-risk and uncertain items from the upper-right quadrant should be then inserted in a new space. For each item, the team may diverge on many different ways to validate or invalidate these assumptions and questions.

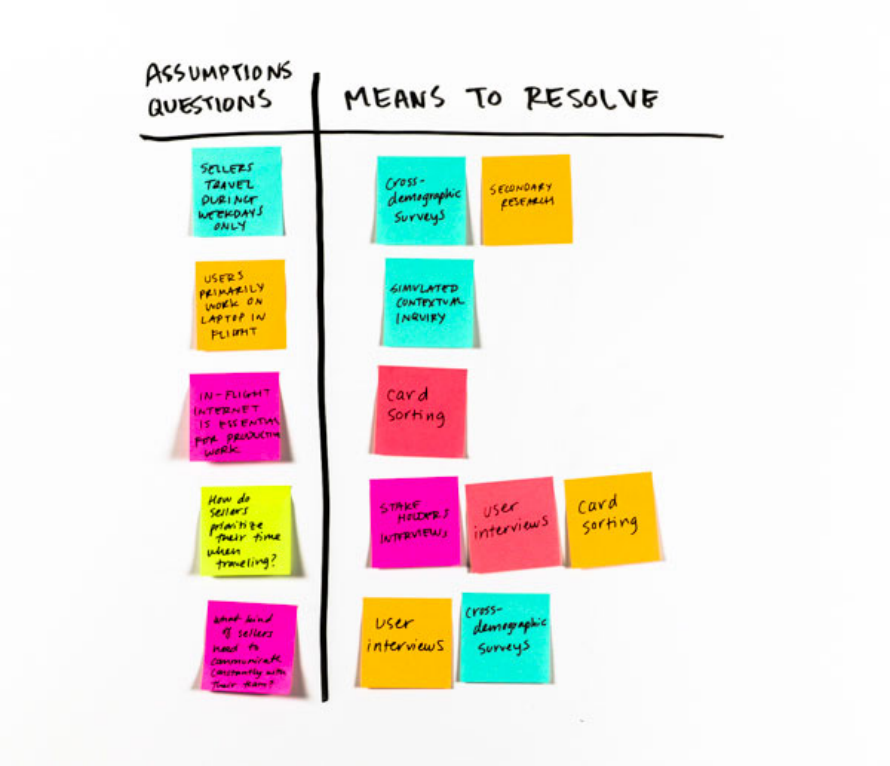


Figure 21 - "Assumptions and Questions" activity. Retrieved August 2020 from ("Design Thinking Activities and Tools - Enterprise Design Thinking," n.d.).

Storyboards, with an estimated duration of 20 minutes, facilitate idea communication through visual stories, staging them to be appropriate for the users. To start the activity the team should identify a character, setting, and plot and pick scenes that show the plot development. The story then should be illustrated, as a form of a comic strip.

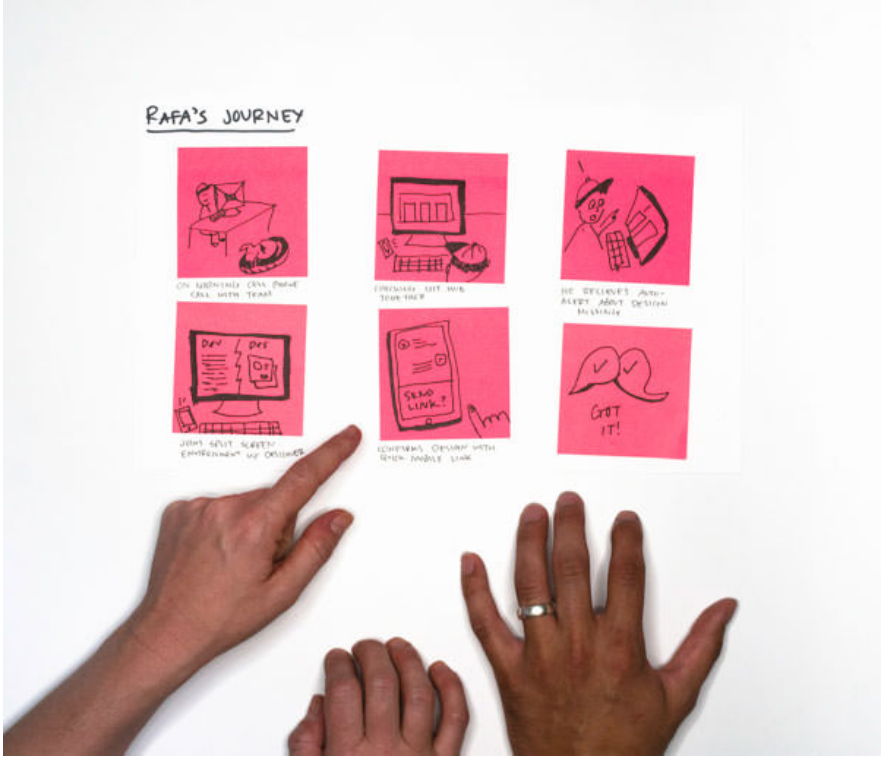


Figure 22 - Storyboard activity. Retrieved August 2020 from ("Design Thinking Activities and Tools - Enterprise Design Thinking," n.d.).

The "Experience-based Roadmap" goal is to differentiate the long-term experience of the most essential near-term outcomes. IBM suggests 60 minutes to complete the activity. The activity starts with writing the statement "Our user can/our user will be able to..." on the top of a large sheet of paper, labeling "Short-term" on the left and "Long-term" on the right. Next, the team should write on sticky notes to complete the sentences and group them (short-term, long-term, and in-between). After grouping all the sentences, the teams should draw the lines between "Stage 1," "Stage 2," and "Stage 3", the stages that represent the user experience.

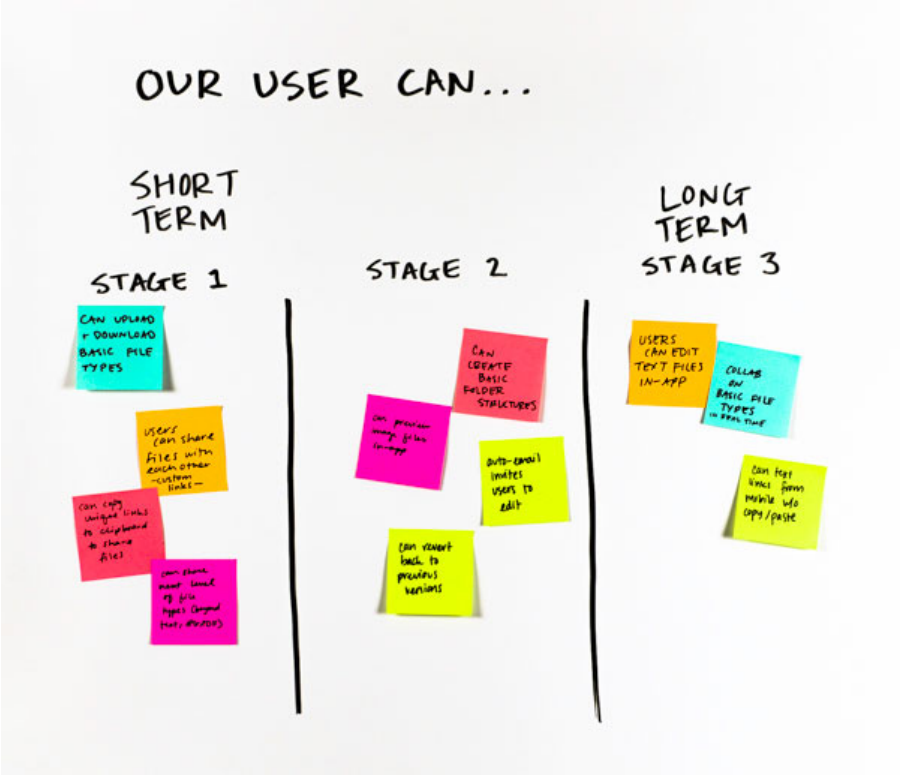


Figure 23 - "Experience-based Roadmap" activity. Retrieved August 2020 from ("Design Thinking Activities and Tools - Enterprise Design Thinking," n.d.).

Overall, the presented co-design toolkits are diverse in terms of who they are applied for and can help not only on the co-design process but also on a design team organization (as seen on IBM toolkit). MAKE (k)it engages participants in a co-design process of a crafting/prototyping activity, by making available a guide for a researcher/designer. The Co-Design Toolbox follows the design thinking process and consists of a set of activities to engage participants in brainstorming sessions. Design Buffet aims to stimulate creativity by engaging participants and random games and activities. IDEO offers several activities to engage people of all ages and makes them available, on their website, and case studies using the activities. Lastly, the IBM toolkit offers design teams the possibility to organize themselves and better understand their users' needs and wishes and design according to it.

However, there is still a lack of application of toolkits as a way to design and engage people in online communities and the present dissertation aims to contribute to that.

Final thoughts on the Literature Review

As mentioned in chapter 1, the world population is aging at a fast rate (WHO, 2003), with people living longer and remaining more active into older age (Czaja et al., 2019). At the same time, there are several advancements in information and Communication Technologies (ICT), and senior citizens need to fully interact with them since non-users or non-literate users in a digital context will be in a disadvantage as ICT is progressively becoming the exclusive infrastructure of communication and information access (Zadražilová, 2018). Additionally, a considerable number of senior citizens are living alone (Czaja et al., 2019) and social media or online communities are, therefore, very likely to foster meaningful social contact (Leist, 2013), reducing the effects of social isolation and loneliness (Findlay, 2003).

It is a myth that senior citizens wish to avoid technology (Czaja et al., 2019), being this segment a growing market. Although there is a noticeable growing trend in ICT usage among senior citizens, its usage is still less significant when compared to younger aged groups (PORDATA, 2016). Reasons for that, according to Lee and colleagues (2011) include the perceived "I'm too old to use technology", functional problems caused by physiological and psychological problems (see chapter 1.3), and the fact that people feel that no one is teaching them how to use technology. Furthermore, conventional product interfaces still present serious difficulties for senior citizens (Huppert, 2003), and inclusive design and collaborative design are being adopted as a strategy to surpass those difficulties and engage senior citizens in modern technologies (Reddy et al., 2019; Steinfeld & Maisel, 2012).

Whereas product design and assessment are usually based on the users' cognitive model and the designer's assumptions of their behaviors, co-design involves different stakeholders in the process since its beginning (Muller & Kuhn, 1993; Pejner et al., 2019), being a way to match the users' needs to the product or service, create a sense of ownership of the product and strengthen social networks and community involvement between organizations and all the stakeholders (Jagosh et al., 2012; Muller & Kuhn, 1993). Co-design can help to achieve good user experiences, by being aware and create empathy for sensory experiences, emotions and actions, values, and meaning towards products and inherit sociocultural contexts (Buchenau & Suri, 2000).

Good user experience evokes emotions that can influence the behavior of others, (Heerdink et al., 2013), *i.e.* by engaging people in a group setting, they are more likely to influence the group by, for instance, sparking online dialog and shaping discussions (Huffaker, 2010). That way, emotional design can lead to the adoption of new technologies or the use of new products, such as the online community miOne.

Several user experience evaluation methods, such as eye-tracking (further explained in 2.4) were studied, as well as co-design techniques, resultant of a systematic literature review (see chapter 2.2.1). The most applied techniques were group workshops;

interviews and focus groups; questionnaires; paper-prototyping and cultural probes. The previously mentioned techniques can be used depending on the time of the development life cycle, who participates with whom and what, and the appropriate group sizes for the practice (Yamauchi, 2012).

Although there are some co-design toolkits in the market as mentioned in Related Work, its specificities to design online communities are in need. The following Chapter presents the empirical study, detailing the research method and procedures that will be undertaken in this research.

6. Empirical Study

The present research aims to understand whether and how co-design can influence the senior citizens' experience with online communities by engaging them with a User Experience toolkit. The Action Research method is used and further explained in this chapter, including the associated procedures, and tools used for data collection.

6.1. The Research Method

In order to answer the research question *"In what way can co-design influence the senior citizens' experience with an online community?"*, the qualitative Action Research Method is used.

In qualitative research, a phenomenon is investigated from the perspective of the participant being studied and opportunities are created for the researcher and the participant to mutually share and learn with each other (Hirsch, Greenwood, & Leven, 2000). This research is appropriate for studying a limited number of in-depth cases (Johnson & Onwuegbuzie, 2004), as they further understand the people's reported experiences (emotions, beliefs, and behaviors).

Action Research (AR) grounds on Kurt Lewi's work, in the mid-1940s, as a response to perceived problems in social systems (Adelman, 1993). Gillis and Jackson (2001, p. 264) define Action Research as a "systematic collection and analysis of data for the purpose of taking action and making change", involving action researchers and stakeholders who are willing to improve their current situation by (a) defining problems, (b) generating relevant knowledge about those problems, (c) learning and executing social research techniques, (d) taking actions and (c) interpreting the results (Hirsch et al., 2000).

Kemmis and McTaggart (2014) approach action research in terms of a spiral with three stages: 1. Planning to initiate change; 2. Acting to implement the change and Observing the implementation process and its inputs; and 3. Reflecting on processes of change, followed by successive cycles of improvement through re-planning.

This research follows the strategy of a spiral of action research and it is comprised of 4 main phases:

- Phase 1 - Co-design Research and Toolkit Development (Planning): In the first phase of the research, a literature review on the main topics is conducted as well as a systematic literature review on co-design techniques applied to senior citizens (further explained in chapter 2.2.1), and the first version of a toolkit of user experience (*i.e.* a toolkit that aims to create a positive experience and at the same time perform a user experience and user interface evaluation of the online community miOne), is designed. Moreover, co-design activities and user experience evaluation are planned, to conduct in Phase 2.

- Phase 2 - Applying the Co-design Toolkit (Acting): Co-design activities using the designed toolkit will take place in this phase with learners from Universities of the Third Age.

- Phase 3 - Assessing the Co-design Toolkit Effectiveness (Observing): The observing phase will be connected with the acting phase through direct observation and feedback from the participants. A group discussion in the form of a focus group and questionnaires will be given to the participants, at the end of the co-design activities, and the received inputs will be analyzed.

- Phase 4 - (Re)design of the online community miOne (Reflecting): After analyzing the previously mentioned inputs, the online community miOne may be changed to better fit the needs of its main target. A set of guidelines for designing online communities are expected to be formulated.

The toolkit, co-design activities, and online community miOne were in constant change during the process after a reflection on the previously conducted activities, its problems, and participants' feedback. Therefore, the mentioned spiral phases are not sequential and might overlap, and the process is likely to become fluid, open, and responsive (Kemmis, S dan McTaggart, 2014). A graphic representation of the research method applied in this dissertation, adapted from (Mazzarella & Escobar-tello, 2015), is presented below – c.f. Figure 24.

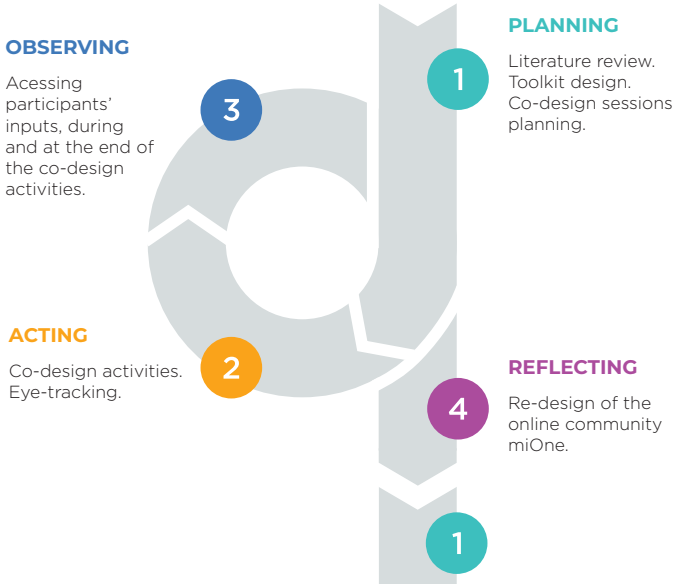


Figure 24 - Spiral of Action Research. Adapted from (Mazzarella & Escobar-tello, 2015).

The phases presented above are summarized in Table 9, containing the activities and methods that were carried out throughout the study, and the instruments used for data collection.

Table 9 - Scheduled activities that were carried out in the Research

Phase	Date	Activities	Methods	Data Collection
Phase 1 – Co-design Research and Toolkit Development	September 2019 – May 2020	Literature review; Co-design toolkit research, conception, and preliminary tests; Planning and developing co-design sessions' materials, data collection, and instruments; Systematic literature review on co-design Techniques.	Literature review.	Databases (Scopus, Web of Science, Google Scholar).
Phase 2 – Applying the Co-design Toolkit	February 2020 – June 2020	Co-design sessions: Application of the developed toolkit; User experience and interface tests.	Co-design; User Experience; Usability testing; Direct observation.	Field notes; Participant observation.
Phase 3 – *Assessing the Co-design sessions and Toolkit Effectiveness*	February 2020 - June 2020	Group discussion and application of a questionnaire to understand senior citizens' opinions on the co-design session, toolkit, and the miOne online community	Direct observation; Group Discussions. User Experience; Usability testing.	Field notes; Participant observation; Semi-structured interview; Questionnaire.
Phase 4 - (Re) design of the miOne online community	June 2020 – July 2020	Apply the inputs of the co-design sessions, eye-tracking, semi-structured interviews, and questionnaires to redesign the miOne online community	Direct observation; Group Discussions; User Experience; Usability testing.	Interviews Questionnaires. Eye-tracking.

As shown in Table 9, this research was divided into four phases: Co-design Research and Toolkit Development; Applying the Co-design Toolkit; Assessing the Co-design Toolkit

Effectiveness; and (Re) design of the online community miOne. The activities started in September 2019 and lasted until July 2020 and each phase will be described in the following section, namely in terms of the activities that were carried out, method, and instruments used for data collection.

6.1.1. Description of the methods used

In this topic, each procedure used in the different research phases is described. The following methods were used in phases 2 and 3 – Co-design, User Experience, Usability, Eye-Tracking, Direct Observation, Group Discussions, and Questionnaires.

Applied Co-design and Design Thinking Techniques

Based on the information gathered about co-design and design thinking (previously mentioned in chapter 0 and 2.3), the applied techniques were: Scenario Building and Card sorting games combined with questionnaire surveying, concept mapping, and AEIOU Registration.

Usability Evaluation

Usability is a collection of techniques used to measure characteristics of a user's interaction with a product (Cooper et al., 2014). It is defined by The International Standards Organization (Organizacion Internacional de Normatizacion - ISO, 2018) as: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use." In usability testing, a facilitator gives a set of tasks (*i.e.,* realistic activities that the participant might perform in real life) to the participants and observes the participants' behavior and feedback. Follow-up questions can be asked by the facilitator to gain more insights into the participants' feedback (Nielsen, 2003).

User Experience Evaluation

The definition of user experience and user experience evaluation methods are presented in chapter 2.1. For the user experience evaluation, different aspects relative to Information Architecture Design, Interaction Design, and Visual Design were taken into account. This evaluation relied on in-situ observations of the users' interaction with the platform, self-reports (questionnaire surveying), and physiological measurement (the use of eye-tracker to assess the user's navigation in the online community miOne.

Direct observation

According to Quivy and Van Campenhoudt (1992), direct observation aims to register the participants' behaviors at the moment they occur, allowing the researcher to collect information, without the intervention of the observed subjects. The authors mention two direct observation variations: ethnological or participant observation and

non-participant observation. In the ethnological observation, the researcher studies the community over a long time by participating in it and avoiding disturbing the environment. In the non-participant observation, the researcher observes from the 'exterior'.

Group Discussions

In this qualitative research method, a small group of representative participants gathers to discuss a determined topic chosen by the researcher or an issue to generate data (Wong, 2008). To conduct a group discussion, the moderators usually prepare a structured list of topics to cover (Pak & McLaughlin, 2010), and often the meeting is recorded on audio or video for later reference (Cooper et al., 2014). Unlike methods such as individual interviews, participants are encouraged to communicate with each other to exchange their points of view and experiences (Wong, 2008).

6.1.2. Instruments Used for Data Collection

In this topic, each instrument used for data collection is described. The following were used in phases 2 and 3 – Participant Observation Field Notes, Eye-Tracker, Questionnaires, and Semi-structured Interviews.

Participant Observation

In participant observation, the researcher is immersed in daily aspects of people's activities as a way to uncover or reconstruct their practices, performances, behaviors, and actions in natural settings (Kawulich, 2005).

According to McGrath & Laliberte Rudman (2019), participant observation can bring many benefits when compared to other data collection instruments. For instance, participant observation researchers can verify what people usually do not talk about in interviews. Moreover, they can observe not only the participant but its social environment.

Field Notes

Field notes are defined as written records of observational data, reporting social interactions in the context they occurred (Gibbons et al., 1986).

It is ideal to take field notes while the observation is occurring since the researcher's memory will fade and there are more risks of inconsistent and confusing notes. However, in many cases, that is not possible or can lead to a disruption of the 'natural' environment (Gibbons et al., 1986). Moreover, fieldnotes are selective since it is impossible to capture everything that is happening. The researcher needs to select information based on its relevance to the research problems and background expectations (Wolfinger, 2002).

Eye-tracker

The definition of the eye-tracker evaluation method is presented in chapter 2.4 and the rationale for using it in this research was to understand how users interacted with navigational tools on the miOne online community, namely the access to community groups and publication in a group (the most basic and essential actions in the platform). The purpose of this test is to guide the designer in the (re)design of the online community based on reported difficulties by participants during the toolkit sessions, aiming at ensuring the noticeability and easiness to find elements.

Self-administrated Questionnaires and Semi-structured Interviews

The definitions of questionnaires and interviews were provided in chapter 2.2.1. In self-administered questionnaires, respondents have to make their own decision for the meaning of the question, having an absence of the presence of the interviewer (Alasuutari, Bickman, & Brannen, 2012), whereas interviews may be a way of administering a questionnaire orally.

In this latter case, the interviewer has a series of open guiding questions about the topics in the study and allows the participants to speak freely about them, directing the interview to its objectives each time the interviewees move away from them and ask questions at the right time (Quivy et al., 1992).

The questionnaires and interviews were used to assess the post-experience of the toolkit and identify the requirements for the (re) design of the miOne online community.

6.1.3. Description of the Phases and Activities

The following is a brief description of each research phase and the activities that were undertaken.

Phase 1 – Co-design Research and Toolkit Development

In this phase, a literature review on the topics ‘Co-design’, ‘User experience’, ‘Senior citizens’, and ‘Online communities’ was carried out in order to understand the way the application of co-design activities with older adults could influence their engagement of online communities. Furthermore, a systematic literature review on co-design techniques applied to older adults was conducted, as well as a review of the related work in which recent examples of toolkits applied in co-design were explored.

After the literature review, the co-design sessions were planned by contacting the Universities of the Third Age, defining the goals of each session, activities, materials, and the tools used for data collection.

The first version of a UX toolkit focused on the main themes of the miOne community – *i.e.* communication, news, tourism, and health, being these themes covered in the co-design sessions.

Toolkit Conceptualization and Design

The toolkit activities were created taking into consideration the three phases of the online community use – pre-experience, experience, and post-experience. It consists of seven activities, one activity for the pre-experience ('More than Words), five activities for the experience phase ('Secret Rules', 'Lucky vs Unlucky Tourist', 'Secret Friend', 'Find the Fake News', 'News Match', 'Win-Win' and 'Doctor-Patient') and one activity for the post-experience. The goals for each activity, estimated duration, procedures, analysis, and materials were defined. Furthermore, a sticker book was given at the beginning of the process, being part of the toolkit. A toolkit utilization guideline was also designed, and it is available to consult as well as all the designed materials[15].

The sticker book and the toolkit activities are further described below.

Sticker book

A sticker book was designed to be part of the toolkit. Its purpose was to motivate and involve the participants in the co-design activities through a gamification process.

In the back of the sticker book, the information about the miOne online community and the SEDUCE 2.0 project are presented[16] (see Figure 25 and Figure 26).

A sticker book was given to each participant of the presential co-design sessions and the correspondent sticker was given in the correspondent session (some sessions had more than one associated sticker). There are 8 spaces for stickers inside the sticker book, corresponding to the themes approached with the toolkit (Health, tourism, and news) and functionalities (First contact with the online community, registration and profile editing, engagement with other participants, and use of chat), having an extra sticker space for participants that attended all sessions.

[15] Toolkit materials available at: https://drive.google.com/drive/folders/1xCiGXLKqpdyC1i48wmpR-2Eb8UfFkTd7?usp=sharing

[16] This sticker book used the miOne banner on the front and back page, designed by Cátia Amador (designer in team Campus, miOne, and GPS).

Figure 25 - Sticker book (front and back pages).

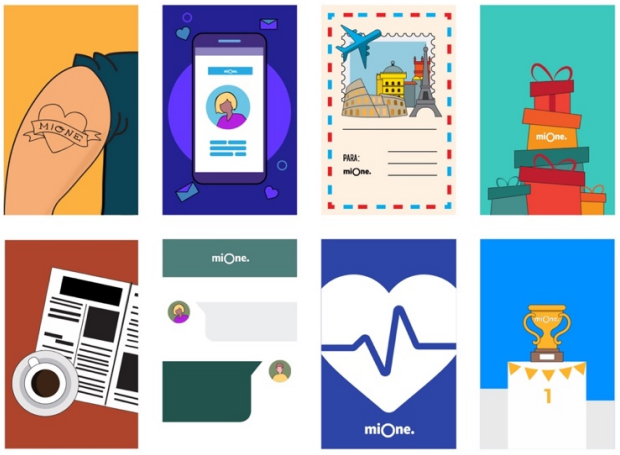


Figure 26 - Stickers designed to fill the sticker book.

Toolkit activity 1 – 'More than Words'

The game 'More than Words' aims to be an ice-breaking activity, whose purpose is to understand the user's experiences, motivations, and interests in digital platforms.

The Toolkit materials for this game consist of a card box and a set of cards (represented in Figure 27) with words that can be related to digital platforms and online communities or the services that can be delivered in these communities – *e.g., Share,*

Groups Entertainment, News, Tourism. The box and the cards were designed using only two neutral contrasting colors (black and white) and visual cues were reduced to not interfere with the users' cognitive model of the words that were written in cards.

Figure 27 - 'More than Words' cards and box.

The 'More than Words' game is estimated to last 30 minutes. For the game, participants are divided into groups of 4 to 5 and a set of post-its and markers are distributed. To start the game, a moderator randomly chooses a card and says/shows the concept written on the card to the participants. Participants have to think fast and come up with at least one word related to that concept and write the word on the given post-its. A blank canvas is displayed in the middle of the groups of participants to place the card and the post-its' with the related words, forming a concept map. Finally, the session proceeds with a discussion around these concept maps.

The collected data for this game is qualitative, using direct observation and field notes to register any discussion or difficulties that may occur during the game. Moderators photograph or take notes of the words that participants write to create a concept map and find possible features for the online community, gathering the participants' interests and motivations.

Toolkit Activity 2 – Secret Rules

'Secret Rules' is a role-play activity that aims to establish the participants' first contact with the miOne online community and foster the participants' adherence to the platform. This activity is also expected to enable UX researchers to discover possible experience and usability challenges.

The materials designed for this activity are a card box and deck of cards containing the secret rules and visual representation of each role - possible roles are leader, visitor, ghost, paparazzo, and big mouth (represented in Figure 28). Moreover, each role has a set of 'secret rules' with tasks to complete, which are given to the participants. A script is also given to the moderators to assist in the activity procedures and analysis.

Figure 28 - Secret Rules cards and box.

The 'Secret Rules' activity has an estimated time of 40 minutes. To start the activity, each participant receives a random card. The moderator then checks the role of the participants, gives them the sheet with the tasks to complete, and reveals the identity of the leader. The participants only know who the leader is but do not know each other's roles and have to help the leader to find the visitor. They could present themselves in the online community, making attempts to unravel the other's identities and find the visitor.

In the context of this study, this activity is undertaken during the first contact with the miOne online community and, therefore, it is important to register participants' complaints, suggestions, and difficulties. However, this activity can also be performed after this first contact with the platform. For the analysis, information about the Activity, Environments, Interactions, Objects, and Users (AEIOU) is registered.

Toolkit Activity 3 – Lucky vs Unlucky Tourist

The activity 'Lucky vs Unlucky Tourist' aims to analyze the participants' use of community groups and identify the functional requirements for delivering touristic services in the online community, based on the participants' travel experiences.

This activity is conducted online in a community group (e.g. the group entitled 'Travel' in case of the miOne community) with an estimated duration of 40 minutes. Participants are divided into two groups - Group 1: 'The Lucky Tourist'; and Group 2: 'The Unlucky Tourist'. Group 1 aims to defend tourist services, whereas Group 2 complains and criticizes different services, vacations, check-in times, among others in the miOne online community.

In this activity, it is important to observe the participants interacting with the online community and groups to understand if they feel any difficulties or frustrations on the use of the platform. Moreover, their publications should be analyzed to gather possible requirements for designing and developing tourism products or/and services.

Toolkit Activity 4 – Secret Friend

The activity 'Secret Friend' aims to foster the participants' participation on the miOne platform outside the co-design sessions and analyze the participants' use of online communities to share their experiences towards identity objects - Photos, Audio, or Videos (Preferences, Emotions, Thoughts, Environments, Interactions, Relations, and Daily Activities).

For this activity, only the online community is used. Each participant has to post on the online community something that can identify his/her 'secret' friend (randomly assigned), through videos, photos, text…without mentioning their name.

It is important to register if the participants did the activity and further engaged with the platform, trying to unravel who their secret friends were, outside the co-design sessions.

Toolkit Activity 5 – Find the Fake News

'Find the Fake News' aims to gain further insights on the participants' interaction with the news - reactions (with the use of emoticons) and debate. Besides, this activity aims to create awareness of fake news and educate the participants for a trusted news search.

The materials needed for this activity are 5 or more pieces of news that are fake (existent or created for the activity) and a credible piece of news that is shared in the miOne online community. The activity is estimated to last 40 minutes. Participants engage with the news posted in the group by reading, commenting, debating, and reacting to them to identify and justify why they are true or fake. At the end of the activity, a credible piece of news is revealed and a discussion about trustworthy news sources is followed.

During this activity, direct observation, field notes, and posts on the online community are important to understand the difficulties of the participants' interaction with the news, gathering insights on the daily habits of news consumption.

Toolkit Activity 6 – News Match

The activity 'News Match' aims to create awareness of the dangers of fake news and how to conduct a news search effectively.

For this activity, the moderator prepares a set of duplicated words written in small pieces of paper containing news categories (*e.g.* sport, health, culture, science, and technology), distributing them for the participants, and ensuring that the same word is assigned to at least two participants. Based on the word that was assigned to each participant, these apply the previous knowledge acquired in previous activities, searching for credible news and share them in miOne. Afterwards, participants have to look through the shared news and find who shared the piece of news of the same topic, commenting "we have the same theme."

Similar to what occurs in the previous activity, it is important to gather information about the users' interaction with the news feature and perceived difficulties in sharing news and analyzing field notes through direct observation and participants' public posts. Furthermore, in the case of miOne, the plug-in miOne to easily share news is encouraged to be installed during the activity to test its effectiveness and difficulties in using it.

Toolkit Activity 7 – Win-Win

The 'Win-Win' game, inspired by an existing game called 'Cards Against Humanity',[17] aims to be a fun way to approach important topics about health without participants' feeling that they need to share their health issues.

The materials of the game consist of a card box, white cards with phrases or words, and blue cards with an incomplete affirmation/question, represented by lines (see Figure 29). Some of the blue cards have two or three lines to fill, and players should choose the same number of white cards.

[17] Available at: https://cardsagainsthumanity.com/ (Date accessed: 25/10/2020).

Figure 29 - Win-Win game.

To start the game, each player receives ten white cards from the deck. One of the players take a blue card from the deck and places it in the center of the table, so that it could be read by everyone. Players (at the same time) should place the cards that can fill in the blanks. At the end of each turn, the player who withdraws the blue card decides which answer was the best answer. The player with the best answer receives 1 point. The game is repeated until the players run out of white cards. Whoever has the most points at the end wins.

Moderators of the activity should incite discussion about the topics presented in the played cards and register it.

Toolkit Activity 8 – Doctor – Patient

The role-play activity 'Doctor-Patient' aims to test the participants' interaction with the chat miOne and define the functional services/requirements for health-related information.

Half of the group of participants play the role of "doctor", whereas the other half play the role of "patient". Patients are given a small piece of paper with a disease name and are given an initial time to use the Internet to research about the disease and tell the doctor (in the chat room) the symptoms they are feeling (the symptoms caused by the fictitious disease). The doctor has to use the symptoms to try to search the disease and give instructions on how to proceed on the miOne chat.

Possible difficulties and suggestions on the use of the chatroom should be noted by the activity moderator.

Toolkit Activity 8 – Pic-UX

Pic-UX is adapted from the game Pictionary, as a way of identifying the participants' mental model associated with a positive experience. Moreover, this activity aims to establish a connection between the participants' association of a positive UX to different task scenarios in the online community, using self-congruity between the user's conceptual model and recall of the perceived experience in the miOne online community.

For this activity, participants are divided into two groups. One member of the starting team selects a word card from the previous deck of cards "More than Words", having 10 seconds to examine the word. The participant can't speak the word out loud and has 60 seconds to draw a representation of that word, whereas the moderator takes a photo and uploads it to the group. Guesses are made in the comments associated with the post. Sketches may not include letters or numbers. The other participants have 2 minutes to guess the represented word. Sketching and guessing continues until the word is identified or time is up. The participant who guesses the word correctly is the one who chooses the next word. If no one guesses the word in the stipulated time, another participant is randomly assigned to choose a new word. The team that guessed more words wins.

At the end of the first part of the activity, the previous groups choose cards from the same deck and associate them with a moment or feature they remember from the online community, in this case the online community miOne ('Register and Login', 'Groups', 'Communities', 'News', 'Health' and 'Tourism'). Registration of users' associations with the concepts and the connection with the online community features. A comparison with the concepts of the pre-experience activity should be made. Difficulties during the game and the usage of the platform should also be registered.

Once again, it is important to gather insights on the user experience when interacting with the miOne. community and user interface in order to generate a set of guidelines to design online communities. Therefore, an extra co-design session with co-design activities and a one-hour eye-tracking activity was planned and conducted in the following phase with a group of participants from the Academia Sénior de Penamacor at the University de Aveiro, in order to identify the problems of the online community interface. This co-design session and eye-tracking evaluation helped to establish contact with the Academia Sénior de Penamacor and Vila Velha de Ródão, which given the COVID-19 outbreak were invited to participate in online co-design sessions.

Phase 2 - Applying the co-design toolkit

This phase uses the previously designed toolkit to engage participants from the Universities of the Third Age in the co-design sessions of the miOne online community. The toolkit was applied in Portuguese as it is the language of the participants. The activities were divided into six sessions for each university (presential), and four sessions (online).

Toolkit activities and co-design sessions, in this phase, were changed accordingly with the participants' feedback and previous observations. The redesign and implementation of some features of the miOne online community were also made during the co-design activities in order to better address the participants' needs.

Presential co-design sessions

From February to March of 2020, a set of six presential co-design sessions with one hour each were carried out at the Universities of Third Age of Esmoriz, Gafanha da Nazaré, and Oliveira de Azeméis to apply the toolkit and perform a user interface and user experience evaluation of the miOne online community. Due to the COVID-19 pandemic, session 4 and 5 were only conducted in the Universities of Third Age of Esmoriz and Gafanha da Nazaré. The last toolkit activity, 'Pic-UX' was relative to the post-experience of the online community miOne, and owing to covid-19 lockdown measures, it could not be carried out. The conducted activities are further explained below.

Session 1 – Partners at first sight

The first co-design session was held at the Universities of Third Age of Esmoriz (n=9 participants), Gafanha da Nazaré (n=17 participants), and Oliveira de Azeméis (n=7 participants) on February 5th, 4th, and 3rd, respectively. The goal of the first session was to contextualize the project, explain the scheduled activities, and recruit participants to participate in the sessions. Therefore, the sessions began with a presentation of the co-design sessions and activities. A consent form (see inserir apendice)was given to all of the students, who were interested in the participation of the study before the application of the first activity of the toolkit – the 'More Than Words' game (c.f. Figure 30), described in section 6.1.3.

Although group dynamics were possible in two Universities of Third Age (division into smaller groups and distribution of one deck of cards per group) while performing the activity 'More Than Words', the whole class group was considered at one of the Universities given that the disposition of the classroom that enabled individual seatwork only.

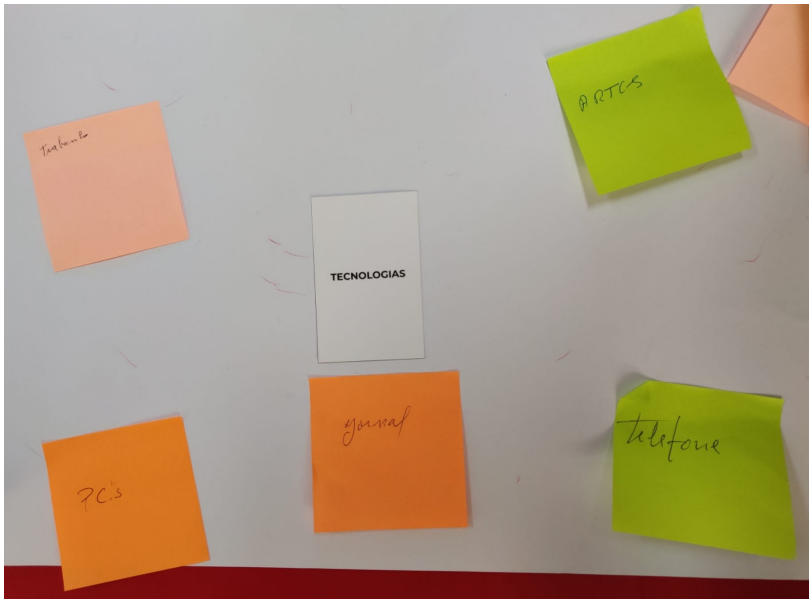


Figure 30 - Toolkit activity 'More than Words'.

To foster the participants' discussion and reflection on the game, they were asked to write on a post-it one thing they would like to see on the Internet/online communities and place it on the canvas.

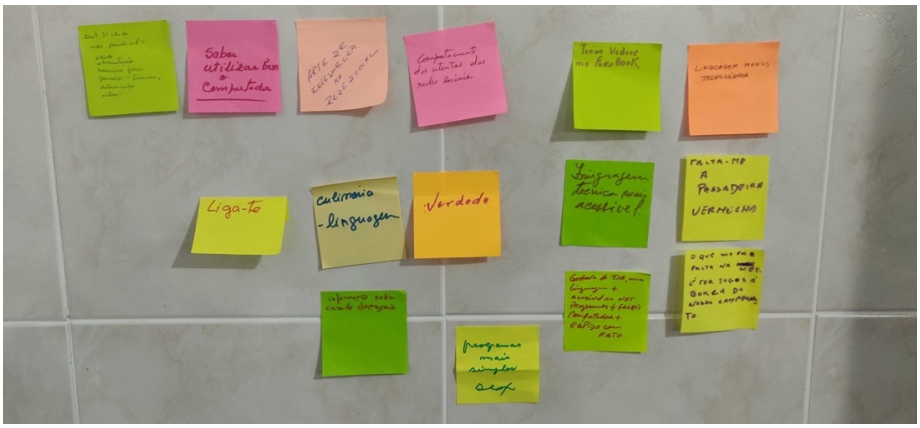


Figure 31 - Activity final question.

Session 2 – A Community is born

Session 2 was held at the Universities of Third Age of Esmoriz (n=10 participants), Gafanha da Nazaré (n= 12 participants), and Oliveira de Azeméis (n=5 participants) on February 12th, 11th, and 10th, respectively.

Initially, the participants accessed the online community miOne in order to complete the registration, login, and configure their personal pages. After completing the registration, the role-play toolkit activity 'Secret Rules' (c.f. Figure 32; Figure 33) was presented to the participants and started. At the end of the co-design session, a discussion with all participants was initiated in order to discover the visitor.

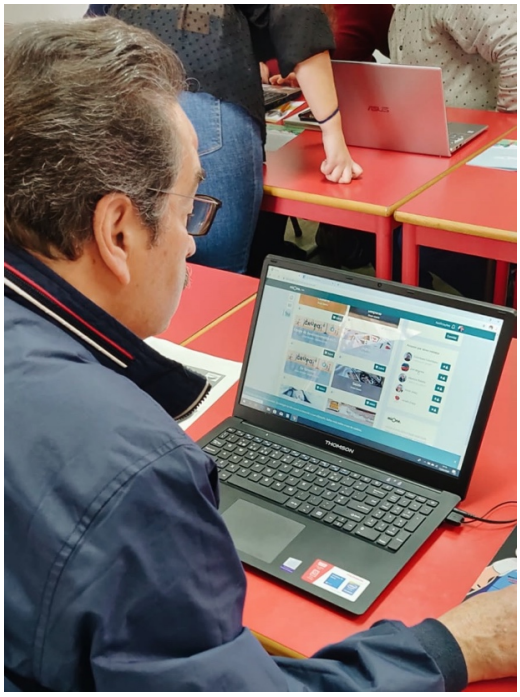


Figure 32 - Participant from the University of the Third Age of Esmoriz interacting with the miOne community.

Figure 33 – Activity 'Secret Rules' being presented to the participants at the University of the Third Age of Esmoriz.

Session 3 – The Traveler's Soul

Session 3 was held at the Universities of the Third Age of Esmoriz (n= 9 participants), Gafanha da Nazaré (n= 9 participants), and Oliveira de Azeméis (n= 3 participants) on February 19th, 18th, and March 9th, respectively.

Firstly, there was an initial presentation of the activity 'Lucky vs Unlucky Tourist.' In order to facilitate the distinction of the groups and test if participants could change their profile pictures without difficulties, participants were given two profile pictures, one picture representing the lucky tourist and one picture representing the unlucky tourist (c.f. Figure 34) and had to change their picture according to their role. After changing the profile picture, the activity started. The moderators encouraged the participants to publish images and text to interact with the other participants' posts. At the end of the stipulated time for the activity, the moderators choose the winning team based on the content of the posts published.

Figure 34 - Activity 'Lucky vs Unlucky Tourist' profile pictures.

When there were only ten minutes left for the ending of the co-design session, the activity 'Secret Friend' was presented to the participants to do at home. Some participants chose to do the activity during the co-design session, whereas some of them accessed miOne after the co-design sessions. Participants were encouraged to engage with each other's posts in order to find secret friends.

Session 4 - There are news that look like comedy and others that are pure drama

Session 4 was held at the Universities of the Third Age of Esmoriz (n=9 participants) and Gafanha da Nazaré (n=8 participants) on February 26th and March 3rd, respectively.

At the beginning of the co-design session, a discussion on the secret friends (the activity of the previous co-design session) started, in which the participants tried to guess their secret friends.

Then, the activity of 'Fake News' was introduced to the participants. For this toolkit activity, seven news with different topics were shared in a miOne group created for each University of the Third Age. At the end of the activity, a credible piece of news was revealed and a discussion about the news started.

After the activity 'Fake News', the activity 'News Match' has begun with the words 'coronavirus', 'euthanasia', 'politics', and 'global warming'. An introduction to the miOne plug-in was made and the moderators helped participants to use it.

In the Universidade Sénior da Gafanha da Nazaré, participants took more than the stipulated time to complete the previous activity, when the 'News Match' activity was conducted their ICT class was almost ending and some participants did not conduct the activity as they had other classes to attend to. Only 6 participants from that university participated.

Session 5 – Win-Win

Session 5 was only held at the Universities of Third Age of Esmoriz (n=7 participants) and Gafanha da Nazaré (n=9 participants) on March 4th and 10th, respectively.

The activity 'Win-Win' was introduced to the participants and they were organized into group settings. At the University of the Third Age of Esmoriz, participants played together and at the University of the Third Age of Gafanha da Nazaré, two groups were formed.

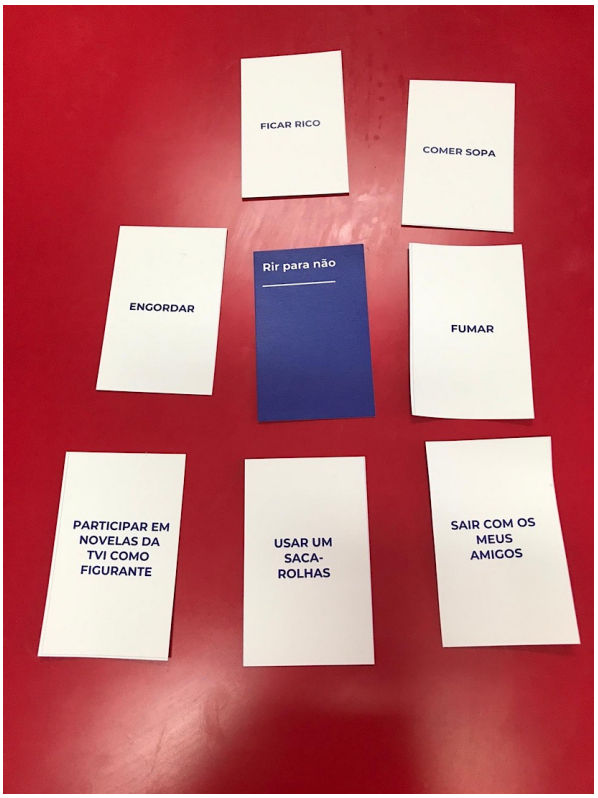


Figure 35 - Win-Win activity.

After the win-win activity, a toolkit role-playing activity 'Doctor-Patient' (further explained in chapter 6.1.3) took place. Half of the participants' role-played the doctors and the other half played the patients. Papers included such diseases' names as flu and migraine, diabetes, and anxiety, which were distributed to the patients.

Co-design activities at the University of Aveiro

During a visit of Academia Sénior de Penamacor to the University of Aveiro on March 2nd of 2020, a set of four activities were planned and conducted. Those activities were concerned with the theme's news, health, and travel, using one of the toolkit activities – 'Find the Fake News' and adding new ones. As the participants would only be available at the University of Aveiro for one hour, a quick co-design session, with three

thematic stations (i.e., health, tourism, and news) and 5 activities with a maximum for the expected time of 25 minutes per station was organized. Participants could complete one station and move to the other until they had completed all stations. The following activities are presented below.

Find the Fake News

This activity was adapted from the toolkit activity, 'Find the Fake News', previously explained in the present chapter. participants did not bring their computers or other digital devices, they had to comment and guess the fake and true news as a group, choosing one member to use the platform and be their spokesperson.

Guess the News

The purpose of this activity was to generate discussion around the news themes and get participants to communicate with each other. For each activity, participants were divided into two smaller groups. Participants from one group received a news headline with a highlighted word (G1), whereas the participants from the other group received the same headline without that word (G2). As a result, the participants of the first group had to explain the news to G2 without revealing the word missing in the headline.

Guess the calories

The present activity aims to be a fun way to discuss health-related issues by rating healthy and unhealthy foods. A set of cards with the image of a piece of food (*e.g.*, apple) was designed and participants had to guess how many calories there were in that piece of food, depending on the presented quantity.

The online co-design sessions

As previously mentioned, the study limitations due to the Covid-19 outbreak led to the need of adapting the co-design sessions to a non-presential format. Online co-design sessions were planned with the students and two coordinators of the Academia Sénior de Penamacor and the Academia Sénior de Vila Velha de Rodão. The activities started on April 9th of 2020 and ended on May 29th with the application of a semi-structured interview in a group setting. The co-design sessions were publicized on the miOne Facebook page[18] and videocalls were conducted, using the Zoom platform [19] to interact with the participants and present them some toolkit activities that were adapted so that they could be performed online. The weekly co-design sessions were planned in order to coincide with the end of the academic year of the Universities of the Third Age and the schedule was negotiated according to the availability of the participants. The procedures are undertaken in each session and the main objectives are described below.

[18] Available at: https://www.facebook.com/comunidademiOne/ (Date accessed: 25/10/2020).
[19] Available at: https://zoom.us/ (Date accessed: 25/10/2020).

Session 1 – Welcome to miOne and Easter Celebrations

A total of 6 adult learners at the Universities of Third Age and 2 coordinators participated in Session 1. This session covered two activities with the objective of building a trusting relationship between investigators and participants and establishing the first contact with the miOne online community.

The session started with the presentation of the team and the project, as well as a brief explanation of future activities. The activities of this session consisted of: (a) Registering with the community and editing the profile information (profile picture and section 'about me') to test if participants could register and configure their accounts easily; and (b) Share your Easter celebrations (*e.g.,* photos, recipes, traditions) during the week. One of the moderators demonstrated, step by step, the registration in the community, also providing a user manual that participants could access in case of any doubts during the process.

Figure 36 - miOne' user manual.

Session 2 – The Traveler's Soul (Online)

Session 2 could count on the participation of 5 adult learners and 2 coordinators. The session started with the presentation of the adapted toolkit activity 'Lucky vs Unlucky Tourist' (c.f. chapter 7.1). For the activity, the participants were randomly divided into two groups presented in the videocall: lucky tourists and unlucky tourists. In the 'Travel' miOne group, participants shared their good or bad travel experiences, depending on the group, trying to convince or discourage other participants from traveling.

Session 3 – Find the Fake News (Online)

Session 3 had a total of 4 participants and 2 coordinators. This session started with the presentation of the adapted toolkit activity 'Find the Fake News.' Given the current context, this activity aimed to educate participants on the dangers of misinformation and fake news about COVID-19. For the activity, the moderator shared in a group five news about COVID-19, four of which were false and only one true.

Session 4 – Win-Win (Online)

The last session was an adaptation from the toolkit activity 'Win-Win' with a total of 3 participants and 2 coordinators. In the group 'Health', the moderator posted 13 images with sentences that were incomplete (c.f. chapter 7.1). Participants had to complete the blank spaces with the words/sentences they thought were best, commenting on the posts of the images. Moderators encouraged participants to vote on their favorite answer by commenting on the posts.

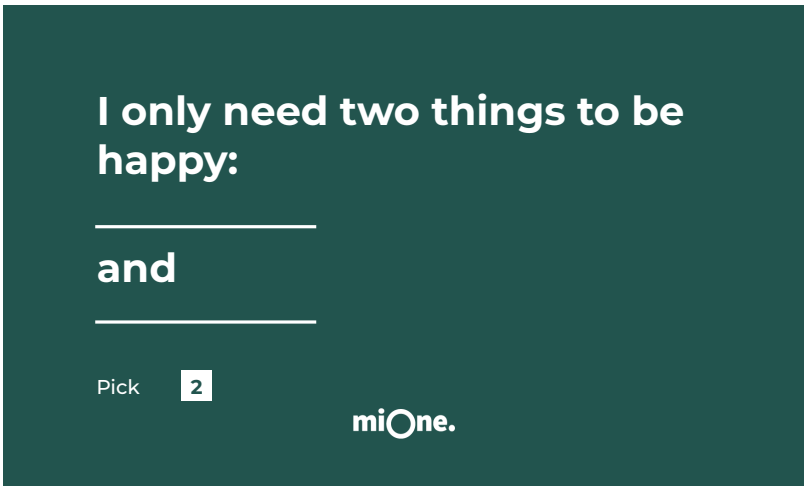


Figure 37 - Win-win online activity.

Phase 3 - Assessing the Co-design sessions and Toolkit Effectiveness

To support the data collected from the direct observation and field notes and gain further insights on participants' experience with the toolkit and the miOne online community, an online questionnaire was distributed to the participants of the co-design sessions, presential and online, and a semi-structured interview in a group setting was conducted, only with the participants who could participate due to the COVID-19 pandemic limitations. The two data collection instruments are further explained in the following sub-chapters.

Questionnaire

The questionnaire was administered to the participants, after the online co-design sessions on June 22. These were sent out to the participants and the coordinators of the Universities of the Third Age. Considering that reaching the participants was hard in a time of social confinement and most of them have not used the Internet frequently, the time to fill the questionnaire was extended to November 9, 2020.

The first section of the questionnaire is relative to the sociodemographic data of the participants, asking the participants' age, genre ('Feminine', 'Masculine' or 'Other'), the education level ('1st to 4th grade', '5th to 6th grade', '7th to 9th grade', '10th to 12th grade' 'University Studies' and 'Postgraduate Training') and an open-ended question regarding the area of residence of the participants.

In terms of the participants' frequency and habits of using the Internet and Social Networks Websites or Online Communities, they were asked "How many hours do you spend on the Internet (per day)?" with an ordinal scale with the options 'Less than 1 hour', '1 to 3 hours', '3 to 5 hours', '5 to 7 hours' and 'More than 7 hours' and "What means do you usually use to access the internet?" with the options 'Personal Computer or Notebook', 'Tablet or iPad', 'Smartphone or iPhone' and 'other, which one?'.

The question "For what purposes do you use the Internet?" was posed to identify their motivations to use the Internet, presenting the following options: 'Search content', 'Contact family and friends', 'Contact people with the same interests', 'Send e-mails', 'Access social networks websites', 'Play online', 'Watch movies or videos', 'Read news', 'Listen to music', 'Book a trip', 'Online shopping', 'Have classes' and 'Attend events', giving the possibility to add other purpose with the option 'Other, which one?'. These options were given as they are among the most performed activities by older age groups (Eurostat, 2018) and some activities they could perform at the internet in the context of the Universities of Third Age.

Moreover, to understand which social network websites participants use and how often they use them, the question "How often do you use the following Social Network Websites/Online Communities?" is asked, mentioning five social network websites that have higher active user penetration, according to Statista data (Clement, 2020)–

'Facebook', 'Instagram', 'Whatsapp', 'Youtube', and 'Twitter' – and the online community miOne, and giving a weekly scale from 'Never' to 'Everyday' for each social network/online community. Lastly, the question "What is the main reason for which you use social network websites?" with the following options: 'To spend time', 'Talk to family and friends', 'Meet new people', 'See and post about subjects of my interest', 'See events', 'To Learn', 'To Play', 'Read news' and the possibility to add other reason 'Other, which one?'. Among these options are activities users could perform at miOne and future platform activities.

The third part of the questionnaire aims to perform a UX evaluation of the online community miOne by questioning participants about the main interaction difficulties felt with the community and the most interesting functionalities of the platform. In the beginning, the participants were asked whether they had a miOne account since the following questions were relative to the user experience in the community. If participants did not have an account, they were directed to a questionnaire section that contained information about the miOne online community and activities, asking them whether they would be interested in participating in these activities and their contact to be contacted by the author of this dissertation.

In case the participants had a miOne account, they proceeded with the next questions about their experiences in the community. In specific, the first question asked the participants to rate the following statements about miOne, using a Likert scale from 'Totally disagree' to 'Totally agree': 'It is intuitive and easy to use', 'It is easy to find information', 'It is esthetically pleasing', 'It has a nice color scheme', 'I'd recommend it to a friend' 'I use it for leisure', and 'I use it for learning'.

Similarly, the participants' perceived difficulties were also assessed, containing the following features: 'Registration', 'Access and profile edition', 'Publication of contents', 'Publication of contents with images or videos', 'Join a group', 'Access the news', 'Share news', 'Debate news', 'React to news', 'General use of the online community', in which a Likert scale from 'Very easy' to 'Very hard' was applied. The open-ended question "Do you have any suggestions for the miOne community to help overcome these difficulties?" was added to help to explain the difficulties mentioned.

Regarding the features in the miOne online community that could interest the participants the most, they were given the following activity options that are enabled in the community: 'Read news', 'Share news', 'Debate news', 'Join groups', 'Create groups', 'Join communities', 'Share photos and videos', 'Make video calls', 'Manage events', 'Consult health information', 'Play games', 'Have weekly challenges and rewards for community interaction', 'Chat through text messages', 'Have health suggestions' and 'Recommendation of places to visit, routes and plan trips'. Using a Likert scale from 'Nothing interesting' to 'Completely interesting.' An open-ended question on the same topic was also provided "What future features do you suggest for the miOne community? Note: "You can leave an additional comment/ suggestion about the miOne community."

Finally, the fourth and last part of the questionnaire had the purpose of analyzing the influence of the UX toolkit in the miOne online community. Furthermore, it aims to improve the toolkit by identifying the participants' favorite and least favorite activities and understand whether the use of the toolkit can be used and extrapolated outside of the co-design sessions. That way, a set of guidelines for the development of online communities aimed at this target audience are also provided.

In this later section of the questionnaire, participants were asked to indicate whether they participated in online or presential toolkit activities. Then, they were asked to select their favorite activity from a list of the activities that were carried out and answer the following open-ended questions: "What did you enjoy most about the activities?", "What did you least like about the activities?" and "Describe your experience in participating in the mentioned activities."

To understand whether the co-design activities motivated the participants to use the community, participants were asked if they continued to use miOne (options of 'yes' or 'no') after the ending of the co-design sessions and to justify their answer. Moreover, the next question focused on the way the activities could positively or negatively influence the usage of the community and possible toolkit improvements, *i.e.* "How do you consider that the activities developed motivate or discourage the use of the miOne community?"; "What would you suggest to improve the activities relative to the miOne community?". Given that at the time of writing this Master's thesis there was a COVID-19 outbreak, an additional question was added i.e. "In your opinion, to what extent do the activities carried out help to combat social isolation?".

To end the questionnaire, participants were optionally asked provided with an input where they can add their e-mail address if they want to be contacted or informed about miOne initiatives and the study results.

Online semi-structured interview within a group setting

A semi-structured interview with a duration of 90 minutes occurred after the online co-design sessions ended, on May 29th. The purpose of this interview was to understand the level of interaction and motivations that participants had to engage with social networks and online communities, proposing a set of design guidelines for developing online communities.

An interview protocol was established, integrating questions concerning the use of social networks, topics of interest in online communities, user experience in the miOne online community, and evaluation and acceptability of the toolkit and the miOne community (see Table 10). Taking into consideration the definition of semi-structured interviews (see chapter 2.2.1), the questions served as a guide and there was some flexibility in the way participants could lead the conversation.

An introduction to the purpose of the interview was given, and participants were asked if they would like to participate. Then, participants were asked for consent to record the interview to facilitate posterior analysis. A PowerPoint presentation was also shown to the participants, in order to recall previous activities and announce the winners in each activity.

Table 10 - Group data collection questions and goals for data analysis.

Data collection questions	**Goals for data analysis**
1. Do you use social networks on a daily basis? 1.1. What motivates you to use social networks? 1.2. What are the reasons for you not to use social networks?	Identify participants' motivations for using social networks.
2. Do you belong to any online community or social network group where people with common interests share messages and content? 2.1. What leisure activities do these groups like to discuss?	Identify activities and topics of interest in an online community context.
3. What distinguishes the miOne online community from the other platforms you use? What drives you to use miOne?	Relate the miOne community to the 'Novelty' dimension of UX.
4. Do you consider that the use of the platform is intuitive? 4.1. What difficulties did you have while using the miOne community? 4.3. Did you need help during activities? Was it easy to get help with tasks?	Relate the miOne community to the 'Perspicuity', 'Efficiency and' Dependency 'dimensions of UX ("ISO 9241-210:2010(En), Ergonomics of Human-System Interaction — Part 210: Human-Centred Design for Interactive Systems," n.d.).
5. Which feature has captured your interest the most? 5.1. What other features would you add to miOne? 5.2. The miOne team also plans to add health features, events, and video conference meetings. Do you consider these features relevant? Why?	Relate the miOne community to the UX 'Attractiveness' and 'Stimulus' dimensions ("ISO 9241-210:2010(En), Ergonomics of Human-System Interaction — Part 210: Human-Centred Design for Interactive Systems," n.d.).

Table 10 - Group data collection questions and goals for data analysis (cont.).

Data collection questions	Goals for data analysis
6. How was your experience doing the activities? 6.1. What activity did you most enjoy participating in? Why? 6.2. Which of the activities do you consider the least interesting/useful for using the platform? 6.3. Can you think of any activities that you would like to do to interact with the miOne community? 6.4. In what way do the activities carried out to motivate the use of miOne? 7. In your opinion, to what extent do the activities carried out help to combat social isolation?	Analyze the toolkit's contribution to the experience of using the miOne community.
8. Describe the social network or online community of your dreams	Identify a set of guidelines for the development of online communities aimed at this target audience.

Phase 4 - (Re)design of the online community miOne

In the last phase, an Eye-tracking evaluation .and the redesign of the online community were carried out, taking into consideration the participants' feedback, observation of the co-design sessions, questionnaire, and group discussions.

Eye-tracking evaluation

An eye-tracking session was held on March 2nd, 2020 at the University of Aveiro from 3 pm to 4 pm, with five adult learners from the Academia Sénior de Penamacor. This evaluation session involved a presentation of the aim of the research, the researcher, the informed consent, a user story as a script for users to follow during the evaluation, and the interaction with the miOne community using eye-tracker.

As participants did not know the researcher and the project, a presentation was made about the project and the eye-tracking evaluation procedures were introduced and explained.

To analyse participants' data using the eye-tracker and enable screen recording, participants' faces and voice, participants were given a consent form – see Appendix 4 – Consent form of the eye-tracking evaluation.

Participants were then given a paper sheet with a user story focused on testing the miOne navigation by finding the group menu, joining, and publishing in a group of the online community. The user story was:

"This year you want to go on a summer vacation and decided to join the group 'Travel' to ask for suggestions from those who already have more experience in the subject".

To provide some extra guidance if needed, participants had also points they could follow to complete the task: 1) Join the 'Travel' group; and 2) Post 'Suggestions for trips?' – see Appendix 5 – Eye-tracking researcher script.

At the beginning of the activity, information about the age of the participants, genre, and usage or need to use glasses was registered – further detailed in this chapter. The age of the participants and usage of glasses might affect the eye-tracking detection regarding that as a result of changes inherent to the aging process, older adults' pupils are affected, changing size more slowly and being less able to dilate. These changes result in less light entering the eye resultant in the loss of the ability to distinguish details in low light. Also, cataracts are common on senior citizens, making the vision hazy and susceptible to reflected light (Pak & McLaughlin, 2010), as previously noticed in subchapter 1.3.

It is also worth noting that eye-trackers don't handle well with bi or varifocal lenses, given that the lens distorts the shape of the pupil, causing detection errors (*Tobii Pro: Eye-tracking study recruitment – managing participants with vision irregularities*, n.d.).

The researcher watched the participants and provided some assistance when needed. Participants also had the tasks sheet with them and could consult it whenever they needed to. For this test, users needed to have a miOne account, and a generated password and e-mail were given to the participants as the registration process could take a lot of time and would not be the focus of the evaluation. A camera and microphone positioned at the top of the computer were also recording the participants' faces and voices, in case an analysis of participants facial expression was needed to check the verbal feedback given during the task. The eye-tracking evaluation setup is presented in Figure 38.

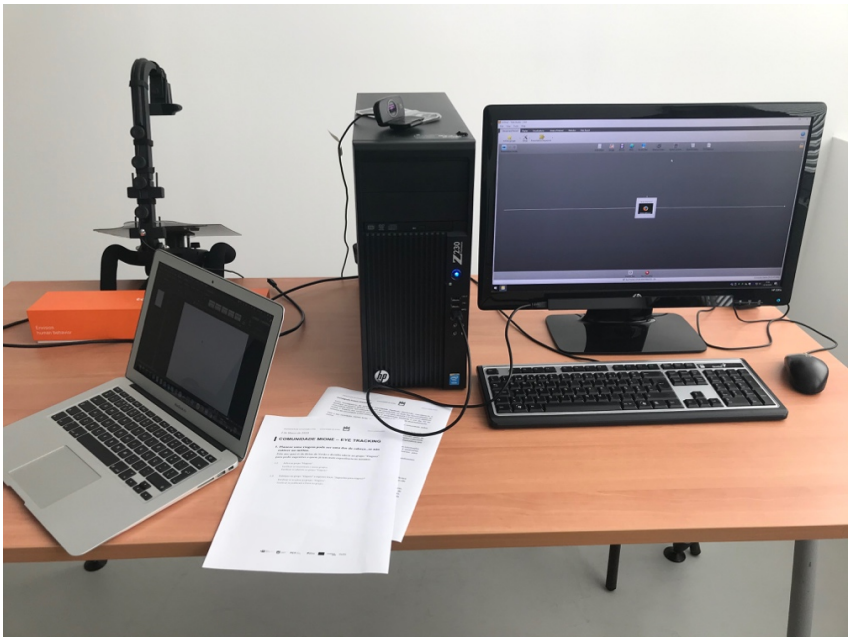


Figure 38 - Eye-tracking evaluation setup.

6.1.4. Data Analysis

As previously mentioned, this research follows a triangulation analysis, gathering mostly qualitative data from different sources: direct observation, field notes, semi-structured interviews, questionnaires, eye tracker data.

The software NVIVO[20] was used to organize and analyze non-numerical or unstructured data such as images or interviews, whereas the software SPSS[21], an IBM software was used to represent descriptive data relative to the questionnaires used.

6.1.5. Ethical Considerations

The data collected in this study followed the procedures approved by the Ethics and Deontology Council of the University of Aveiro Ethical Approval for the SEDUCE 2.0 project - use of Communication and Information in the miOne online community by senior citizens (Project FCT POCI-01-0145-FEDER-031696). These ethical procedures include (a) consent form for all the participants; (b) voluntary participation in the study; (c) confidentiality and anonymity in the data collection and analysis.

6.1.6. The role of the researcher

The researcher plays an important role in collecting, interpreting, and interpreting the data. Given my involvement in the activities of the SEDUCE 2.0 project and my relation

[20] Available at: https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home (Date accessed: 19/05/2020)

[21] Available at: https://www.ibm.com/analytics/spss-statistics-software (Date accessed: 19/05/2020)

with the adult learners from the Universities of the Third Age on a daily basis, it can bring some inevitable biases to the study. Hence, the triangulation of different data sources is expected to help to overcome some of those biases.

6.2. Research contextualization

6.2.1. Universities of Third Age

The Seduce 2.0 project partnered with Universities of the Third Age and Senior Academies to conduct co-design activities of the online community miOne. The organizations, which accepted to be part of this research, were: Academia Sénior de Penamacor[22], Academia Sénior de Vila Velha de Ródão[23], Universidade Sénior de Esmoriz[24], Universidade Sénior da Gafanha da Nazaré[25] and Universidade Sénior de Oliveira de Azeméis [26]. The following is a description of the context for each University of the Third Age.

ASP – Academia Sénior de Penamacor; ASVVR – Academia Sénior de Vila Velha de Ródão

The Academia Sénior de Penamacor (ASP) and the Academia Sénior de Vila Velha de Ródão (ASVVR) belong to the Associação Para o Desenvolvimento da Raia Centro – Sul (ADRACES[27]), an organization that aims to contribute to improving the quality of life of rural communities. The previously mentioned organizations follow an innovative concept of active aging, focused on the quality of life of the senior citizens aged over 50 years old of the Municipality of Penamacor and Vila Velha de Ródão. The aim is to be a socio-educational response to regularly create and direct social, cultural, educational, and social activities. Educational activities operate on a non-formal basis, without certification purposes, and in the context of lifelong training.

USE – Universidade Sénior de Esmoriz

The Universidade sénior de Esmoriz (USE) aims to promote social, cultural, educational, and social activities for people aged over 50 years old to promote active aging, reducing their degree of dependence on third parties, enriching their training, and developing unexplored skills.

[22] Available at: https://www.facebook.com/academiaseniorpenamacor (Date accessed: 19/05/2020)
[23] Available at: https://www.facebook.com/academiaseniorvilavelharodao (Date accessed: 19/05/2020)
[24] Available at: https://rutises.wixsite.com/esmoriz (Date accessed: 19/05/2020)
[25] Available at: www.facebook.com/universidadeseniorgafanhanazareilhavo (Date accessed: 19/05/2020)
[26] Available at: https://www.usoa.pt/ (Date accessed: 19/05/2020)
[27] Available at: https://www.adraces.pt/ (Date accessed: 19/05/2020)

USGN – Universidade Sénior da Gafanha da Nazaré

The Universidade Sénior da Gafanha da Nazaré (USGN) aims to foster the social, cultural and civic participation of retired citizens, aged 50 and over.

Participants can choose from vast disciplines that are offered such as dance; notions of global, social, and personal security; theater; sewing; nutrition and health; communication history; English; information and communication technologies; music; arts; agriculture; photography; among others (Barbosa, 2017).

USOA - Universidade Sénior de Oliveira de Azeméis

The Universidade Superior de Oliveira de Azeméis (USOA) is a non-profit organization that seeks to collect and promote lifelong learning and the exchange of knowledge from both theoretical and practical disciplines. This organization promotes social volunteering, socio-cultural initiatives, solidarity, conviviality, and leisure.

6.2.2. Participants

A convenience sample was used in this research and, therefore, data collection cannot be inferred to other contexts. The criteria for this study sample were a) being 50 years old and over; and (b) showing interest in ICT, not requiring participants to be experts on the subject.

In relation to the presential co-design sessions the sample consisted in 17 to 30 students from the Universidade Sénior de Esmoriz, Universidade Sénior da Gafanha da Nazaré and Universidade Sénior de Oliveira de Azeméis per session, 53% males (n=16) and 47% female (n=14), aged between 56 and 86 years old (M=68,9 years; SD=7,28) (Further information and codification can be accessed in **Appendix 6 – Presential participants codification**. Considering that the toolkit involved a pack of 6 weekly activities, there were some participant's absences in some of the sessions and withdrawals in the later activity owing to the participants' difficulty to maintain a routine in participating in online activities during the COVID-19 outbreak.

For the online co-design sessions, the sample varied from 3 to 6 participants (OP) per session from the Academia Sénior de Penamacor and Academia Sénior de Vila Velha de Ródão, 17% male (n=1) and 83% female (n=5), aged between 52 and 72 years old (M=65 years; SD =7,24). Furthermore, the sample includes 2 coordinators from each Universitiy of the Third Age, 1 male and 1 female aged 42 (C1) and 49 (C2) respectively, who were involved in all the activities and helped creating empathy with the participants and gave their perspective on the conducted activities, and the miOne platform (c.f. Table 11).

Table 11 - Details of the online co-design sessions sample.

Participant	Age	Genre	University of Third Age
OP1	52	Female	Academia Sénior de Vila Velha de Ródão
OP2	62	Female	Academia Sénior de Penamacor
OP3	66	Female	Academia Sénior de Vila Velha de Ródão
OP4	68	Female	Academia Sénior de Vila Velha de Ródão
OP5	70	Female	Academia Sénior de Vila Velha de Ródão
OP6	72	Male	Academia Sénior de Vila Velha de Ródão

The semi-structured interview within a group setting was conducted online in a videocall with the participants from the online co-design sessions, having a total sample of 2 students from the Academia Sénior de Penamacor and Academia Sénior de Vila Velha de Ródão (OP2 and OP3) and the 2 coordinators.

In terms of the questionnaire, it was distributed to all participants in the activities who could be reached online, via Facebook and miOne chat. A total of 21 participants answered the questionnaire (almost 57% of the total sample) and further information on the respondent sample will be detailed chapter 7.

Lastly, the eye-tracking evaluation had a total of 5 participants (EP) from Academia Sénior de Penamacor, 60% females (n=3) and 40% males (n=2) aged between 70 and 80 years old (M=75,8; SD= 4,15). Three of the participants are classified as older-old and the other two participants younger-old. Furthermore, as previously mentioned, it was important to note if participants had any vision problems, so the researcher noted if they were using glasses and if they were not wearing, if they needed to use. Table 12 presents the details of the eye-tracking participants.

Table 12 - Details of the sample of the eye-tracking evaluation

Participant	Age	Genre	Observations
EP1	78	Female	Was using glasses
EP2	78	Female	Was using glasses
EP3	70	Female	Was using glasses
EP4	73	Female	Was using glasses
EP5	80	Female	Was not using glasses however needed to use them

Table 13 presents a summary of the sample for the different sessions

Table 13 - Sample summary.

Method	**Sample**
Presential Co-design sessions	29 to 17
Online Co-design sessions	8 to 5
Eye-tracking	5
Semi-structured Interview	4
Questionnaire	21

Having described the method used, undertaken procedures and sample, the next chapter presents the research results.

7. Data Analysis, Evaluation and Discussion of Results

This chapter presents the results obtained from the data collected in the different phases of the 'Action Research' design, which are essential to draw conclusions and answer the research question "In what way can co-design influence senior citizens' experience with online communities?"

7.1. Phase 1 – Co-design Research and Toolkit Development

An important outcome of this Master's thesis is the development of the UX toolkit grounded on the literature review, in which the activities were described in subsection 6.1.3.

The toolkit consists of 6-week activities that may be performed either face-to-face or online during the users' pre-experience, experience, and post-experience.

The activities contained in this toolkit are in accordance with the most cited co-design strategies with the older target group mentioned in section 2.1: a) Delivery of the activities in the form of workshop sessions followed by reflection periods with interview and questionnaire surveying; (b) The use of scenario building in such games as 'Secret Rules' or/and 'The Lucky/Unlucky Tourist'; (c) Use of Online Cultural Probes (*e.g.,* Secret Friend activity); (d) The use of autobiographical storytelling games (*e.g.* Win-win); and (e) Consider the people's experiences in past, present and future lives in pre-, during and post-design (Sanders & Stappers, 2014) by dividing the activities into pre-experience, experience and post-experience.

This toolkit has been applied in presential sessions of three Universities of the Third Age and adapted to an online context. The next section describes the results of the toolkit application.

7.2. Phase 2 - Applying the co-design toolkit

This UX toolkit has been applied in presential sessions of three Universities of the Third Age and adapted to an online context. The next section describes the results of the toolkit application in these two application scenarios: A. Presential Sessions; and B. Online sessions.

A. Presential sessions

This application of the designed UX toolkit in presential sessions of three Universities was performed during 5 weeks in each University of the Third Age, being later interrupted with the COVID-19 measure – total social confinement. These sessions were: (A1) Session 1- Partners at first sight; (A2) Session 2- A Community is born that encompassed the games 'More than Words' and 'Secret Rules'; (A3) Session 3 – The

Traveler's Soul that integrated the game 'The Lucky vs Unlucky Tourist' and the activity 'Secret Friend'; (A4) Session 4 – There are news that look like comedy and others that are pure drama that integrated the activities 'Find the Fake News' and 'News Match'; and (A5) Session 5 - Win-win that embodied the activities 'Win-win', and 'Chat-Doctor-Patient.'

(A1) Session 1 – Partners at first sight

Session 1 entitled 'Partners at first sight' corresponded to the 'Pre-experience' phase and had the goal of understanding the end-users' experiences, motivations, and interests of adult learners to digital platforms.

In this session, participants received the sticker book and the first session sticker. They were also told that one sticker would be assigned to each session (chapter 6.1.3). This activity has been essential to ensure participants' attendance in each session, as pointed out in the researchers' diary.

> *"All participants brought their sticker books, and it is not the first time that at the end of the co-design session they reminded me to give them the session's corresponding sticker. One participant was worried because there were three stickers missing (the last two and the bonus) and the moderators told the participants that there was only one session left."*
>
> - Researcher's diary [March 4th, 2020]

In general, session stickers are a good strategy for motivating the participants' attendance in research activities that prolong time and helps the researcher to monitor withdrawals and routines in the activities.

The expectations towards the miOne online community were also assessed in the toolkit 'More than Words' (chapter 6.1.3). While performing this activity involving one solely big group at one of the Universities of the Third Age, difficulties emerged relative to self-expression and the brainstorming process. Hence, the group dynamics were restructured into smaller groups. This decision was registered in the following passage of the researcher's diary.

> *"In the first University of the Third Age (UTA), [Anonymized UTA], as participants were doing the activity "for themselves", they felt less motivated to finish the activity on time and sometimes they gave on writing the word. In the other universities, [Anonymized UTA] and [Anonymized UTA], the activity was changed to avoid that. A competition against two groups was included – the group that completed the board with related words first won. That change resulted in a most speeded activity, and therefore more spontaneous related words, and it was noticeable that it created a competitive spirit among participants, and they had more fun doing it. "*

- Researcher's diary [February 3rd, 4th and 5th, 2020]

The 'More than Words' concepts that participants from the Universities of the Third Age shared their associated words were the following: 'Activity', 'Communication', 'Confidence', 'Debate', 'Events', 'Family', 'Photography', 'Story', 'Inclusion', 'Influence', 'Internet', 'Games', 'Memory', 'News', 'Opinion', 'Share', 'Personal', 'Publication', 'Health', 'Socialization', 'Technology', 'Tourism' and 'Union'. A concept map with most frequent word/s that participants connected to each of the presented concepts were made- Appendix 7 – 'More than Words' concept map. Following the results of the most relevant concepts (with more repetitions, discussion, valid words, and number of respondents) are described below, i*.e.,* 'Activity', 'Communication', 'Internet', 'Games', 'Memory', 'News', 'Publication', 'Health' and 'Technologies'.

The most cited words associated with the concept 'Activity' were categorized into Sports/Physical Exercise (n=5) and Work (n=3) out of 11 citations. The most written word was "Exercise", which the participants referred to as physical exercise during the discussions and showed interest in such activities as "Riding a bike", "Running", and "Football". Three other citations were non-related with these categories, i.e., Willingness to participate, Games, and Music.

Relative to the concept 'Communication', there were a total of 9 citations of related words. Whereas 3 participants related the concept with Internet (n=1) and social media - *i.e.* "Facebook" (n=2), there was also a focus on "Relationship" (n=1) and "family" (n=1). Other citations were relative to the act of talking/transmitting a message (n=3). This concept was also associated with leisure-oriented activities (n=1), as mentioned by one of the participants:

> *"One participant associated this concept to a leisure activity - "theater", stating that she does and loves theater and showed interest when one moderator explained that she could share content on this activity by participating in a miOne group dedicated to it. "*

- Researcher's diary [February 3rd, 2020]

Concerning the concept 'Internet', there were 17 cited related words. The most frequent words were "Facebook" (n=3) and "Information" (n=3), followed by "News" (n=2), "Computer" (n=2) and "Communication" (n=2). Moreover, some participants (n=3) associated it with "Complicated", "Confusing", "Unknown", mentioning the difficulties felt, while using it.

Regarding 'Games', there were 13 citations. Almost half of the participants (n=6) mentioned the word "Football", whereas others referred to other sports (n=1), "Card games" (n=1), "Word search game" (n=1), "Scratchcards" (n=1), entertainment (n=1) and the dual connotation to games – "good and bad games" (n=1).

The concept 'Memory' generated 14 citations of related words. The most frequent word was associated with a cognitive process – *i.e.,* "Brain/ Mind/Thought/Reasoning" (n=9), and "Sciences" (n=1). Moreover, one participant associated memory with "Lack of health" felt as aging (n=2). Two participants associated it with "Computer" (n=1) and "ROM" (n=1).

In terms of 'News', there were 8 citations of related words, in which half of those were related to the "Newspaper" (n=4), "novelty" (n=1), "subject" (n=1), "magazine" (n=1) and "corona virus" (n=1). "News" and "Newspaper" were also the most frequent word related to the concept of the cards 'Publication'. This latter concept was also associated to "Comment" and "Like", being also interlinked with the concept of social networks.

The concept of 'Health' had 19 citations, being the most associated word "Well-being" (n=6), followed by "Happiness" (n=4), "Prevention" (n=1), diseases (n=2) medical terms – *i.e.,* physicians, x-ray, hospital (n=3), its need or ambiguity (n=2). One participant wrote "About health, I do not want to talk" (n=1), showing that this topic might be a hard subject to discuss with the participants and, therefore, it should be approached carefully.

There were 13 citations relative to the concept 'Technologies', being the most frequent: "Computer" (n=4) and "Informatics" (n=3) or media-related – *e.g.* telephone or newspaper (n=2), followed by "Byte" (n=1) and "Machinery" (n=1) , "Work" (n=1), and "Art" (n=1).

Lastly, the concept 'Tourism' was also related to the nine related terms, being the most frequent "Fun" and "Tours". In general, participants showed an interest in tourism activities.

At the end of the session, the following question has been posed: "What would you like to see on the Internet or online communities/social network?" Five themes emerged: (1) Leisure-oriented activities; (2) How-to overpass difficulties in using the computer and the Internet; (3) Health information; (4) Social Networks; and (5) Interpersonal Relations. The most frequent statements of the presented themes are presented below:

1. Leisure-oriented activities (n=13 citations): In specific, participants mentioned they would like to have directions on hiking trails (n=2 citations), see the sea online (n=2 citations), watch a theatre play (n=2 citations) among other activities such as watch movies, craftworks…
2. How-to overpass difficulties in using the computer and internet (n=8 citations): Participants stated they needed less technological jargon (n=4 citations), and many felt uncomfortable by excessive advertisement (n=2 citations).
3. Health information (n=4 citations): This was one of the participants' concerns and one of the participants mentioned that he/she would like to have "a website of 3rd age about healthy lifestyle, health, food, physical exercise…".
4. Social Networks (n=3 citations): Although no associated words were found, participants mentioned that they would like to understand the "art of growing older

on social media" and the "behavior of social network users." One user also mentioned wanting to download videos from Facebook.

5. Interpersonal Relations (n=3 citations): No frequent words were found. One participant stated they would like to "have more true friends".

These interests are in accordance with those identified by Nimrod's (2010a) content analysis of 14 leading online communities, e.g. family, health, recreation, technology, aging, and travel.

(A2) Session 2 – A community is born

Session 2 entitled 'A community is born' corresponded to the 'Experience' phase and had the goal of both establishing the participants' first contact with the miOne online community and foster the participants' adherence to the community. This session integrated the game 'Secret Rules'.

It is worth noting that for this activity, only one of the Universities of the Third Age, only one participant had an e-mail and Facebook account, whereas the other participants have shown many difficulties in using the computer and need of assistance during the whole process. Therefore, the researcher helped the participants to create an e-mail and register in the online community miOne. For that particular reason, participants could not finish the sessions' activity on time. At the other Universities of the Third Age, some participants (n=3) also had to be assisted during the co-design sessions, while using the use of a computer/internet.

Concerning the registration on the miOne online community, users who used the e-mail had difficulties creating an account mainly because of the lack of feedback relative to the password requirements. For instance, a password should contain special characters and many of the participants did not know what a special character was and felt frustrated when trying to choose a password to use, leading to dropouts in the activity. The researcher assisted these participants by providing some examples of special characters and their use on passwords.

Another difficulty that was felt by many participants was to find their profiles (n=5). When they found the profile picture on the top right side of the website, they expected to click on it and immediately go to their profile picture. Some participants waited to be redirected to their profile and did not realize that the other menu opened, and they had to click again on their profile picture/name – see Figure 39.

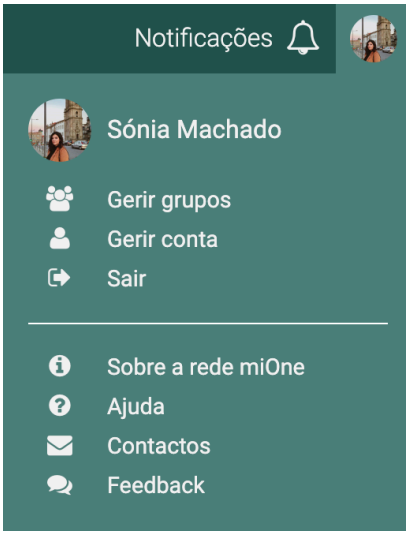


Figure 39 - Profile Menu.

When configuring their profiles with a profile picture and a self-description, some participants also showed difficulties (n=5). The clickable area to edit profile picture was also not easily identifiable, and moderators had to give some assistance after giving some time for them to explore. Furthermore, one participant was constantly clicking on the center of the pre-defined cover banner (see Figure 40) to change the profile picture.

Figure 40 - Pre-defined cover banner.

In the section 'About me', participants were also expecting to click on 'Write something about you' ("Escreva algo sobre si") (n=11) and immediately start to write instead of having to click again on 'Write something about you' – Figure 41.

Figure 41 - 'About me' page.

These were some of the observations about the Activities, Environments, Interactions, Objects, and Users (AEIOU) that were registered. Further information can be consulted in Appendix 8 – AEIOU Registration.

Furthermore, based on the previously mentioned observations a user journey map containing the problems encountered, needs and solutions for solving those problems, was formulated for the process of interacting with miOne for the first time – see Appendix 9 – User Journey Map.

(A3) Session 3 – The Traveler's Soul

Session 3 entitled 'The Traveler's Soul' was also part of the 'Experience' phase, having the goal of analyzing the participants' use of a community group and identifying the functional requirements for touristic services in the online community based on the participants' travel experiences. This session integrated the game 'The Lucky vs Unlucky Tourist' and the activity 'Secret Friend.'

Before advancing with the game, participants still had problems with the login even after being guided through the process in the last session. Moreover, participants were asked to change their profile pictures to one picture that identified their roles (lucky or unlucky tourist) at the beginning of the session (as explained in chapter 6.1.3). There were still participants who did not notice the placement of the profile picture and could not recall how they changed their profile picture, even this activity was carried out in the previous session. Furthermore, participants still had difficulties in finding the community groups, and hover animations difficulted the interaction.

At the end of the session, one participant stated, "Last class, I was very confused but after interacting again today (with the miOne community) …I feel like I understand". Moreover, one participant saw the chat new functionality at the time of the co-design session and decided to explore it.

In terms of the activity per se, it was well understood by all the participants and they have shown some excitement in sharing their traveling adventures.

They were also very competitive in the activity, as shown in the following passage of the researcher's diary:

> *"At first, the participants from [anonymized University] did not post any photography. When they were told that the publication of photos could help to choose a winning team, the participants tried to add photos to their existing publications by editing them. However, that was not possible in the miOne. online community and, therefore, participants created new publications with photos included. Moreover, some participants added images to their publications by clicking on the clip icon (the icon to add files)."*
>
> - Researcher's diary [February 19th, 2020]

Regarding the content of the publications, the team of unlucky tourists was the elected winners from all of the Universities of the Third Age and the reasons that were pointed out to not travel were bad food (n=2), hotels with lack of hygiene (n=2), COVID-19 (n=2), loud neighbors (n=1), getting lost (n=1), plane turbulence(n=1), train malfunction (n=1) and staying in the local town to visit the city attractions without spending money (n=1).

The lucky tourists mentioned the exchange of knowledge and cultures (n=1), meeting new people (n=1), traveling using environmental-friendly transportation and reducing the traveling costs (n=1), see monuments and different architecture (n=1), assist a concert (n=1), and visit museums (n=1).

Most of the Lucky Tourists described real traveling experiences or trips as good traveling experience, except one participant who decided to role-play in a traveling journey as a lucky tourist.

Furthermore, one participant took advantage of the activity to promote the group excursions. while sharing a poster of the event. At the end of this activity, the online community may constitute a good space to share provide information about places' history, gastronomy, culture, architecture, and museums. Moreover, travel reviews and traveling storytelling should be encouraged.

In terms of the activity 'Secret Friend', participants from one of the Universities wrote about their secret friends during the time of the class and visited the miOne online community in an attempt to guess the secret friend. Other Participants had a short period of time in completing the first task and some of them went to post and comment on their secret friends on miOne after the session. None of the participants posted photography, videos, identifying objects, or described memories with that person. Instead, their

descriptions were text-based on physical and psychological attributes, or/and behavior during the classes.

At the beginning of the co-design session that followed this session, the participants showed interest in knowing who their secret friend was. This may suggest the same concern noticed by Nicol and colleagues (2016) in that senior citizens were less comfortable with showing their photos and were more likely to show their postcards as cultural probes.

(A4) Session 4 – There are news that look like comedy and others that are pure drama

Session 4 entitled 'There are news that look like comedy and others that are pure drama' was also part of the 'Experience' phase, having the goal of analyzing the participants' interactions with news and creating awareness of fake news. This session integrated the activities 'Find the Fake News' and 'News Match.'

In the activity 'Find the Fake News', participants understood the purpose of the activity and showed interest in participating in it, discussing the news out loud with their colleagues and trying to guess the true news. In general, participants felt at ease in this activity, as noticed in the following passage of the researcher's diary:

> *"Two participants from the [anonymized University] needed help during the whole process as they had difficulties with the basics of using a computer. The other participants completed the activity by themselves, although some advice was given by the moderators during the session. Some participants also assisted their colleagues in performing the activity."*
>
> - Researcher's diary [February 26th and March 3rd, 2020]

At the beginning of the activity, participants joined the group of news at the miOne online community. Despite the usage of the platform in the previous activities, many participants still could not find the groups' menu. Relative to the news, they did not have many difficulties in interacting with the news, but some of them (n=4) did not distinguish the difference between the debate and post comments.

The comments' input was confusing for some participants, given the low contrast and some elements that were not easily identifiable as clickable. For that reason, some participants had difficulties in commenting on publications for the first time.

Figure 42 - Comments input.

The participants were also suggested to read the news and comment on them, justifying their choices on considering them as true and fake news (see section 6.1.3).

However, most of them (n=16) did not read the news, and their choices were based on the news' headline or prior opinions. Only 7 participants read the entire news and justified their choice. Furthermore, one participant tried to read the entire news but had difficulties in returning to the miOne page., as mentioned in the following passage:

> *"One participant received help to find the group and interact with the activity news. After some time, the participant was interacting with the posts of the main page and left the group, feeling lost. "*
>
> - Researcher's diary [February 26th, 2020]

Relative to news' credibility and awareness of fake news, only 5 participants guessed the credible piece of news and two selected it but did not justify their choice. Other participants searched the news on other information sources to check if that information was credible and helped other participants to search the content and comment on the news. Beyond the news search and the identification of the information source, ensuring news' readability is also important as there were some participants who read the whole information on a screen. This observation was registered in the researcher's diary:

> "*One participant was the last to complete the activity, reading the whole news 'information before deciding whether they were credible or fake, justifying the decision made".*
>
> - Researcher's diary [March 3rd, 2020]

In 'News Match', participants were assisted in the installation of the miOne news plug-in (as mentioned in chapter 6.1.3). They freely explored the plug-in for sharing news in the miOne online community, and most of the participants skipped the steps relative to the section on "How to use the Plug-in" (Figure 43).

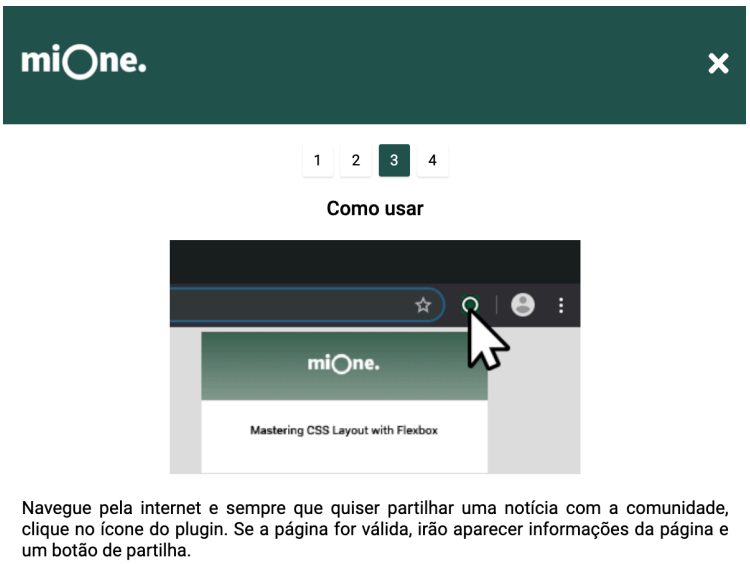


Figure 43 - Plug-in miOne introduction.

Participants were also told to share a piece of news in a group. Some participants (n=4) tried to post the news linked directly to the group, resulting in the publication of a news link. Hence, there was a need to detect whether the shared link was from a news' source. Moreover, the piece of news was only shared in the general community and participants had to (re)share it to publish it in a group.

There was also confusion with some of the language used. One participant asked about the reason for having the verb "Share" (Partilhar) as an instruction when the call-to-action button was labeled with "Post" (Publicar) (Figure 44).

Furthermore, participants did not know where to click to give their opinion on the shared piece of news ("Share your opinion about this news"/ "Partilhe a sua opinião sobre esta notícia" area) as there was low contrast and no click area was defined.

Figure 44 - Share news input.

In terms of the activity itself participants easily understood its purpose and shared news relative to a certain topic. However, not all participants tried to guess who their matching pair was.

(A5) Session 5 – Win-win

Session 5 entitled 'Win-win' was the last session of the 'Experience' phase, having the goal of motivating the participants to openly talk about health topics and test the chat functionality. This session integrated the game 'Win-win' and the activity 'Chat-Doctor-Patient.'

Considering that some of the participants were not very encouraged to talk about health-related issues, the win-win game served as an icebreaker to approach health and wellbeing in a ludic manner. In general, this team game also generated some competition and the desire to prolong the whole experience online. This observation was registered in the field notes of the researcher's diary:

> *"At the [anonymized University of the Third Age], due to a higher number of participants, two groups (5 and 6 participants) were formed. At [anonymized University of the Third Age], the participants played together. In general, participants understood the purpose of the game and wanted to continue for longer. They had fun. One participant stated 'None of the cards fit. Do I have to go to the deck? […] Ah, but this game is to laugh'. Furthermore, it was noticeable that It created a sense of competition. During the game, one player stated, "I'm always choosing funny cards and no one has chosen me [as the winner] …". As for the participants from the [anonymized University of the Third Age], each team was always checking the score from the opponent team. When the game was over, participants expected to continue it on the miOne online community. One participant mentioned. "Is that it? What about now? Is it to write it on miOne?".*
>
> - Researcher's diary [March 3rd and 10th, 2020]

Relative to the activity 'Chat Doctor-Patient', participants were very excited to talk to each other in the chatroom and perform a role-play activity. Given that it was a group-based activity, some participants were grouped with people more or less experienced in ICT. This description of the participants' dynamics and the environment is provided in the following passage:

> *"In the [anonymized University of the Third Age], the participants who played the role of 'patient' took a long time to search the disease and made those participants who played 'doctor' to wait, and vice-versa. Most of the 'patients' did not search for the disease that was given to them. Instead, they would tell the 'doctor' the symptoms they associate with that disease. Similarly, the 'doctors' almost did not search for content about the presented symptoms and tried to guess the disease based on previously acquired knowledge. Overall, participants had fun and played with their colleagues. For instance, one participant from the [anonymized University of the Third Age] answered that the best way to cure the patient's disease was to drink a lot of wine."*
>
> - Researcher's diary [March 3rd and 10th, 2020]

It is worth noting, however, that the miOne chat was in development and some *bugs* occurred. During the participants' interaction, the following difficulties were noted: (a) overall lack of contrast in the writing boxes (*i.e.*, 'Escreva nome da(s) pessoas', 'Escreva a sua mensagem') (Figure 45); (b) difficulty in checking the cursor placement to write and where they were writing. Also, participants added the name of the person they would like

to send a message to first and expected to add the persons' name on the bottom part of the chat – see Figure 45.

Figure 45 - New conversation chat input.

Furthermore, participants felt the need to attach pictures to the message sent. In addition, one participant mentioned that the option of having a spellchecking would be also interesting. Moreover, the participants had difficulty in detecting when someone was talking to them via chat and, in the beginning, the moderators had to tell them that they had a message.

So far, this section discussed the activities performed face to face, which were interrupted with mandatory social confinement. The following section describes the results of the toolkit application in online sessions.

B. Online Co-design sessions

This application of the designed UX toolkit has been adapted to online sessions, involving a 4-week package of activities/challenges and most participants and two coordinators of two Senior Academies. These sessions were: (B1) Session 1- Welcome to miOne and Easter Celebrations; (B2) Session 2- Lucky vs Unlucky Tourist; (B3) Session 3 – Find the Fake News; and (B4) Win-win. The following is an overview of the added value of each session.

B1. Session 1 - Welcome to miOne and Easter Celebrations

During the first session, participants felt difficulties in joining the weekly videocall to participate in the activities and needed extra help in registering at miOne. In general, the participants and coordinators registered at the miOne online community without difficulty and only one of the participants did not change the profile data. However, the need to explore the platform before interacting with it was mentioned by one of the coordinators. None of the participants posted anything in the community relative to the activity, however, two participants posted other contents.

B2. Session 2 – Lucky vs Unlucky Tourist (online)

In the video call, the participants showed interest in the theme of "traveling" and shared some enthusiasm to participate in the proposed activity. For example, one participant showed a special interest in the topic and told traveling stories, despite having difficulties accessing the group 'Viagens' in a smartphone (a device that the participant was using to access the Internet), being unable to publish the content. Similar to the presential co-design sessions, the participants had difficulties in finding the menu containing the community groups. Another participant also showed difficulties in publishing in the group.

The coordinators also shared positive travel experiences, including photographs of their trips. Relative to the reasons for traveling mentioned by the participants who played the role of lucky tourists, these were: Meet new cultures (n=1); Meet new people (n=1); Try different gastronomies (n=1); and Get together with colleagues (n=1).

B3. Session 3 – Find the Fake News (Online)

Two participants and one coordinator were actively engaged in this activity. The participants interacted with the news by commenting, sharing, and reacting to it. However, no participant got credible news right.

Furthermore, one participant and one coordinator independently shared other news on the topic. In the interview, one coordinator exposed their concern with the theme "Fake news" and its influence on social networks. In addition, by monitoring the public sharing and commenting activities relative to news, there was considerable interest in news' interactions.

Similar to the presential co-design sessions, participants had difficulty in sharing a news link directly to the group, instead of posting it in the news section or activity page.

B4. Session 4 – Win-win (online)

During the adaption of the game win-win, the theme "health" generated interest from the participant and the two coordinators, being elected of one of the most favorite activities.

In view of the aforementioned presential and online activities highlight the following 'best practices': (a) Delineate a strategy for motivating the participants' attendance in research activities that prolong in time (*e.g.* Session Stickers and a sticker book), (b) Use small group dynamics; (c) use group competition in activities, whenever possible; (d) Assess the participants' mental concept and expectations in a pre-experience activity; (e) Devote some activities to ice-breaking and reflection; (f) Theme-based activities relied on scenario-building help to identify functional requirements; (g) Prioritize autobiographical storytelling games. Instead of traditional kits of cultural probes, and (h) Involve the coordinators/professors at the Universities of the Third Age/caregivers whenever possible in order to motivate the participants to the activities.

Relative to the miOne online community, the following requirements emerged: (a) Provide leisure-oriented activities; (b) Focus on interpersonal relations; (c) Present health information; and (d) 'how-to' tutorials relative to the use of computers and Internet. Ensuring news' readability has been also shown as important beyond news search and the identification of information sources. In tourism, travel reviews, information about places' history, gastronomy and culture, and traveling storytelling should be encouraged.

Finally, UI elements' placement in the interface, community navigability, contrast, content labelling and the identification of clickable areas were some of the aspects that needed improvement in information, interface and visual design and, therefore, a proposal will be presented in Phase 4. (Re) design of the miOne online community.

7.3. Phase 3 - Assessing the Co-design sessions and Toolkit Effectiveness

A group interview and the administration of a questionnaire were carried out to assess the participants' ICT opinions on the online community, and co-design sessions and toolkit effectiveness. This section is subdivided accordingly with the results of the application of the two instruments of data collection: A. Questionnaire; and B. Semi-structured interview in a group setting.

A. Questionnaire

Before discussing the results of the questionnaire administration, caution must be applied in the interpretation process, given that a convenience sample was used and, therefore, results cannot be extrapolated to other contexts and only a descriptive data analysis will be made.

The questionnaire had a total of 21 answers, in which only 19 respondents mentioned having a miOne online account and of those only 17 respondents participated in the co-design activities. As mentioned in chapter chapter 6.1.3, the questions posed were relative to the sociodemographic data, frequency and habits of using the Internet and Social Network Websites, experiences in the miOne online community and difficulties, and influence of the UX toolkit in the miOne online community.

In terms of the sample of sociodemographic data, the respondents aged between 42 years old and 87 years old (M=66,76; SD=10,261). Four groups were formed based on the participants' age: pre-old, young-old, older-old, and oldest-old (see chapter 1.2), excluding the two participants aged bellow 50 years old being the coordinators of the University of Third Age. Figure 46 presents a graphic of the age group distribution.

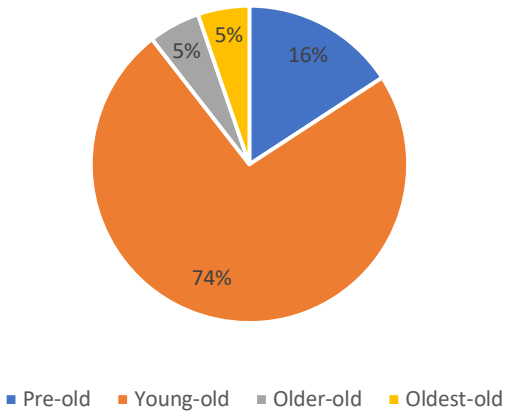


Figure 46 – Graphic of the age groups distribution (%) – 21 respondents.

Most of the respondents fitted within the young-old category (n=14), whereas the older-old and oldest-old categories had only one participant each and the pre-old group had 3 participants.

Concerning participants' genre, 57.1% (n=12) of respondents were male and 42.9% of respondents identified female (n=9) and most of the participants were from the Aveiro district (n=15) – Aveiro (n=3), Esmoriz (n=6), Gafanha da Nazaré (n=3) and Ílhavo (n=3). Also, there other regions were also represented - Centre region of Portugal [n=2), Vila Velha de Ródão (n=2), Alentejo (n=1), and Penamacor (n=1).

Relative to the participants' education level, 33.3% (n=7) of respondents said they have completed the 1st to 4th class, being the same percentage of respondents who completed the 10th to 12th class. Three participants had the 7th to 9th class, only 2 had the 5th to 6th class and 2 respondents attended the university. Figure 47 shows the respondents' education level distribution.

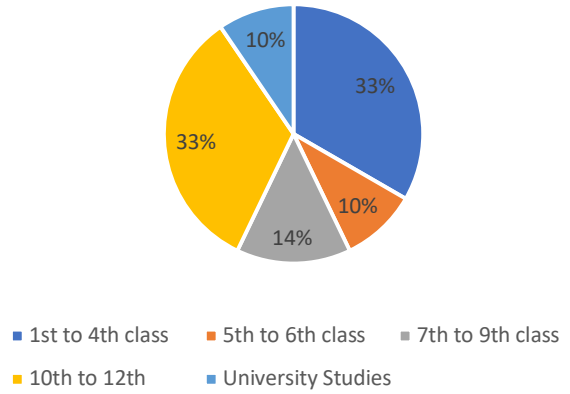


Figure 47 – Respondents' education level distribution (%) – 21 respondents.

When surveyed about the usage of Internet and the device used to access It, most of the respondents 71.4% (n=15) affirmed spending to 1 to 3 hours daily on the internet. A percentage of 14.3% (n=3) participants were likely to spend about 3 to 5 hours, whereas 9.5% (n=2) stated that less than an hour on the internet was sent per day. Only 1 respondent affirmed to spend 5 to 7 hours on the internet per day (Figure 48).

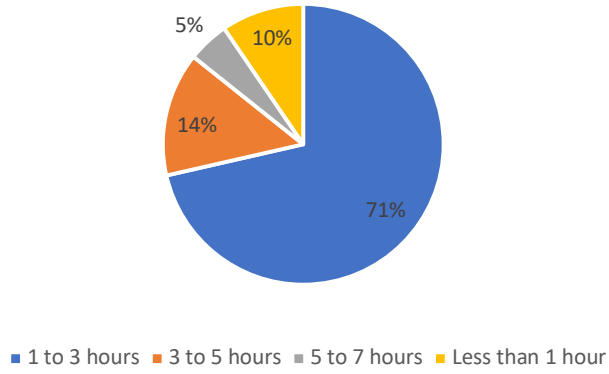


Figure 48 - Respondents' usage of Internet and devices (%) – 21 respondents.

In terms of the device that participants used to access the Internet, most of the respondents seem to prefer a PC/Notebook to access the Internet (90.5%, n=19). Indeed, most participants use only a PC/Notebook to access the internet (57.1%, n=12), 19% (n=4) of participants use both a PC/Notebook and a Smartphone/iPhone, and 9.5% (n=2) use a PC/Notebook and a Tablet or iPad. Only one participant (4.8%) uses the three combined. A total of 28.6% (n=6) users referred to use solely a Smartphone/iPhone and 19.1% (n=4) a Tablet/iPad. Figure 49 presents the devices used by the respondents.

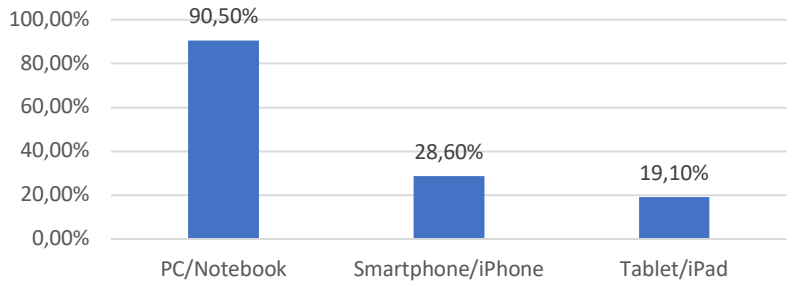


Figure 49 - Devices used to access the internet.

Regarding the activities respondents do when using the Internet, 71,4% (n=15) of respondents use the Internet to access social networks, 66,7% (n=14) to search content, 61,9% (n=13) to contact family and friends, 61,9% (n=13) to send e-mails and 42,9% (n=9) to read news. Figure 50 presents the five most performed activities on the internet.

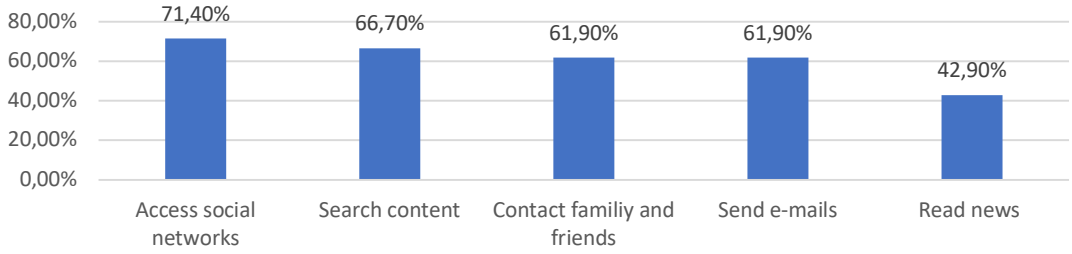


Figure 50 – Respondents' most performed activities online.

As illustrated in Figure 50, social networks are used by many respondents (71,4%, n=15). In specific, Facebook is by far the most used social network website - representing a total of 71,4% (n=15) of respondents using it every day and 9,5% (n=2) using it 4 to 5 times a week.

Figure 51 shows the frequency of using some of the social networks – *e.g. Facebook*, *Instagram*, *Youtube*, *Whatsapp*, *Twitter*, and miOne. As can be observed, the popularity of Facebook is followed by Instagram (14,3% use it every day and 4,9% use it 4 to 5 times a week) and Youtube (4,8% use it every day and 14,3% use it 4 to 5 times a week). In terms of the usage of the miOne online community, 14,3% (n=3) stated that they use it 4 to 5 times a week, however, 28,6% (n=6) of participants said they never use it.

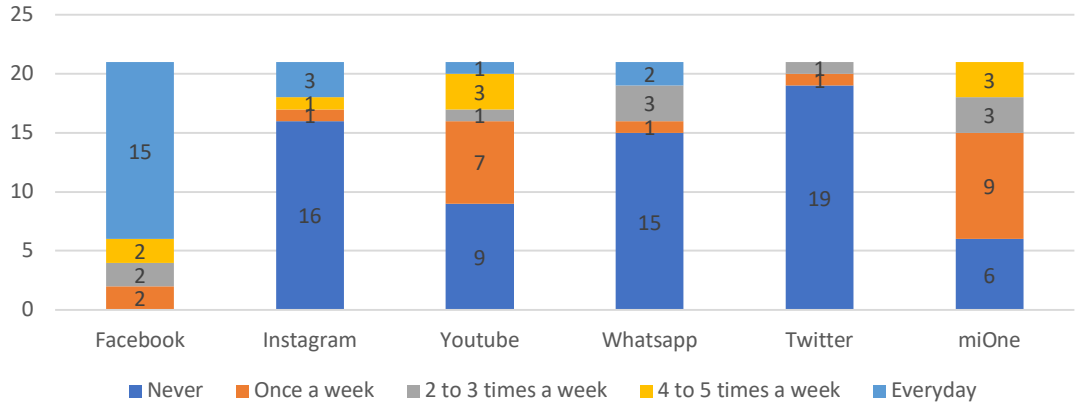


Figure 51 – Usage of the social networks by respondents.

When participants were surveyed about the activities performed in social media (Figure 52), 66,7% (n=14) of respondents stated that they use social networks to see and publish about topics of their interest, 61,9% (n=13) use social networks to talk to their family and friends, 57,1% (n=12) use social networks to pass the time, 52,4% (n=11) use social media to learn, and 47,6% use it to stay in touch with the news. This latter activity has been also cited during the participants' sessions, suggesting that social media/online communities may be also regarded as a source for news search.

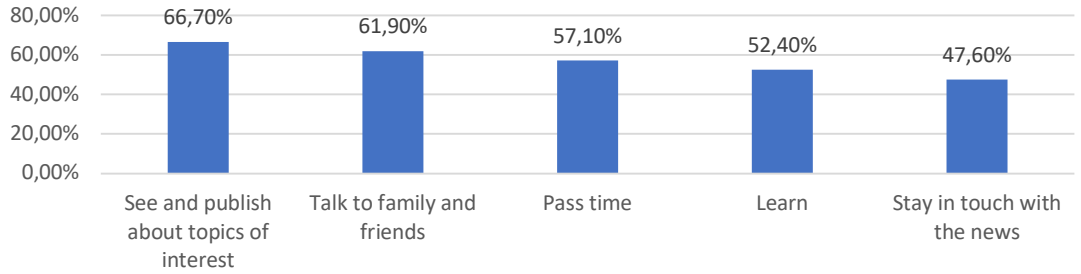


Figure 52 – Respondents' activities on social networks.

The third part of the questionnaire was relative to the experience in the miOne online community. For that, respondents were first asked whether they had a miOne online account. Only 9,5% (n=2) of respondents did not have a miOne account and were redirected to a different part of the questionnaire that, as explained in chapter 6.1.3.

For those who had a miOne account (90,5%, n=19), they were asked to rate seven statements about the online community miOne (see chapter 6.1.3) relative to their experience in terms of intuitiveness, easiness of use, information findability, aesthetics, and color scheme (using a 5-point Likert scale from 'Totally Disagree' to 'Totally Agree'). Moreover, they asked whether they'd recommend to a friend and usage in leisure and learning.

Figure 53 shows the respondents' perceived experience with the miOne online community[28]. In terms of intuitiveness, 76,1% (n=16) of users agreed or totally agreed that the community was intuitive and easy to use, and 14,3% (n=3) were neutral. A total of 81% also agreed or totally agreed that finding information was easy (n=17), whereas 9,5% (n=2) were neutral.

Regarding aesthetics, 76.2% of respondents found the online community "aesthetically pleasing", whereas 1 respondent disagreed with the statement and 2 were neutral. As for the statement "It has a pleasant color scheme", 66,6% (n=14) of participants agreed or totally agreed, 19% (n=4) were neutral and 1 respondent 4,8% disagreed with the statement.

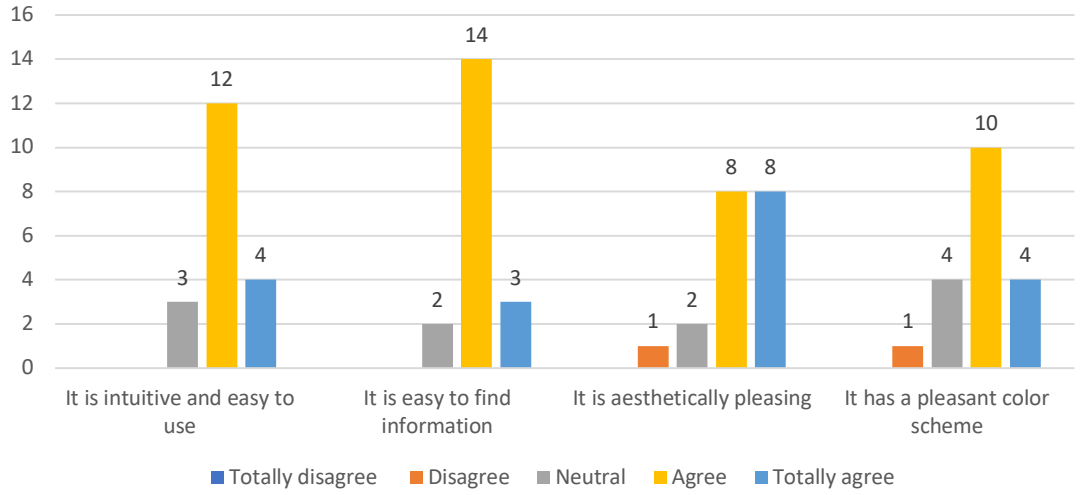


Figure 53 – Respondents' perceived experience with the miOne online community

Moreover, 47,6% of respondents agreed (33,3%) or totally agreed (14,3%) that they would use miOne for leisure activities (Figure 54), whereas 61,9% of respondents agreed (42,9%) or totally agreed (19%) that they would use miOne for their education.

More than seventy percent of respondents (71.4%) would also recommend the miOne online community to a friend (N=15). However, 2 respondents were neutral, 1 respondent disagreed, and 1 respondent totally disagreed with the statement.

[28] 9,5% (n=2) participants did not answered the following questionnaire questions as they did not have a miOne account.

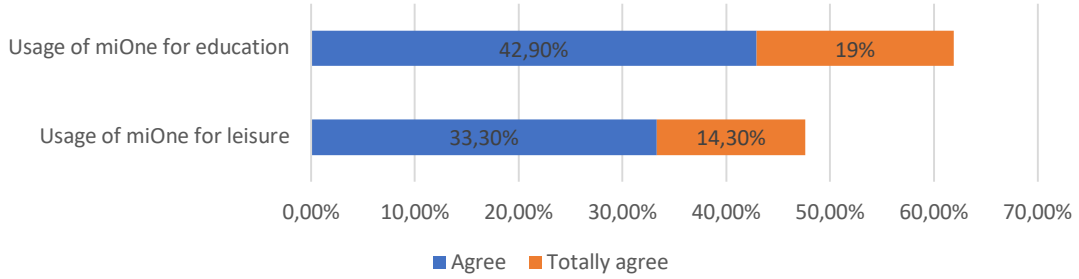


Figure 54 - Respondents' willingness to use the miOne online community in a leisure/educational context.

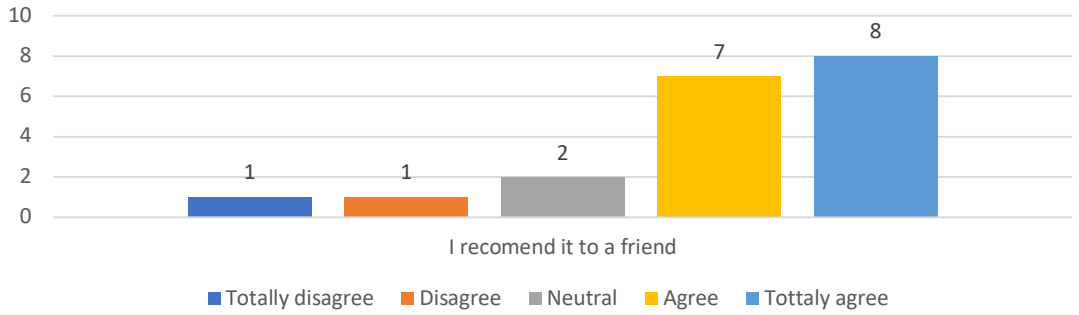


Figure 55 - Respondents' willingness to recommend the miOne online community.

Turning now to the participants' perceived difficulties in using the miOne online community, they rated into 'Very easy' to 'Very hard' (using a 5-point Likert scale) the principal functionalities of the miOne online community, *i.e.,* registration, access and edition of the users' profile, group adherence, and news interactions (as mentioned in chapter 6.1.3).

Concerning the registration in the miOne online community, 61,9% (n=13) of the respondents found that the registration process was very easy or easy, and 28,6% (n=6) stated that it is moderately difficult. The access and edition of the users' profile was very easy for 9,5% (n=2), easy for 52,5% (n=11), moderately difficult for 19% (n=4) of and difficult for 9,5% (n=2).

In terms of content publication, 57,2% of respondents stated that it was very easy or easy (n=12), 28,6%, classified it as moderate (n=6) and one participant (4,8%) said it was hard. In specific, three respondents found that adding images or videos to their publications was very easy and 38,1% (n=8) found it easy, whereas four respondents (19,1%) found it very hard or very hard. Also, group adherence was found very easy or easy by 52,3% of participants (n=11) and moderately difficult or difficult by 38,2% (n=8)

In the specific case of news' interactions, 19% (n=4) of users found that accessing the news at the miOne online community was very easy, 42,9% (n=9) easy and 28,6% (n=6) moderately difficult or difficult. According to the participants, the easiest action to perform was to debate news (61.9% found it easy - N=13, and 28.6% found it difficult – N=6), followed by news reactions through the use of emoticons (57.1% found it easy - N=12, and

28.6% found it difficult – N=7), and sharing news (52.3% found it easy - N=11, and 4.8% found it difficult – N=2).

In terms of the overall difficulty in using the miOne online community, 52.3% (N=11) found it moderately or very easy to use, whereas 4,8% (n=1) found it difficult. For the success of this community, the following five out of 15 functionalities were pointed out as the most interesting: Join communities, Health suggestions, Recommendations of places to visits, routes and plan trips, Reading News and Consulting Health Information (Figure 56).

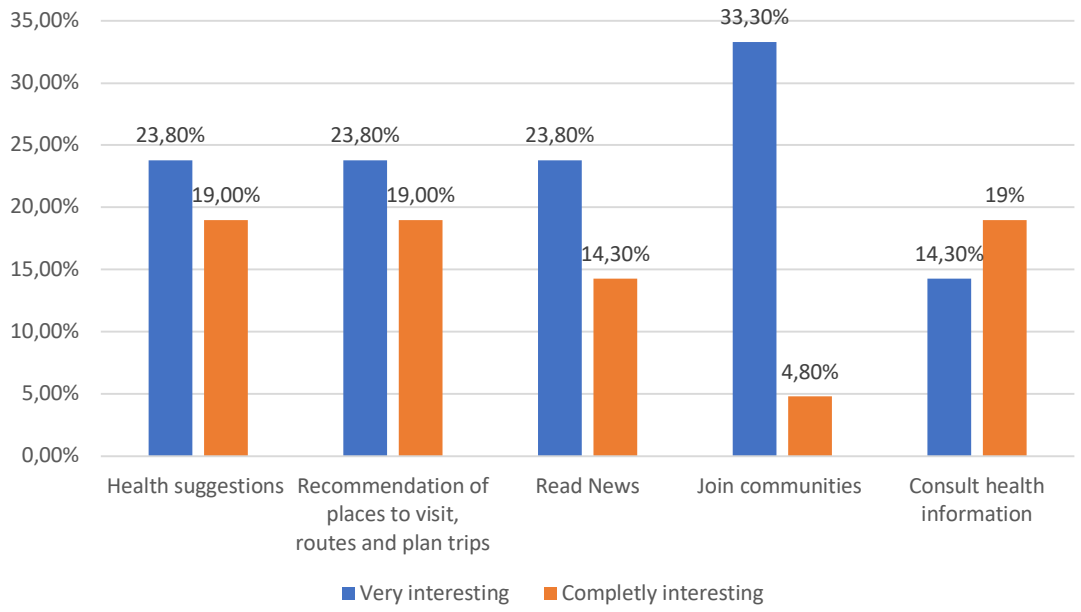


Figure 56 - The most interesting functionalities of the miOne online communities pointed out by respondents.

One participant also added that the platform could have information about nutrition and another suggested that miOne could have a connection to Facebook.

With respect to the co-design activities, the participants were asked about the 8 toolkit activities in order to select their favorites. It is important to note, however, that only 3 activities from the presential co-design sessions were adapted to the online context – 'Lucky vs Unlucky Tourist', 'Find the Fake News' and 'Win-Win' so those activities might be chosen by a higher number or respondents.

In general, 'Find the Fake News' was the participants' favorite activity, being elected by 70,6% (n=12) participants, followed by 'Lucky vs Unlucky Tourist' (52,9%; n=9), 'Secret Friend' (35,3%; n=6), 'More than Words' (29,4%; n=5), and 'News Match' (23,5%; n=4). Figure 57 shows the ranking of the participants' preference relative to the kit activities.

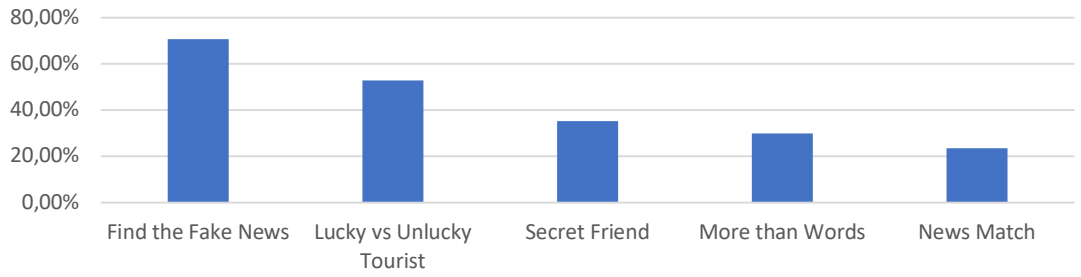


Figure 57 - Favorite toolkit activities (%) – 17 respondents.

When participants were asked about what the participants liked the most in the toolkit activities, two participants mentioned the organization of these:

> *"The collective involvement of the participants and the organized way in which the activities were prepared."*

> *"The initiative of the monitors, in making the group interact with each other, in perceiving the different challenges of the games, etc.".*

Moreover, three participants stated that they enjoyed the exchange of ideas, enthusiasm, and friendliness of other participants. Meeting new people and role-play activities were mentioned as an added value of the toolkit activities.

> *"It was a new experience even more shared with UA students and students from Senior Academies. The involvement of different generations has made these moments unique".*

> *"It was a great experience. Made us perform many activities and in the roles of various characters".*

In times of a COVID-19 pandemic, 52,9% (n=9) revelated they would continue to use the online community, whereas the remaining 47,15% (n=8) stated they would not continue. Among the reasons for not participating were task overload and laziness. One participant mentioned that with COVID-19, there was little time spent on social media, except for visiting Facebook. Another participant said that he/she did not use miOne because he/she had difficulties using the platform.

In response to "How do you consider that the activities developed motivate or discourage the use of the miOne community?", most users stated that the communication with other people and the knowledge gained with the activities was what motivated them. For instance, one participant highlighted the fact that social-driven activities in the context of an online community were what motivated him/her the most.

Furthermore, one user argues:

"They always motivate, because it is very important the connection between people and this social network. Having a very particular functionality creates bonds of affinity between people and it also achieves a closer relationship with miOne users".

However, two participants noted factors that demotivated them. One participant mentioned the lack of adherence to the activities and the other felt that there was a lack of communication when these activities would be carried out.

To improve the toolkit activities, participants suggested games with riddles, proverbs, and activities with music.

Moreover, one participant observed:

"I think that a deeper work to promote the miOne network will be necessary in order to mobilize the participation of more users".

In general, participants perceived the co-design sessions as a way for them to occupy their minds, learn new things, meet people, and discuss topics of their interest. Some participants even mentioned COVID-19 and the fact that the possibility to talk to others, at online sessions, helped them to feel less isolated. This observation is illustrated in the following participants' statements:

"Online activities are a great help nowadays when the possibility of face-to-face activities was withdrawn".

"A very important tool (miOne) that should be explored by entities with responsibility in the territories, as it will allow proximity to the local communities, creating dynamics and helping to combat social isolation."

Another essential data collection instrument for assessing the co-design sessions and toolkit effectiveness was the semi-structured interview in a group setting, in which the results will be presented in the section that follows: B. Semi-structured interview in a group setting.

B. Semi-structured interview in a group setting

A group interview was undertaken with the participants of the online activities to support the data collected in the questionnaire and, subsequently, assess their motivations to use social networks, topics of interest, experience in the miOne online community and analyze the possible contribution of the designed toolkit.

In regard to the motivations for using social networks (N=4), all participants used social networks on a daily basis. Indeed, a word frequency analysis of participants'

statements has revealed that the most used social networks by the participants were Facebook, and Instagram.

The main motivation highlighted by the participants to use social networks was its use for leisure-based activities and the possible reasons that could threaten their participation and discourage them from using social networks can be categorized into three categories: (1) Hate Speech; (2) Misinformation; and (3) Addiction. Table 14 compiles some of the participants' statements relative to the threats of social networks.

Table 14 – Participants' statements for the threats of social networks

Categories	**Examples**
Hate Speech	(C2): "*The thing I hate most about these groups is when they start talking about things they don't understand. It's what I used to say, it's 'spew hate'. Then, when we face people and talk to them, they can't talk to us".*
Misinformation	(C1): "*Last week we talked about fake news and you know that they are in vogue and end up being great influencers in public opinion on the themes that are being posted on social networks. And what generates this? It generates bad information, constant conflicts due to the fact that people are poorly informed because the truth does not correspond to what is on social networks.*"
Addiction	OP2: "*I have said to myself 'today I am not going to the computer, today I am not going to the computer' but I can't, I have to go* " (Referring to the urge to access Facebook).

To prevent the mentioned threats of social networks, participants stated that they are being very careful with the friends they add on social networks. Participants' statement are transcript bellow:

> OP2: "*When I don't like something on Facebook, I do a general cleaning! (Referring to unfriending people) I have no problems with Facebook*".

> OP3: "*I use Facebook but regarding this aspect in friendships I am also restricted*".

When asked whether the participants belonged to any online community or social network group where people with common interests share messages and content, most participants stated that they did not belong to any groups. But when the interviewer referred "Facebook groups" as an example, the participants stated that they adhered to groups or communities with the following topics of interest: (1) health and fitness; (2) retirement and (3) Education. Table 15 compiles some of the participants' exemplar statements.

Table 15 – Participants' statements about the groups/online communities they belong to

Categories	Examples
Health and fitness	(C2): *"I have a group on WhatsApp that was created by my two professors of gymnastics from the academy. [...] since we are quarantined, as we don't have classes, they send me the links over there*". (OP2): "*I am part of the paleo group (paleolithic diet)".*
Retirement	(OP3): "*I am part of the group [...] of telephones personnel from Lisbon and Porto. I was an employee there. There are many retired colleagues in the group and we occasionally exchange ideas [...]*."
Education	(C1): "*We have groups on social networks, in this case on Facebook, where we interact at a personal and community level (Senior university group) but basically it serves to share information, share details with the group […]"*

Then, participants were asked about the way the miOne online community distinguished from the other platforms. Relative to this matter, PO2 stated that they were not able to answer the question because the miOne online community is in its earliest stage. Also, C2 stated that the miOne community could be used at the classes of the Universities of the Third Age however, the low adherence to online activities was a problem felt by the coordinators.

The C1 stated added that this lack of adherence to online activities is owe to the "escape" of the commitments, in which the presential classroom classes were part of their routines, *i.e.* "With this social distance that does not require us to be in the classroom, it is much easier to escape the commitments [...]". Likewise, C2 states that the dissemination of classes and activities on social networks, despite being seen by many students, they seem to not have any impact on the participation of adult learners at the Universities of the Third Age.

Furthermore, PO3 affirms that there were some attempts to convince colleagues to go to the meetings but without success. In the participants' words, "there are colleagues in the Informatic classes who I have tried to reach them (to come to the co-design sessions) but not all of them can go because they don't have the possibility to be at the computer and deal with extra activities that go beyond their daily lives."

Concerning the intuitiveness and difficulties felt during the usage of the miOne online community, C1 mentioned that the main difficulty for the adult learners at the University of the Third Age was the fact that miOne was another "social network" but focused on posting more serious topics than the traditional social networks the adult learners usually use.

C2 mentioned that although there may be some struggles at the beginning when interacting with the miOne online community, it "is very simple [...] there are some things that you have adapt […] and say we had more difficulty or less difficulty there, but it is a matter of adjusting to things".

Relative to the access to the community, PO3 mentioned that the main difficulties were entering the zoom meetings but the miOne platform was already "recorded" at her computer and that was easier to enter there. However, the participant mentioned that some difficulties have arisen with the publication of photography on the miOne online community, but when needed, they could count with the assistance from any members of the research team.

According to PO2, the feature that has captured interest the most was the health thematic group, loving health-related topics and contents posted about health (Win-Win game). PO2 also suggests that the miOne online community should continue to bring those contents to the platform.

Still about the features that have captured the participants' interest the most, C2 emphasized the shareability of photographs in the community. The rest of the participants mistakenly associated the features of the online community with the co-design activities, mentioning the Win-win game as their favorite activity (n=3).

As for the features that could be added to the miOne online community, PO2 and PO3 mentioned "Health-related services" and "News", although this latter is already a feature in the community.

C1 also mentioned that the miOne chat should be altered, stating:

> C1: *"[…] chat rooms are more functional and easier to interact with than the one there is now. Although we can talk to each other through miOne chat, it is still a bit 'clumsy'. If you see for example Facebook, in this case Messenger, is extremely easy to communicate and interact and make video calls. It would be interesting for you to take this small leap so that people could use this network in the same way,*"

Then, participants were surveyed about the toolkit activities (as explained on chapter 6.1.3) and PO3 mentioned a difficulty felt during the activity "Lucky vs Unlucky Tourist" activity, which was not being able to post her text at miOne 'Travel' group, when she was still beginning to explore miOne.

Afterwards participants were asked to think about an activity they would like to carry using the miOne online community. In response, C2 gave an idea of a game that consisted in posting content (anonymously) and the other users should try to guess who posted that content.

> C2: "For example, a challenge with 3 photographs unidentified. The miOne community should vote for the one (which they like most) …or a text or a joke".
>
> C1: "(…) and it turns out to be fun because we understand if the members of the miOne network know or if they have an idea of who the photographer is […]".

For the question "In what way do the activities carried out motivate the use of miOne?", PO3 stated that the conducted activities and the platform miOne were motivating since they helped her to know new people, learn new things and escape from routine.

Regarding the miOne community, participants PO2 and PO3 affirmed that the online community also contributed to fight against social isolation and showed willingness to continue the activities.

> OP2: "*Yes, a little. Because when I go to Facebook it annoys me to be there and then I go to miOne's page. So, they came to help.*"
>
> OP3: "*Before entering here (the co-design session) I went to the miOne page and I saw that everything was the same (no communication of that session) [...] I went directly to the page of (the coordinator of the University of the Third Age), and said to him 'How are we today? Do we have a meeting? (miOne sessions*)".

The last question asked participants to describe the social network of their dreams. Collectively participants mentioned that it should contain information about four *topics:* (1) health; (2) culinary, (3) sports and (4) economy. They would also enjoy a community in which cooking recipes about healthy food and fishing was shared, reinforcing the idea of the photo contest.

Taken together, these studies support the notion that there are a number of recommendations to improve both the online community and toolkit design, such as: (a) Attend some of the participants' interests (i.e. health, cooking, sports); (b) Incorporate learning challenges and news; (c) Create social-driven activities relative to health suggestions, traveling recommendations and news; (d) Define strict policies on hate speech and misinformation to create a safe and welcome environment in miOne; and (e) add more games with riddles, proverbs, and activities with music.

Based on the inputs gathered in Phase 1- Co-design Research and Toolkit Development, Phase 2 - Applying the co-design toolkit, and Phase 3 - Assessing the Co-design sessions and Toolkit Effectiveness, the next session presents the (re)design of the miOne online community.

7.4. Phase 4 - (Re)design of the miOne online community

In this section, the results of an eye-tracking evaluation to assess the user's navigation in the miOne online community (A) and a proposal for the redesign of the miOne online community (B) are presented.

A. Eye-tracking evaluation session

To evaluate the usability of the miOne online community, the fixation points and saccades were analyzed. The participants' interactions and main difficulties with the use of the platform were also noted.

Most participants did not find or looked at the area of the left navigation, where they could find the groups' menu. Only one participant looked at the area and did not recognize it as being the needed menu. As a result, and despite trying to give 'hints' to where the place was, the researcher had to tell everyone where to find that menu in order to proceed with the evaluation. After being told where the groups menu was, one participant (EP2) stated, "It's that the doll (icon) of the groups is usually not like that".

Through the analysis of the heatmap (Figure 58) of the main page, it is noticed that participants' eyes fixated at the "Where do you want to publish" while trying to find the groups menu.

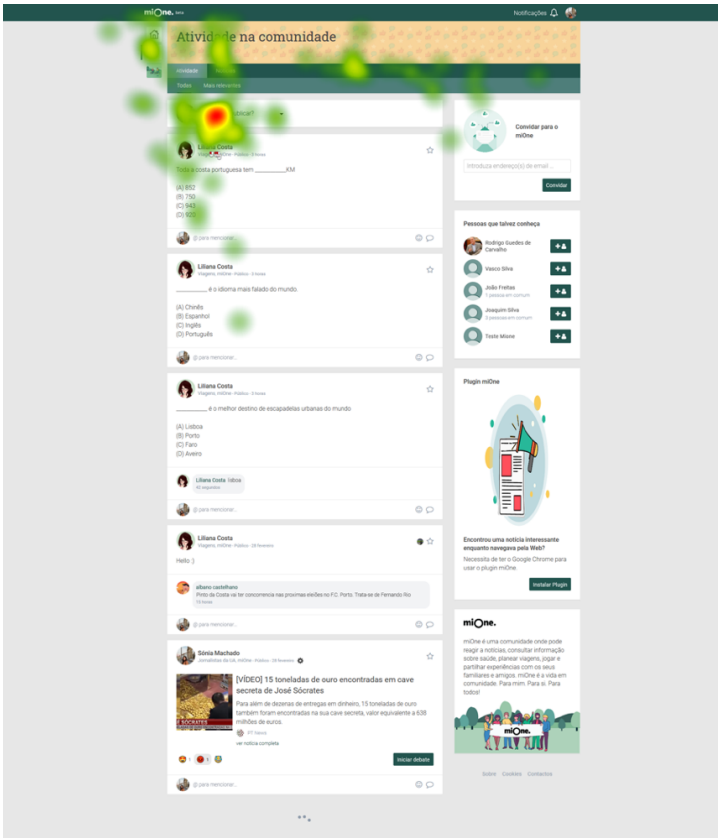


Figure 58 - Heatmap of the main page.

The participants did not use the hover menu to click in 'Ver grupos' (see groups), instead they clicked on the miOne community icon and were directed to the main page of that community and (n=4) participants had to be told how to enter the groups area (click on 'Groups' ('Grupos') at the navigation of the community). At the groups page, though the analysis of the heatmaps, it is possible to see that participants focused their eyes at the page navigation and information about the community - Figure 59. (n=2) participants needed to be told to click on the 'Travel' ('Viagens') group. Although, analyzing participants saccades (an example of the saccades resultant of one evaluation are presented on Figure 60), the travel group area was the first thing they looked. However, they deviated their attention to the navigation and header of the page.

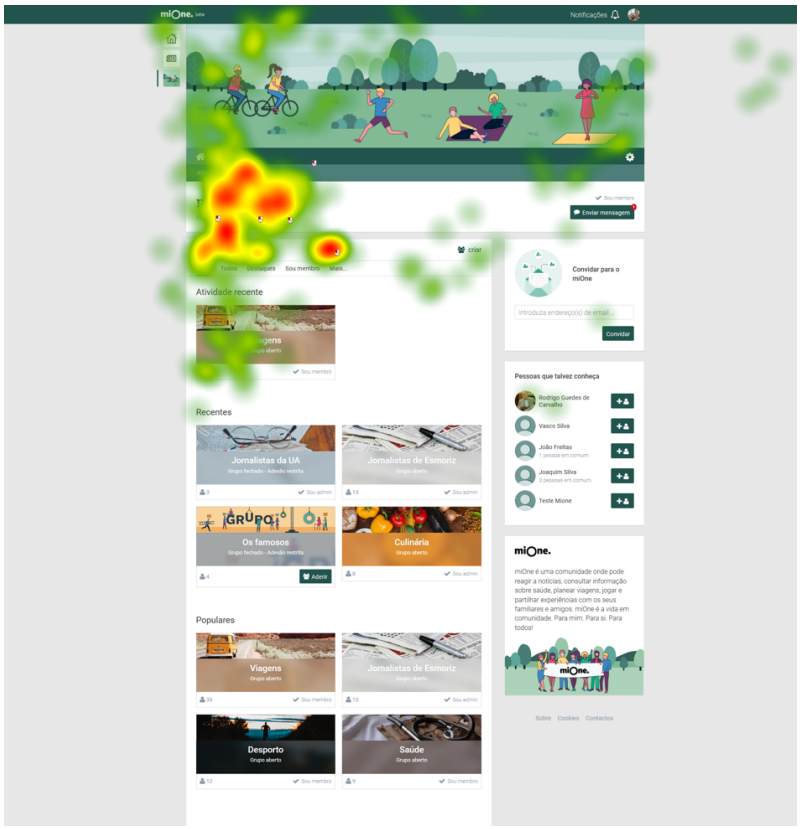


Figure 59 - Heatmap of the groups page.

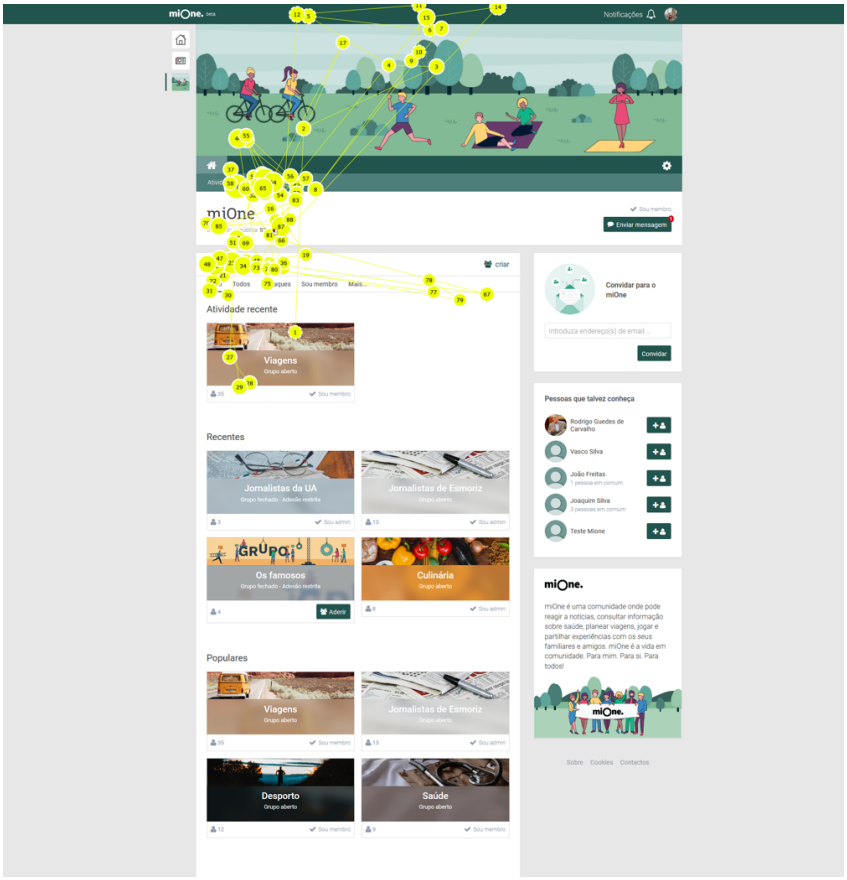


Figure 60 - (EP1) saccades.

As far as the publication of the given sentence “Suggestions for travelling?”, only one participant found the publication input. Although all participants looked at “where do you want to post” they did not perceive it as a writing area and searched for other places. One participant tried to click on the ‘Send message’ (‘Enviar mensagem’) icon, an icon that opens a chat conversation with the members of that group.

B. (Re) design

The redesign of the online community miOne was made having in consideration the results of the application of the toolkit, co-design sessions, questionnaire, semi-structured interview, and the eye-tracking evaluation. Each of the presented data collection methods contributed not only to the redesign of this online community but also to one of the aims of the present dissertation, that is to “propose a set of ‘Best Practices’ or ‘Guidelines’ for designing and developing senior online communities.”

‘Best Practices’ and ‘Guidelines’ for designing and developing senior online communities

Nineteen ‘Best Practices’ and ‘Guidelines’ for the general requirements of an online community were identified and grouped into 3 main categories: (a) Information

architecture design; (b) Interaction design; and (c) Visual design – further explained in chapter 2.1. Having the following sub-sections: navigation, content, use of color, use of images, user feedback, and support. The mentioned 'Best practices' and 'Guidelines' and are described below, reinforcing examples of the previously mentioned results that originated them:

Information architecture design

Navigation

1. *Show clearly where the user is*
   For instance, one member was interacting the whole time at the activity page thinking he was at the group of the activity.

2. *Display the home button on every page*
   Whenever is possible the "home" button should be available so that users can minimize errors and easily return to a familiar page when lost. Users resorted to that during the activities.

3. *High contrast and bolder navigation cues should be provided*

4. *Navigation should be consistent*
   Participants clicked on the 'home' button and were directed to the page of the presentation of the miOne, instead of the activity page.

5. *Avoid double clicks*
   Users are expected to click and go directly to the place they need to go. At miOne for instance, users were expected to click on the profile picture and go directly to their profile and click on the 'Write something about me" and immediately start to write.

6. *Avoid drop-down menus*
   Users ignored drop-down menus (e.g., the profile menu). If needed they should be clearly identified.

7. *Avoid hover menus*
   Some participants with more difficulties on the basics of using a computer could not perform the action needed to click on a button on a hover menu. Psychological and physiological changes inherent to the aging process difficult the steadiness needed. Furthermore, diseases that might appear with age such as Parkinson also difficult this task.

8. *Use icons that correspond to senior citizens affordances*
   Although the icon with the image of the community miOne (3rd button) was not the icon of the groups, participants could not identify where the groups'

menu would be inside of that menu, as they did not recognize the icon. Users did not know where to change the profile picture and some users didn't understand that the pencil icon had that purpose.

9. *Create redundancy – display always text in front of the icons; different ways to go to one place*
   Previous to the configuration of users' profile some users could not find the area where their profile picture is. Adding the name of the user next to the profile picture could help to getting users' attention. Providing multiples ways to access the same page, without being overwhelming could also help users to navigate to the page without feeling lost.

Content

1. *Language should be simplified, clear, and consistent*
   For instance, one user questioned the term 'Share' and 'Post' at the same input when sharing news.

2. *Only relevant information should be displayed*
   Participants often ignored big displays of information. At the 'Find the Fake News' activity, for instance, participants only focused on the title of the news. Moreover, they would skip the 'Getting started' instructions without reading.

3. *Important information should be concentrated in the center of the screen*
   Analyzing the eye-tracking evaluation It was clear that participants focused their eyes at the center.

Interaction design

User Feedback and Support

1. *Checking for spelling errors*
   Participants often edited/deleted their posts after realizing there was a grammatical error on it.

2. *Clear and easy to follow feedback of errors should be provided*

3. *The possibility to edit a publication or message should be available*

4. *A community tutorial should be provided, and users should be able to access it whenever they need it.*

Visual design

Use of color

1. *Saturated colors should be used*
   During the presential co-design sessions, it was noticeable that in some computers the unsaturated colors presented at miOne difficulted the legibility.

2. *High contrast colors should be used*
   Participants could not read the text in inputs such as the comments and publication.

Use of images and graphics

1. *Avoid the use of meaningless images or graphics*
   One user mistook the predefined header of the profile with changing the profile picture.

Regarding the features and miOne themes implemented at miOne and tested at the co-design sessions: groups, chat, news, tourism, and health; a set of recommendations for designing and implementing these features were also created.

Chat

1. *Other forms of communication besides writing should be provided*
2. *Possibility to delete the message after sending it*
3. *Noticeable and simple notifications should be given when users receive new messages*
4. *Feedback about the visualization of a message should be provided*

News

1. *Categorization by theme should be available*
2. *Users should be able to read the news without leaving the community page*
3. *Users should be guided through the process of sharing news for the first time*
4. *The process of sharing news should be simplified*

Health

1. *Information about the health of the user should remain private/anonymous*
2. *Health-related issues should be approached carefully*
   Some senior citizens do not feel comfortable talking about it. Fun activities such as win-win and the role-play activity doctor-patient helped them feel inhibit and 'joke' with the presented health topics.

miOne (re)design

As for the redesign of the online community miOne, some aspects of the existent design were altered with the mentioned guidelines. During the co-design activities, some of those aspects were changed as participants felt a lot of difficulties using the platform i.e., the left navigation menu, keeping the publication input always opened. Furthermore, it was decided that the platform should have more than one community as some coordinators and teachers at the universities of the Third Age wanted to share the content of the classes with their students.

In order to contextualize the design of the current platform print screens of the initial page are provided in Figure 61, following by the design proposal resultant of the present research (Figure 62).

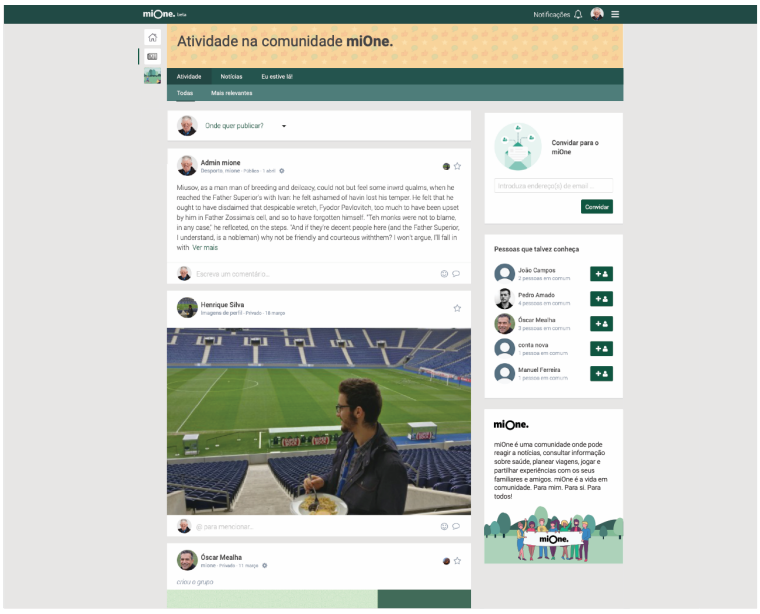


Figure 61 - Old version of the online community miOne.

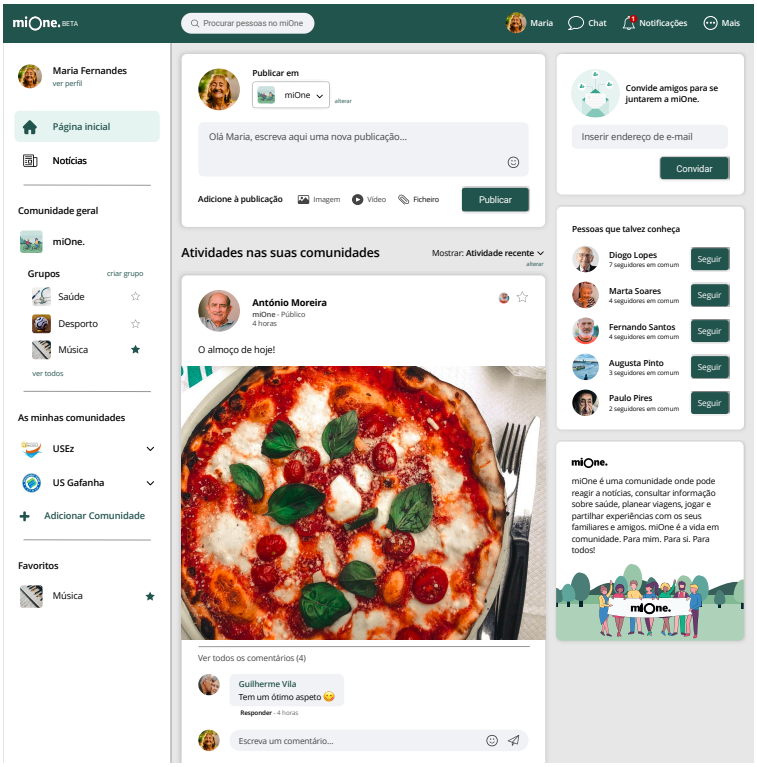


Figure 62 - miOne redesign proposal.

The original miOne color scheme (color green) and the pages that participants did not have difficulties using were not altered. Although, an overall lack of contrast was felt during the usage of the platform, so the text colors and inputs were changed to have higher contrast. The font used for the design was Open Sans, a sans-serif type, and the font size smaller than 12px was avoided.

Moreover, there were left and right margins that occupied a big part of the users' screen, making the font smaller or the need for more scroll. The headers with default images were eliminated as participants often clicked there thinking it was part of the navigation. The changed features/functionalities are further described below.

1. Registration/Login

When users are registering with e-mail and password, they should have the information on the requirements for the password previous to enter one. In the miOne case, as special characters were a requirement, users should also have an example of what special characters are since it was noted that participants were not aware of the meaning of the word e.g. "The password should contain at least one special character (e.g.? - ;)".

The possibility to see the password at the login and register and suggestions on the format of the required password should be provided.

2. Profile

As mentioned, participants did not know where to find the profile area at the top navigation even after changing the profile picture. In order to solve this problem, the name of the user was added to the top navigation, alongside the picture.

Furthermore, at the tested design participants clicked on the profile area and expected to go directly to their profile instead of opening a new menu. A new button was added to the menu “More” (‘Mais’) where users can see those buttons.

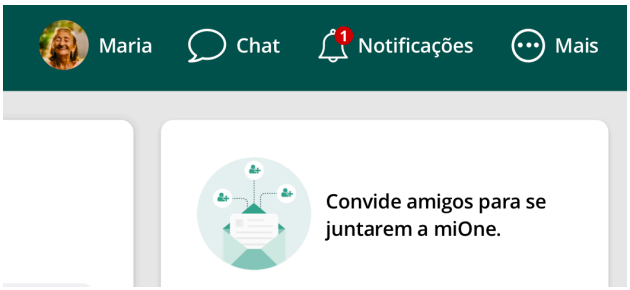


Figure 63 - Proposal of top navigation bar.

As for the configuration of users’ profiles. Some users could not find where to change their profile picture and most of them ignored the cover image. Furthermore, users clicked on ‘Write something about you’ and expected to start writing immediately. At the new proposal of the profile, the icon of editing photo was substituted to the camera icon, to be more familiar to the participants. If users have not inserted a cover image the text “Add cover image” would appear next to the camera icon.

The pencil was used to the input of writing something about them. When selected for the first-time users should be directed to a selected input where they would be allowed to start to write right away.

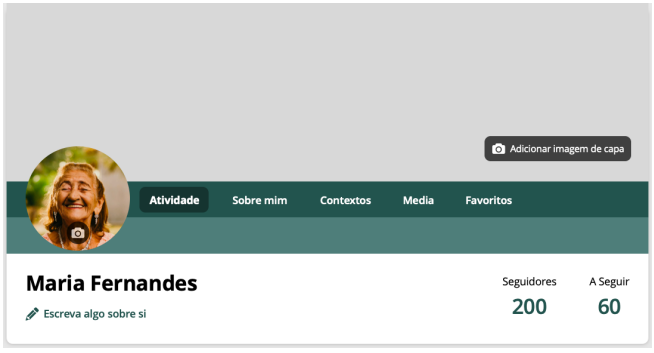


Figure 64 - Profile configuration proposal.

3. Main Page/ Activity Page

One of the main problems registered and explained previously in this chapter was the left navigation menu. As mentioned, participants felt difficulties in using this menu and it had to be altered during the co-design sessions. The old version, represented in Figure 65, was not perceived by the participants as being a menu and containing the groups. Furthermore, the 'hover' functionality was not used by any of the participants.

Figure 65 - Old version of the miOne left menu.

Moreover, the participant did not understand the concept of communities and the difference between communities and groups and the need to add more communities was clear.

To solve these problems and using the already redesigned menu by the designer of the project, at the redesign proposal the icons have the correspondent text at the right. Furthermore, the online community miOne is separated from the others with a subgroup named 'Main community' ('Comunidade geral') that is always 'open', as the platform is based on one main community. The rest of the communities have a drop-down menu. The 'See members' menu was eliminated since now there is more than one community, showing the members of just one community (the miOne community) at the main menu, is not correct. Users can have access to this information on the selected community page. The new design proposal is shown in Figure 66.

Figure 66 - Menu proposal.

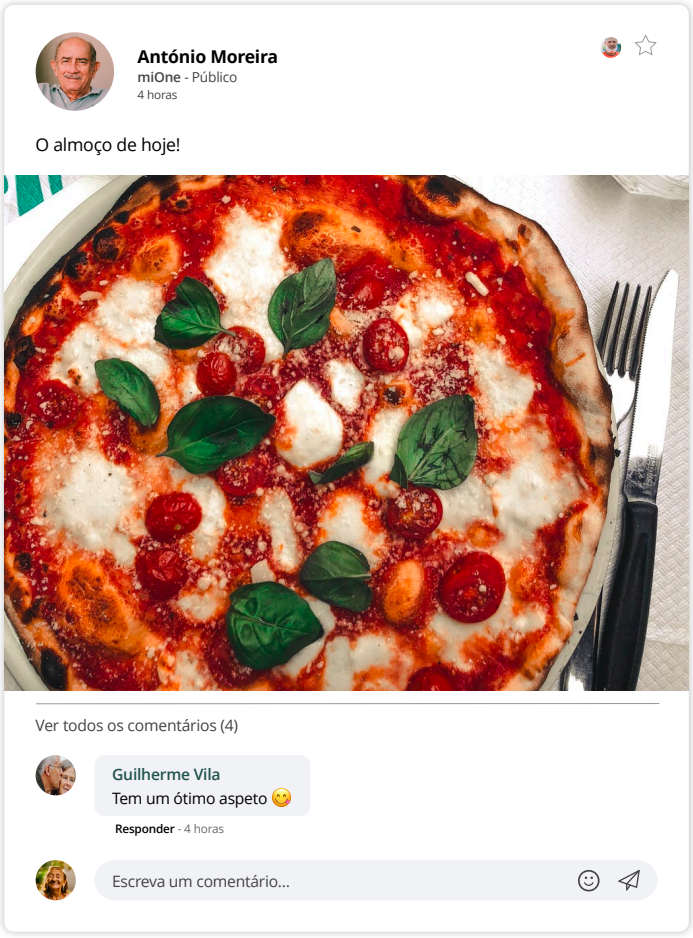
The menu will remain fixed while the remaining elements of the page are scrollable. If the users have a lot of communities the menu becomes also scrollable, independently of the remaining page.

As for the publication input, participants felt that there was a lack of contrast on the input and often did not associate it with the place to write. Furthermore, they expected to immediately start to write when clicking on “Where do you want to pot?” (“Onde quer publicar?”). Also, users often clicked on the file icon to add images or videos to their publications.

To solve this problem the input should be kept always open, with a pre-selected place to post. In the proposal users have the text “Publish in” (“Publica em”) at the top of the drop-down menu where they can select the place they want to post. The drop-down menu is followed by an ‘alter’ (‘alterar’) link, in order to reinforce the action of changing the place to post and create redundancy. The area of the text has now higher contrast and

aims to catch users' attention by using their names at the beginning of the pre-designed text e.g., "Hey Maria, write here a new post…" ("Olá Maria, escreva aqui uma nova publicação…"). The icons of adding pictures, video, and files are now accompanied by the correspondent text to avoid mistakes.

Lastly, participants also felt that there was a lack of contrast in the comments section. Some participants could not find where to click in order to start to write. Similar to the publication area, the comments section has now higher contrast on the text input.



4. News Page

A contextualization of the entire page before and after the redesign proposal is shown in Figure 67 and Figure 68, respectively.

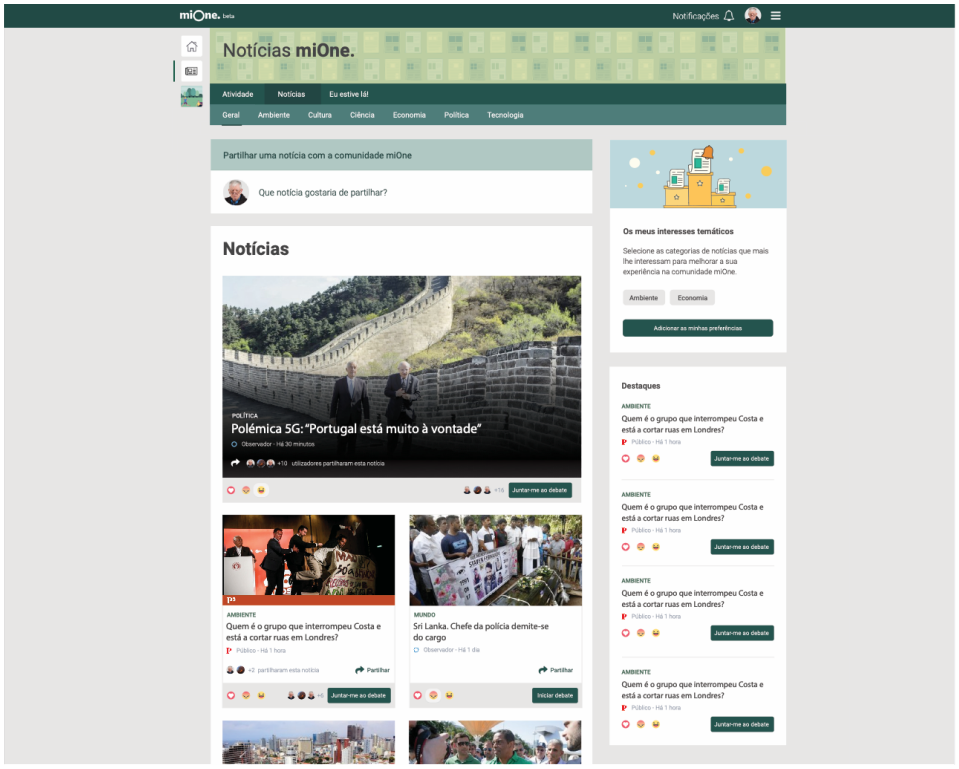


Figure 67 - Current menu.

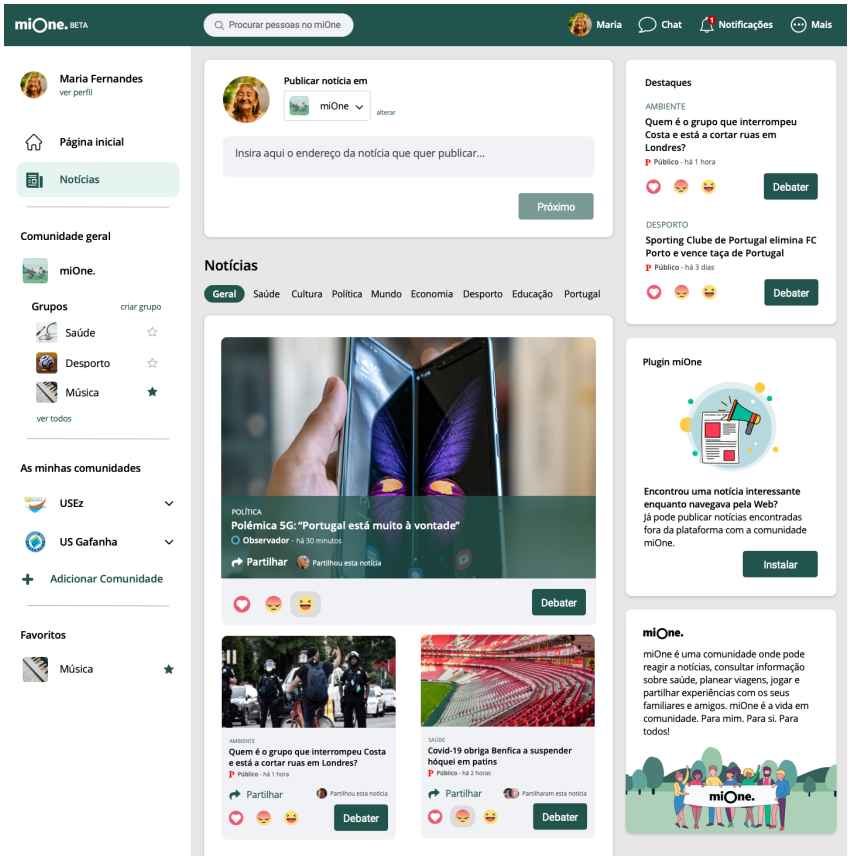


Figure 68 - Proposal of the news page redesign.

Similar to the publication input, the news text input has now more contrast and it is always open, having a text pre-defined to caught the user's attention. There is an overall improvement in the contrast and font size on the presented news and the categories are now in form of tags under the publication input. The term "Share news" in this contest was altered to "Publish news", as with this interaction the users are posting news to the community, and "Share" can be mistaken with sharing existing news ("Partilhar").

5. Chat

The chat was being developed and was added to miOne during the co-design sessions so that participants could test it – see the current miOne chat in Figure 69. Participants felt difficulties using this chat as the contrast of the text input was low (see Figure 70) and participants could not understand the used icons at the top of the conversations (messages, people, and contexts). The current miOne chat is presented at Figure 69.

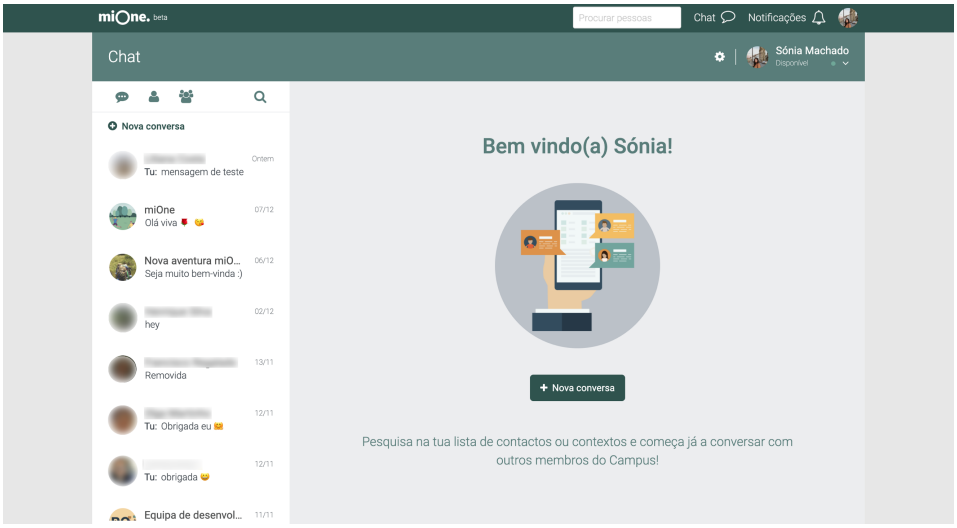


Figure 69 - Current miOne chat.

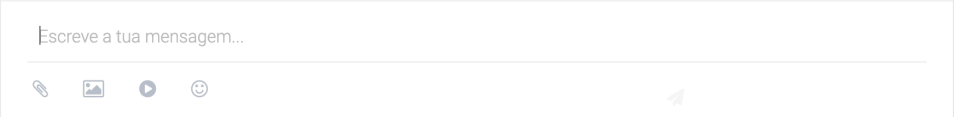


Figure 70 - Current miOne chat text input.

The redesigned chat, similar to the previous redesigns is now with higher contrast on the text input, and the icons are followed by the correspondent text. Furthermore, the possibility to delete a message is given. Finally, as participants value the face-to-face interaction the possibility to do video calls should be added.

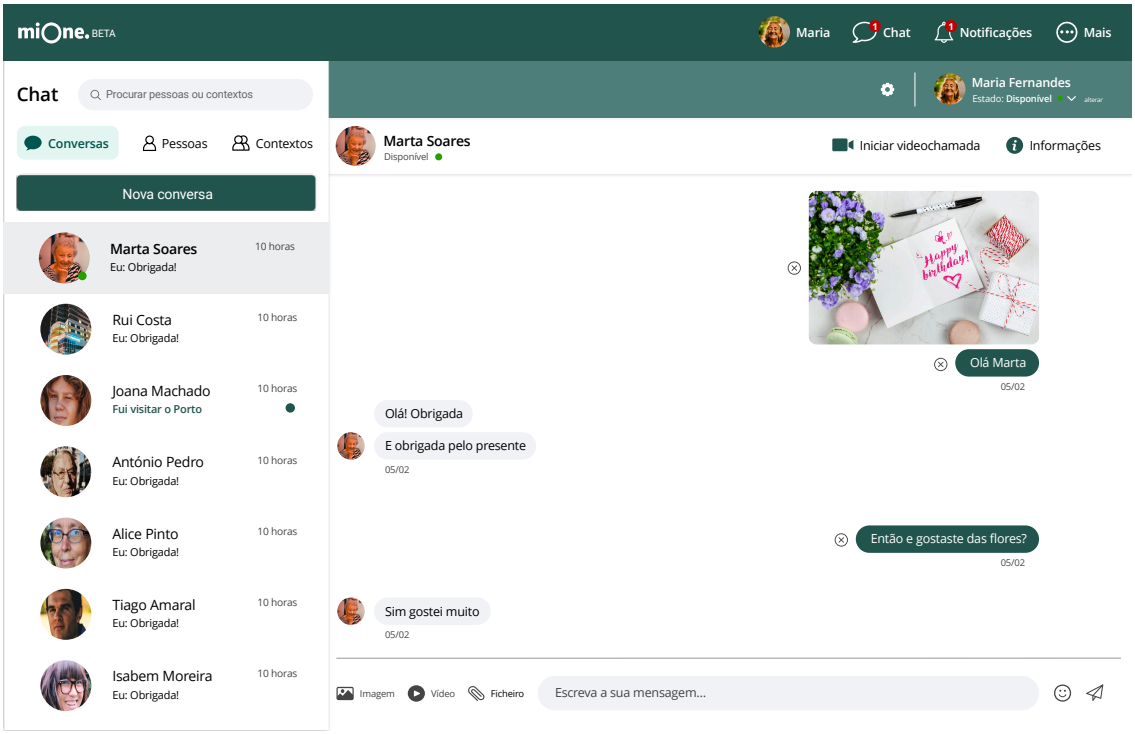


Figure 71 - Chat redesign proposal

Conclusions

This research set out to answer the question "In what way can co-design influence senior citizens' experience with online communities?", and it was possible to conclude that the co-design sessions positively influenced the senior citizens' experience.

This section summarizes the findings of this research, addressing the research question, and the sub-questions announced in the Introduction. In specific, it explains three key aspects of this process: (1) the most applied co-design techniques to senior citizens; (2) how the toolkit application and co-design sessions helped senior citizens to have a better experience in using the miOne community and be engaged in the platform, and (3) a set of "best practices," and guidelines formulated and the miOne redesign. Furthermore, the research contribution to HCI and the research project's limitations are presented, as well as future work.

Addressing the Research Question

To answer the question "In what way can co-design influence senior citizens' experience with online communities?", the inherent sub-questions needed to be addressed beforehand.

In response to the research sub-questions "What are the co-design techniques that have been used with senior citizens in the last six years?" (Goal 1), systematic literature has revealed the mostly applied co-design techniques in senior citizens in the past six years and these has been considered to the toolkit design. These included: a) Delivery of the activities in the form of workshop sessions followed by reflection periods with the interview and questionnaire surveying; (b) The use of scenario-building in such games as 'Secret Rules' or/and 'The Lucky/Unlucky Tourist'; (c) Use of Online Cultural Probes (*e.g.,* Secret Friend activity); (d) The use of autobiographical storytelling games (*e.g.* Win-win); and (e) Consider the people's experiences in past, present and future lives in pre-, during and post-design (Sanders & Stappers, 2014).

The second sub-question "What are the co-design strategies that can engage senior citizens in the different phases of the user experience in an online community (pre-experience, experience, and post-experience)?" was answered by the literature review and the application of the designed toolkit with the adult learners from the Universities of Third Age. For the toolkit, meetings with SEDUCE 2.0 project members were made in order to perfect the toolkit and test it. The toolkit was applied *in situ* at three Universities of the Third Age and online with participants from two Universities of the Third Age. In view of the aforementioned presential and online activities the following 'best practices' for co-design sessions with senior citizens were highlighted: (a) Delineate a strategy for motivating the participants' attendance in research activities that prolong in time (*e.g.* Session Stickers and a sticker book), (b) Use small group dynamics; (c) Use group competition in activities,

whenever possible; (d) Assess the participants' mental concept and expectations in a pre-experience activity; (e) Devote some activities to ice-breaking and reflection; (f) Theme-based activities relied on scenario-building help to identify functional requirements; (g) Prioritize autobiographical storytelling games Instead of traditional kits of cultural probes, and (h) Involve the coordinators/professors at the Universities of the Third Age/caregivers whenever possible in order to motivate the participants to the activities.

Relative to the miOne online community and answering the sub-question "What are the main difficulties that senior citizens have when interacting with the online community interface?", the main problems noticed by the participants at the questionnaires and semi-structured interview, and though observation were: (a) lack of contrast; (b) unfamiliarity with the navigation system of a new platform; (c) usage of icons that do not correspond to senior citizens' affordances; (d) lack of labeling; and (e) unnoticeable clickable areas. A list of best practices and guidelines for designing senior online communities was presented in chapter Data Analysis, Evaluation and Discussion of Results, based on the participants' difficulties and feedback. They were divided into three types of design: Information hierarchy, interaction, and visual design. Once again, the main problems were related to the navigation, content, user feedback and support, and the use of color and images.

As for the interest and motivations of senior citizens, noted through the co-design sessions and the application of the toolkit, the questionnaire and semi-structured interview, the following requirements for the online community miOne, that can be added in the context of other online communities, emerged: (a) Provide leisure-oriented activities; (b) Focus on interpersonal relations; (c) Present health information; and (d) Include 'how-to' tutorials relative to the use of computers and Internet. Ensuring news' readability has been also shown as important beyond news' search and the identification of the information sources. In tourism, travel reviews, information about places' history, gastronomy and culture, and traveling storytelling should be encouraged.

As far as the last sub-question "How do the co-design strategies, the participants' self-reported experience with online communities, and the interaction of adult learners at the Universities of the Third Age with the miOne online community help to explain the influence of co-design in the senior citizens' experience with an online community?" it was noted through the co-design sessions and toolkit application that participants were competitive and enjoyed talking about themselves and with others, especially during the COVID-19 pandemic where most of them were isolated. The conducted co-design sessions allowed them to talk to each other, meet new people while learning more about ICT and helping to redesign the online community miOne "without realizing", as the toolkit activity aimed to be a set of challenges where participants could interact with miOne without being forced to it.

Analyzing some of the questions of the questionnaire, in times of a COVID-19 pandemic, 52,9% (n=9) also revealed they would continue to use the online community, whereas the remaining 47,15% (n=8) stated they would not continue. Among the reasons

for not participating were task overload and laziness. Of particular interest is also the knowledge of whether the participants perceived that the activities motivated or discouraged them to use the miOne community, in which most users stated that the communication with other people and the knowledge gained with the activities were what motivated them. However, two participants noted factors that demotivated them. One participant mentioned the lack of adherence to the activities and the other felt that there was a lack of communication when these activities would be carried out, although the online activities were shared on social media and at miOne.

Concerning the toolkit activities, respondents expressed admiration for the monitors and the different challenges and games, referring to the contact with different generations as ways to create unique moments. Moreover, participants stated that they enjoyed the exchange of ideas, enthusiasm, and friendliness of other participants. Meeting new people and role-play activities were mentioned as an added value of the toolkit activities.

Limitations and Future Directions

Study limitations were found during all stages of the investigation. Starting on the literature review as few studies involved senior citizens in the creation of optimal experiences and in the co-design process of online communities.

Considering time constraints, the toolkit was not tested with “real users” before being applied in the context of the Universities of Third Age. Moreover, during this research, there was a COVID-19 outbreak. Since senior citizens are considered to be at the risk group, the Universities of the Third Age closed almost immediately and the last toolkit activity could not be applied to the Universities of the Third Age, and the last five could not be applied at one of the Universities. After the first round of Universities of the Third Age, the toolkit should’ve been redesigned and applied again at other universities. Due to the COVID-19 pandemic, that was not possible. The study is mainly focused on involving the users in the research process, putting the users from the Universities of the Third Age first. There were limitations regarding the availability of the participants, especially when the presential activities had to be changed to online. Furthermore, as senior citizens are not fully adopting ICTs, some participants did not have the means to access the Internet and join the online sessions.

The mentioned limitations and the reduced sample have also led to a limitation on the guidelines for designing senior online communities as the data collected cannot be extrapolated for other contexts.

As far as the interaction with the online community miOne and its redesign, some features had to be changed during the co-design sessions as miOne is still in the early stages and it is still being developed, some bugs and copy problems were noticeable and made the senior citizens’ interaction with the platform difficult, leading to frustrations and dropouts.

Concerning the design of the toolkit, there are a number of recommendations to improve in the future, both the online community and toolkit design were identified such as (a) Attend some of the participants' interests (i.e. health, cooking, sports); (b) Incorporate learning challenges and news; (c) Create social-driven activities relative to health suggestions, traveling recommendations and news; (d) Define strict policies on hate speech and misinformation to create a safe and welcome environment in miOne; and (e) add more games with riddles, proverbs, and activities with music.

Moreover, as future work, the co-design toolkit should be tested with more Universities of the Third Age and training the students' coordinators may be key to its adherence to the activities. These training activities should focus on explaining how to use the toolkit and what notes and observations they should take in each activity, in order to use the toolkit to test other online communities or as a learning tool and develop a self-sustainable product. Furthermore, the adaptation of the toolkit to the online should be further studied and developed.

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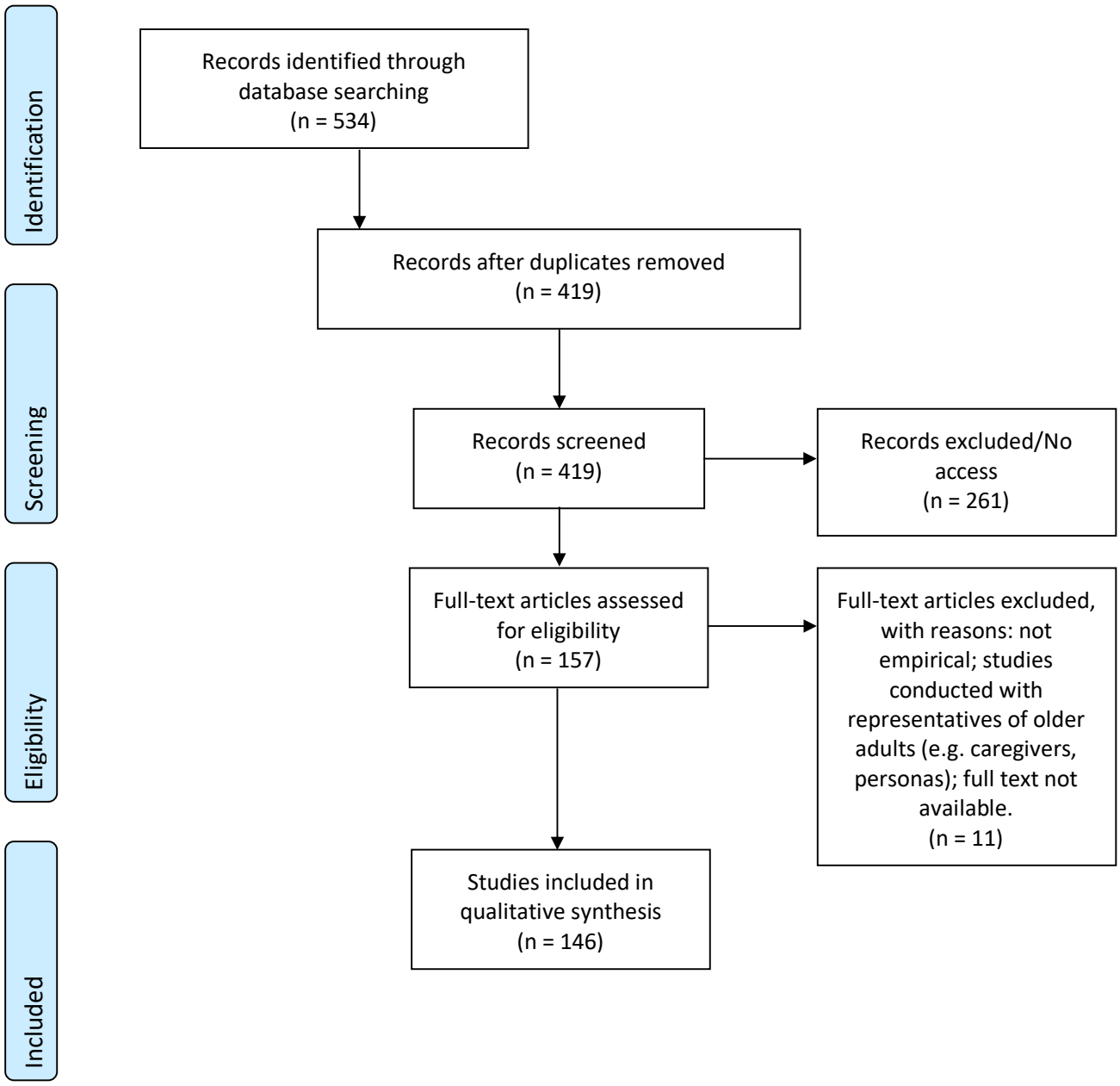
Appendices

Appendix 1 – PRISMA Flow Diagram



Appendix 2 – Systematic Literature Review Summary

No.	Autor/s (year)	Aim	Sample	Methods and Instruments Used
1.	Tsekleves and colleagues (2020)	Using co-design to engage people with dementia as co-designers, encouraging social connectedness, imagination, and creativity	12 older adults with dementia and their carers	Workshops; card sorting activity; collages
2.	Malmborg and colleagues (Malmborg et al., 2016)	Co-design service sharing on mobile and distributed platforms with senior citizens	Approximately 50 senior citizens from 9 senior communities	Interviews; focus groups; probes
3.	Tufail and colleagues (2019)	Understand the way co-design can be applied in rehabilitation of older adults	20 older adult women from a community of older adults	Workshops; focus groups
4.	Wiklund-Axelsson and colleagues (2017)	Using co-design to develop a user interface design for a healthy living app for senior citizens with sensory decline	1st workshop: 7 participants (aged between 71-82, M= 75); 2nd workshop: 5 participants	Workshops; prototype evaluation using eye-tracking and interviews; Product reaction cards
5.	Busija and colleagues (2020)	Development of a conceptual model of the role of Elder in an Australian Indigenous community with the goal of attaining strategies to strengthen the role of Elders	25-50 local area residents of Aboriginal or Torres Strait Islander, aged 18 years and older. To ensure representation of views of young, middle-aged, and older individuals, purposive sampling was used to identify and recruit males and females from three broad age groups: 18–24 years, 25–49 years, and 50 years and older	Individual semi-structured interviews; focus group
6.	Juel and colleagues (2020)	Co-design a novel modular welfare robot	Ølby elderly care center caregivers and residents	Ethnographic observation; situated interviews; focus group; co-design activity using craft materials to prototype; low-fidelity mock-up evaluation

7.	Brookfield and colleagues (2020)	Analysis of and guidance on effective ways to involve older adults in co-design activities	7 activities with older adults (n = 12, 6, 22, 13, 18, 11, 11)	Interviews; focus groups; workshops
8.	Li (2020)	Co-design of a system to support Storytelling between older adults living in a nursing home and their children	Survey with older people and caregivers in a 270~280-bed capacity Dutch nursing home; interviews with older adults and their children	Survey; semi-structured interviews; interaction with the study installation
9.	A. P. King (2020)	Discussion of co-design experiences with various stakeholders to explore the latent needs of older persons in their daily living	42 older adults with 70 or more years old	Co-design activity to brainstorm: participants say related words to given ones by the researchers; unstructured interview based on the different results; collage/prototyping activity using crafty materials;
10.	Lo Bianco and colleagues (2020)	Demonstration of the disharmony between end-user goals and their consideration in service outcomes within aging-in-place and ask “what can design offer health” within this domain	Phase 1 - professionals from occupational therapy, physiotherapy, specialist disability architecture, aged care business development, and management/team leadership; phase 2 - 10 older adults with prior fall prevention experience ranging between 69 to 92 years old	Semi-structured interviews with older participants in their homes; observation
11.	Lan Hing Ting and colleagues (2020)	Understand the needs and values of different stakeholders: elders at risk of falling and their entourage, as well as health professionals, trough co-design	5 older adults	Usability test; in-depth interviews; ethnographic observations
12.	Keirnan and colleagues (2019)	Exploration of the role of technology in improving tensioned relationships between older adults and park managers in	7 domain experts of the Aged Action group aged between 60 and 80 years	Workshops: abstract modeling activity using art and craft materials; Lego Serious Play (LSP) method

		residential retirement parks and villages		
13.	Guerrero and colleagues (2019)	Design and evaluation of an intelligent augmented reality system for assisting older adults' medication management	3 senior citizens with chronic diseases (Ages between 57 and 72), who were homebound and had used medication dispensers for longer than 6 months	Semi-structured interview; activity analysis; hands-on experience sessions and pilot evaluation
14.	Reddy and colleagues (2019)	Pharmacy system intervention	5 older adults and 5 pharmacy staff stakeholders	Card sorting; invisible design video display; evaluation of the potential solutions; prototyping; prototype evaluation
15.	Juliane (2019)	Co-creation of digital public services for older adults through data walks	46 older adults from the district relatively mobile and independent; 10 intermediaries and service providers; project board with 7 service providers and intermediaries	Walking workshop: co-design walks – users created the routes; guided historical walks; user testing
16.	Valaitis and colleagues (2019)	Co-design of interprofessional primary care programs for older adults using the persona-scenario method	70 participants: 15 patients, 29 healthcare providers/community care providers, 12 community service providers, and 14 volunteers	Persona-scenario workshops; A workshop to validate the results of the activity
17.	Callari and colleagues (2019)	Co-creation priorities and design direction for "Smart" footwear to support independent aging	Interviews with 37 older adults and co-creation with 56 older adults (age range from 60 to 95 years), from 8 European countries	Semi-structured interviews. Workshops: discussion to define the topic; develop futuristic ideas on new solutions; address threats to independence; critique a range of clothing, footwear, and furniture; prioritize the health and independence related issues; propose smart footwear ideas
18.	Lin and colleagues (2019)	Effect of a community-based participatory health literacy program on health behaviors and health empowerment among community-dwelling older adults	Intervention group (n=96); Comparison group (n=78); older adults over 50 years old, who are able to perform basic daily activities and lived in northern Taiwan	Interviews face-to-face and via phone; workshops: role-play, hands-on-practices

19.	Swinglehurst and Fudge (2019)	Improve patient care by producing 'practice-based' evidence to inform medicines optimization	Patients (aged 65 or over) and prescribed 10 or more regular items of medication	In-home and in healthcare interactions observations; interviews following Wengraf's Biographic-Narrative Interpretive Method
20.	Knowles and colleagues (2019)	Using co-design and using techniques inspired by action research and agile methodologies to engage end-users in scoping the project, ideating and developing prototypes	Individuals over the age of 55 for whom loneliness is a known risk factor	Co-design workshops: paper-based calendar filling exercise; card sorting; Interviews; user experience evaluation; demo of the Services prototype and feedback
21.	Baker and colleagues (2019)	Understand old adults' views on the types of social virtual reality experiences	22 older adults (aged 70 to 81 years)	Focus groups; co-design workshops: virtual reality scenarios ranking activity; refinement of the scenarios
22.	Petsani and colleagues (2019)	Envisage the CAPTAIN system functionality and how it can assist in everyday problems that older adults face	26 older adults (aged 60 or more years	Co-design session; personas; user scenarios; toolkit evaluation: participants were asked to describe which technologies they would like to use from the toolkit and brainstorm
23.	Jelen and colleagues (2019)	Support older adults in creating customized smart devices for themselves through electronic toolkits	Co-design workshop: 10 crafters older adults (aged between 65-90 years); evaluation: 17 older adults (aged between 65-70 years old)	Focus group; brainstorm and prototypes of ideas they could build; user evaluation
24.	Ambe, A. H. and colleagues (2019)	Application of an Internet of Things (IoT) Unkit experience	2 older women (aged around 80s and 70s years)	Workshops at the homes of participants: card sorting activity; participants gave a "tour" through their favorite and least favorite objects in their homes and routines; prototype evaluation
25.	Ambe, A. H. and colleagues (2019)	Engaging users in imagining, envisioning and speculating on future technology and future life	9 older creative writers (aged between 60 and 86 years)	Workshop; brainstorming: storytelling, plot, characters and message

		through co-created fictional works		
26.	Easton and colleagues (2019)	Co-design and Acceptability test of a virtual agent to support individuals living with physical and mental comorbidities	Workshop 1: 5 individuals diagnosed with COPD with ages from 69 to 86 years old; workshop 2: 4 patients who attended the first workshop with ages between 66-80 years old; 4 health professionals	Workshops; journey mapping; role play; system usability scale questionnaire
27.	Norell Pejner and colleagues (2019)	Collaborate in the development of a home-based system to support and promote medication self-management among older people	10 senior citizens aged 65 years or older and who are utilizing five or more different medications and have home help service and home nursing	Follow-up session after usage of the system; interviews; focus group; test and evaluate the system
28.	Cahill and colleagues (2019)	Identify and validate the requirements for new technology enabling resident wellness and person-centered care delivery, in a residential care environment	Residential home older adults, caregivers, and staff.	Product presentation; co-design session; documentation analysis; observation.
29.	Grates and colleagues (2019)	Gain new perspectives on user participation in technology design processes	962 respondents to a standardized postal survey with ages between 50-101	Survey
30.	Kopeć and colleagues (2019)	Engage older adults in co-design workshops in order to create a virtual reality (VR) automated teller machine (ATM) training simulation	4 retired older adults that participated in a VR showcase, aged between 65 years old and 90 years old	Workshops: Immersion in available VR solutions; VR development - Google Street View and discussion to substitute sketching (brainstorming); VR object prototyping
31.	Van Velsen and colleagues (2019)	Discussion of the participatory design process of mobile mobility aid for older adults	42 older adults with more than 65 years old that could travel without assistance; additional participants with mobility impairment and informal caregivers.	Co-design workshops: fictitious story, user journey, collage/prototyping activity

32.	Amado and colleagues (2019)	Involve older adults in the branding of an online community through participatory design	10 old adults aged between 52 and 87 years old	Administration of the Clinical Self-Concept Inventory; semi-structured interview; co-design exercise – self-brand exercise
33.	Volkmann and colleagues (2019)	Co-design of a digital social platform for older adults, giving them the power to record, visualize and share their life stories	Voice input analysis: total of 19 older adults (M = 68 years); age-appropriate design: 9 older women (M = 68); evaluation: 8 older adults (61-70 years, M = 66)	Voice input analysis evaluation; qualitative interviews after each task; questionnaire; record a simulation game with role-play; User Experience Questionnaire (UEQ)
34.	Alexandrakis and colleagues (2019)	Exploratory sessions to examine participants' needs and record their attitudes and preferences on digitally written narrations; design and iterative refinements of the storytelling platform, and implementation of the platform	5 participants with the age range of 59 to 73 years old	Semi-structured interviews; storytelling and design workshops; prototyping
35.	Martin-Hammond and colleagues (2019)	Exploring older adults' beliefs about the use of intelligent assistants for consumer health information management	18 older adults' participants with 60+ years old (age range from 61 to 93)	Self-rating exercise; co-design workshop: demographic and computer use survey, critique two platforms, affinity diagram session, brainstorm session using scenarios
36.	Raber and colleagues (2019)	Discussion of the relationship building that occurs between the students and older residents living in the long-term care home, specifically the storytelling and co-designing relationships	Third-year communication design students (n=18); residents living in long-term care homes (n=15)	Storytelling activity; content generation utilizing participatory design-based activities

37.	Robertson and colleagues (2019)	Co-designing of a crowdsourced media and metadata submission tool for the Historic Rural Churches of Georgia to accommodate older adult users with low technical savvy and disabilities	3 older adults	Paper prototyping
38.	Ahmed and colleagues (2019)	Visualization of cardiac implantable electronic device data for older adults	Focus Group: 16 patients and 8 informal caregivers; co-design phase: 9 older adults, 7 patients with HF and implant ted CRT devices (M = 67 years) and 2 informal caregivers	Focus groups; usability testing; pilot trial; brainstorming/prototyping activity using crafting materials
39.	Gomes and colleagues (2018)	Co-develop of a collaborative App to challenge youth and elderly to create collaborative stories about places of their city	9 people (aged between 40 and 78 years old) and 13 children (aged between 6 and 13 years old)	Icebreaking activity: Identity on a map their favorite city places and tell stories about them; questionnaires
40.	Raju and colleagues (2018)	Explore the possibilities of using 360 videos enabled intergenerational storytelling	3 participants from one family: 1 older adult (61 years old) and two children	Interaction with a model of a house; crafting activity to define requirements
41.	Kim and Fadem (2018)	Exploration of older adults' current use of patient T portals	Co-design: 17 older adults with 65 or more years; survey: 70 participants	Online survey; card sort activity; design sketch (paper prototype); design critique
42.	Neves and colleagues (2018)	Adoption and feasibility of a communication app to enhance social connectedness amongst frail institutionalized oldest old	5 frail institutionalized oldest old (aged between 81 and 93 years) and 5 relatives.	Individual training session; administration of a social support and loneliness scale; baseline profiling; participants were given a tablet with the application to use for two months; re-application of the scales; usability and accessibility tests; semi-structured interviews
43.	Jarke and Gerhard (2018)	Using cultural probes with older adults for wsharing	12 older adults (aged between 55 and 80 years)	Cultural probes; individual interviews; reflection workshop

		(Tacit) Knowing in Participatory Design		
44.	Kopeć and colleagues (2018)	Engage older adults in a hackathon to Investigate how the participation of older adults would affect the social dynamics in a development team and the general design and quality of the software developed in participatory mode	94 younger adults and 15 older adults (M~=68 years old)	Hackathon participation; observation; affinity group interviews; individual interviews; survey
45.	Maa & Buchmuller, (2018)	Apply Cultural probes in participatory design for and with older adults.	9 women and 3 men (older adults, retired)	Co-design session; cultural probes; interviews; personas and storyboards activity; paper prototypes evaluation; digital prototype evaluation; user evaluation
46.	(Vácha & Kandusová, 2018)	Propose complex solutions using modern technology in order to deliver better services for elderly citizens of Prague in an efficient and integrated way	20 senior citizens with more than 65 years old, half of them used assistance in their homes; 15 family members; 5 health care and social services professionals; 7 politicians and municipal officers responsible for social and health agenda of Prague	Brainstorming workshop
47.	Silva et al. (2018)	Determine senior users preferred way of interrupting television broadcasting for the presentation of informational videos	8 older adults over 60 years old who watch TV regularly and are geographically close to the Aveiro area (M = 74 years)	Sociodemographic data questionnaire; application of scales; user evaluation; final questionnaire
48.	Willging et al., (2018)	Improving Native American elder access to and use of health care through effective health system navigation by engaging	Phase 2: sample stratified by age and gender – older adults aged between 55-64 and 65 or more years	Phase 2: “American Indian Elder Health Questionnaire” (AIEHQ); semi-structured interviews; concept mapping

		participants in co-design activities		
49.	Randall et al., (2018)	Engage independently living older adults with depression and co-occurring physical illness in the design of assistive robots for their homes	9 older adults aged 55 or older, living alone and independently that had a depression diagnosis and a co-occurring physical illness	Semi-structured interview individually, in participants homes; workshops: react to videos and demos of a product using product reaction cards, sketch assistive home robots
50.	Martin-Hammond et al.(2018)	Engaging older adults in participatory design of "smart" tools for health information search	18 older adults aged 65 years or older	Participatory design workshop: surveys; App critique; affinity diagraming; Brainstorm and sketch
51.	Harrington et al.(2018)	Assess the effectiveness of various behavior change strategies on older adults' physical activity levels, and to identify the factors that contribute to use of mHealth technologies	25 older adults aged 65 to 80 years old	Questionnaires; user evaluation: participants were randomly assigned to use one of three fitness apps for 10 weeks; survey; group interview; co-design brainstorm and ideation session
52.	Maqbool & Munteanu (2018)	Understand how seniors plan and manage their short-term and long-term budget in order to design applications which will facilitate their financial goals	10 seniors (aged between 60 and 73 years old)	Interviews; contextual inquiries; workshops of co-design: scenarios activity.
53.	Wu & Munteanu, (2018)	Evaluate a wearable SFRA system in terms of technology acceptance and the effect of improving fall risk awareness	Co-design: 5 participants with more than 55 years old (age ranged between 57 and 67 years)	Co-design workshop: Information gathering and sharing, scenario generation and feature and scenario envisioning; paper prototyping
54.	(Güldenpfennig, 2018)	Application of a co-design toolkit created (a) to provide senior users with early tangible experiences	4 older adults aged between 65 and 91 years	Toolkit application to build a computer; interviews

		of their future systems and (b) to iteratively convert it into the final implementation		
55.	(Çarçani & Mörtberg, 2018)	Enhancing engagement and participation of seniors in social media by using participatory design	7 older adults aged between 65 and 85 years	Cartographic mappings; future workshops
56.	(Doppler et al., 2018)	Co-design and implement a TV and tablet-based communications and entertain- ment platform called BRELOMATE	30 older adults aged between 50 and 84 years	Focus group with the test of 3 interactive prototypes; final questionnaires.
57.	(Pontual Falcão, Yong, Sulmont, Ferguson, & Moffatt, 2017)	Investigate the design of a digital pen and paper-based communication system that allows older adults to connect to their family and friends' e-mail inboxes	22 older adults in total: first group: 19 older adults from a day center (14 female, aged 66–91, mean=73); second group: recruited from a residential facility, consisted of 3 older adults (2 female, aged 85–87)	Semi-structured interviews; brainstorming sessions; design critique
58.	(Sadler et al., 2017)	Developing a novel peer support intervention to promote resilience after stroke.	Interviews: 22 stoke survivors with more than 60 years, 3 interviews with family carers, and 2 were undertaken separately with 2 further carers; focus groups and individual interviews with 38 professionals	Interviews
59.	(Caravau et al., 2017)	Identification of the most efficient way to interrupt the television broadcast in order to present informational videos	19 older adults (16 women and 3 men)	Focus groups with co-design activities

60.	(Herpich, Rist, Seiderer, & André, 2017)	Investigation the use of gamification as a means to increase user appreciation of the CARE system, by engaging older adults in co-design workshops	1st workshop: 12 older adults aged between 60 and 70 years old, living independently in their households; 2nd workshop: 9 residents of a retirement home with 80+ years old	Workshop; Worksheet and cards game; semi-structured interviews; participation in 2 physical exercises.
61.	(Yuan, Hanrahan, Wirth, Rosson, & Carroll, 2017)	Reports an ongoing design study that uses an email lister to support older adults to organize and enact more co-productions together	N/A	Role-play activity
62.	(Pawlowski et al., 2017)	Study design of a community-based participatory public open space intervention in a Danish deprived neighbourhood to promote active living	Older adults with more than 60 years old (n = 16; n = 20)	Co-design activities
63.	(Richards, 2017)	Understand how older adults might use maker technology in their crafts and hobbies to positively impact their health	Discardia, a public crafting event for all ages, and a local senior center lap quilting group	Temporal mapping; affinity diagram; craft activity – the creation of paper circuit projects
64.	(Dodge et al., 2017)	Examine differences and similarities among three targeted household demographics: older adults, families with children, and students in shared housing	24 participants: 9 students from 3 homes, 6 family members from 2 homes, and 9 older adults with more than 55 years old from 6 homes	Presentation of technology examples and drawing; creation of personas
65.	(Hornung et al., 2017)	Investigate the appropriation of tablet devices and a neighborhood portal as	Older adults with ages between 60 and 86 years	Workshops; semi-structured interviews

		well as emerging privacy and security issues through ethnographic and action research in a long-term participatory design project with elderly participants		
66.	(H R Lee et al., 2017)	Designing socially assistive robots with older adults diagnosed with depression and their therapists.	Older adults with low-income and limited education	Co-design workshops; Semi-structured interviews; robot sketches
67.	(Orzeszek et al., 2017)	Provide elderly participants with the knowledge and tools to be able to understand and take part in designing basic applications by engaging them in an entry -level application prototyping course	Beginners group: 9 people aged between 60 and 80 years old; advanced group: 15 people aged between 62 and 88	Prototyping course; demographic survey; standard Future Time Perspective questionnaire; DigiComp digital competencies evaluation questionnaire; paper prototyping; design of interactive mockups; final questionnaires
68.	(Muriana & Hornung, 2017)	Investigate how to facilitate the participation of older adults with and without cognitive impairments in the phase of low-fidelity prototyping	5 to 12 participants from an institution for older adults	Co-design session; Collage; low-fidelity prototyping; storytelling activity; evaluation of a low-fidelity paper prototype; evaluation of an interactive prototype; wireframing tutorial
69.	(Chui et al., 2017)	Improving over-the-counter medication safety for older adults by using co-design techniques	2 pharmacists; 2 technicians; 1 store manager; 100 patients aged 65+ who have received a prescription at the beta site store in the last 12 months; 24 participants from one store: 12 participants during baseline data collection and 12 participants during the post-intervention data collection	Co-design activities: Input from stakeholders; beta & refinement phase; test phase

70.	(Shore et al., 2018)	Generate awareness of needs requirements for age-friendly environments and to provide an example of how participatory design research can inform innovation in business and policy development at a local and state level	22 older adults aged more than 65 years, living in the Limerick environs, independent and living in the community	Daily tasks observation; interviews; cultural probes
71.	(Easton, Burton, Ariss, Bradburn, & Hawley, 2017)	Determine whether it is feasible and acceptable to conduct a controlled trial into the efficacy of the Hip Protectors on a sample of older adults who are residents of assisted living schemes and residential care homes	50 Older adults with 65 or more years old, residents of supported housing schemes/care homes, who speak and understand English, have the cognitive ability to provide informed consent and are medically stable enough to test the hip protectors	Product use
72.	(Biocca et al., 2017)	Engage older adults in the design and implementation of an entertainment platform	71 older adults with more than 65 years old	Questionnaire; p Presentation of mockups and receive opinions about them
73.	(Van Bruinessen et al., 2017)	Support pre-frail older adults to deploy and maintain a physical active lifestyle by integrating existing on and offline services via a web-based self-management platform	16 pre-frail elderly who were able to use a web-based program independently or with minimal support by a professional (aged 74 to 91 years old); healthcare professionals	Group interviews; heuristic evaluation; focus group
74.	(Cahill et al., 2017)	Present a theoretical and methodological framework underpinning the advancement of new technology enabling seniors domicile in	20 older adults and 15 other stakeholders	Interviews and observation; persona and scenario-based design

		residential homes to live with independence, quality of life and dignity		
75.	(Mehrotra et al., 2016)	Co-design and development of an embodied conversational agent that provides a social interface for older adults	Survey: 22 elderly users (M=67.43 years, SD = 2.5 years); focus groups: 14 older adults (M=71.32 years, SD=2.1)	Survey; focus groups; paper prototypes were presented to discuss
76.	(Wargnier et al., 2016)	Development of a prototype of novel rehabilitation tool to treat Post-Fall Syndrome in older adults	8 older adults with age raging from 81 to 94 with mild cognitive impairment and normal cognitive functioning	Survey; product test; evaluation of the virtual reality exposure
77.	(Muriana & Hornung, 2016)	Engaging older adults with or without dementia in participatory design activities	Older adults with ages between 62 and 94 years	Memory game based on storytelling; calendar filling activity; profile questionnaire; drawing
78.	(Frennert & Östlund, 2015)	Understanding of seniors' involvement in the making of eHealth systems	20 participants: 3 older adult men and 3 women, 9 of their relatives and 5 caregivers (a doctor, a nurse, two occupational therapists and a physiotherapist). The average age of the seniors was 80 years, and they ranged in age from 74 to 85 years	Observations; semi-structured interviews
79.	(Subramaniam & Woods, 2016)	Establish an evidence-base for the acceptability and efficacy of using multimedia digital life storybooks with people with dementia in care homes	Six participants with mild to moderate dementia living in care homes and their relatives	Designing creating, and direction a life story movie; questionnaires
80.	(Eftring & Frennert, 2016)	Co-designing a social and assistive robot for seniors	Seniors living alone, 70 + years old, who in the near future will need assistance in	Workshop: presentation of robot pictures and attention cards for scenarios where those robots could

			order to be able to stay in their own homes; workshop 1: 14 older adults (65-86 years); questionnaire: completed by 36 out of approximately 100 seniors; interview: 14 older adults (age range 65–86 years) and 6 informal caregivers (3 men and 3 women); design workshop: 18 older adults (age range 69-84 years); mockup study: 7 older adults (age range 72-76); home trials: 18 older adults (75+ years old)	help; questionnaires; interviews; experience prototyping; mock-up study; user evaluation in laboratory environment; home trials
81.	(Nicol et al., 2016)	Participatory design and formal study of mobile text entry for older adults	Around 35 older adults (M = 65 years old)	Mapping Exercise; Cultural probes; observational studies; metaphor and paper prototyping; user evaluation
82.	(Duh et al., 2016)	Applications of Paper and Interactive Prototypes in Designing Telecare Services for Older Adults	Total of 45 older adults: 32 lived in nursing homes and 13 lived independently (age range from 64 to 91 years)	Paper prototyping; Interactive prototyping
83.	(Lopes et al., 2016)	Understand the impact of the misplacing and loss of personal items in elders with the cognitive disorder who live at home and to understand and document the coping strategies they implemented to deal with the problem	Older adults with cognitive impairment above 60 years old, living at home, having a clinical diagnosis of MCI or AD, and being able to walk with or without walking aid; informal and formal caregivers (social and healthcare professionals) of persons with cognitive impairment	Semi-structured interviews at home; self-observation diary; user evaluation; focus groups; brainstorming session; user evaluation
84.	(Ventura & Talamo, 2016b)	Analysis of a codesign session with elders	4 older adults aged between 76 and 86 years; 3 researchers; 2 caregivers	Paper-mockup interaction and discussion
85.	(Swallow, Petrie, Power, Lewis, & Edwards, 2016)	Designing mobile applications to support and promote physical activity and wellbeing in the built environment;	33 older adults aged 55 to 87	Affinity diagrams; brainstorming; design evaluation on a series of seven-point Linkert items

		explore the degree of design fidelity necessary to encourage and inspire ideation in older adults without inhibiting or suppressing their creativity		
86.	(Verhoeven, Cremers, Schoone, & van Dijk, 2016)	Participatory design of a 'Happy walker' that stimulates mobility among older people	Netherlands: Older adults with ages between 58 and 93 years. Session 1: two groups (n=15; n=6); cultural probes: (n=7). Session 2: (n=7). Session 3: (n=2). User evaluation (n=12); Spain: older adults with 65 or more years. Session 1: (n=13); final user evaluation: (The Netherlands, n = 9; Spain: n = 4)	Co-design sessions; cultural probes; interviews; storyboards; Online questionnaire; scenario development based on personas and user requirements; paper and interactive mockups; user evaluation
87.	(Murphy, 2016)	Explore older students' reactions to existing accessibility technologies, explore participants' reactions to the potential to link fixed learning materials with digital media, explore the next steps for the design of the multimodal notes prototype or other interfaces that use tangible interaction for learning	7 older students aged between 57 and 76 years	Workshop: banana piano exercise (exercise aimed to create a fun atmosphere while introducing the technology); creation and feedback gaining of a use scenario;
88.	(O'Leary, Liu, McClure, Ralston, & Pratt, 2017)	Understand older adults' persuasive reminders for health self-management	23 participants from two populations of people who managed complex chronic illnesses: older adults with type 2 diabetes n=12 (age ranging from 54 to 89 years old), and mothers of children with asthma	Workshops: collages, cultural probes, storyboards
89.	(Rehm, Krummheuer,	Identify social practices trough co-design, where a	3 older adults	Workshops; prompts to elicit discussions

	Rodil, Nguyen, & Thorlacius, 2016)	social robot might make sense for both staff and residents		
90.	(Orso, Spagnolli, Gamberini, Ibañez, & Fabregat, 2015)	Contribute to the literature of HCI for older users by showing - in the context of the development and evaluation of an actual prototype – the way design/evaluation methods can be adapted to older users	Design phase: 6 older adults (expert users and non-experts); tests: 20 older adults (M=70.45) (SD=5.615)	Usability evaluation; illustrated cards to elicit discussion; videoclips watching; individual questionnaires; user experience evaluation
91.	(Martin-Hammond, Ali, Hornback, & Hurst, 2015)	Determine older adults and younger adults' preferences for novel AUIs through co-design sessions	Older adults with 65 or more years old and younger adults aged between 18 to 30 years old	Co-design sessions; survey; Icebreaker activity – feedback of different websites design; videos presentation; surveys
92.	(Gakumo, Enah, Vance, Sahinoglu, & Raper, 2015)	Understand older African Americans' preferences for a health literacy intervention in HIV management	Inclusion criteria included the following: 1) HIV diagnosis for at least 1 year; 2) currently receiving outpatient treatment at the clinic; 3) currently taking an HIV medication regimen; 4) Black or African American; 5) age 45 years; and 6) English speaking. Exclusion criteria included: 1) cognitive impairment; 2) legal blindness; 3) severe hearing loss; 4) pregnancy; and 5) being homeless. The study population was 20 people being 50% (n=10) female with a mean age of 54.9 years	Semi-structured interviews (individually); health literacy measurement
93.	(Tsai, Hsu, & Lo, 2015)	Description of the process of using a co-participatory design method to produce a toy prototype for children and adults	Two industrial designers, six older adults (three male and three female, aged 65–75), and six children (3 male and 3 female, aged 6–10)	Individual semi-structured interviews; scenario creation

94.	(A. Veloso & Costa, 2015)	Providing interesting solutions that cater older adults' game needs and preferences to the game industry, based on the knowledge produced about networked video games for older adults	5 experienced and 5 novice gamers aged 50 and over (aged between 52 and 77 years)	Semi-structured interviews; workshops with game-related activities
95.	(Swallow, Petrie, Power, & Edwards, 2015)	Presenting a selection of the mobility barriers identified in this study and outline of a number of methodological issues relating to the use of photo diaries for eliciting the needs and requirements of older adults	26 participants with 55 or more years old	Cultural probes; home interviews
96.	(Turner et al., 2015)	Understand older adults' perspective in the use of patient portals for personal health information management	74 participants: inclusion criteria included age 60 years and older, the ability to read and speak English, and lack of cognitive impairment, measured by a score of 4 or higher on the 6-item screener to identify cognitive impairment	Individual semi-structured interviews
97.	(Nevay & Lim, 2015)	Engage older adults in co-design workshops to establish requirements for wearables that meet their specific needs and capabilities	6 older adults aged 65 years or older with experience of care homes (visitors or staff)	Empathic design; ideation workshops: A review of existing technology, card sorting activity; prototype evaluation.
98.	(Coelho et al., 2015)	Designing two Facebook based prototypes that allow closing the gap between social network services and older adults	Interviews: 31 older adults with more than 60 years; focus groups: 17 participants with more than 60 years	Interviews; paper prototype; focus groups

99.	(Rodríguez & Jiménez, 2015)	Application in laboratory conditions of analog and digital prototypes from a test designed for cognitive training for older adults	12 people conformed by therapy assistants from the Meredi Hospital ascribed to the University of Rosario and the Caracola day home; 9 older adults	Analog and digital prototype testing applied to each participant
100.	(McNeill & Coventry, 2015)	The Participatory design approach to involve older adults in the design of an intelligent walker	5 focus groups with 4 to 7 older adults each	Focus groups in the form of tea parties; semi-structured interviews; review of existing technology
101.	(van Velsen et al., 2015)	Discuss the development of a community-based, technology-supported health service for detecting prefrailty and preventing frailty and further functional decline via participatory design with a wide range of stakeholders	**Italy**: 60 people representatives from local hospitals, local non-profit organizations that were interested in collaborating, local governments, seniors' associations, and older adults	Workshops
102.	(Naeemabadi et al., 2020)	Identify user requirements for a self-training rehabilitation program	2 groups of patients, health professionals (2 physiotherapists, 1 nurse, 1 orthopedic surgeon), 3 researchers, 4 student assistants, 2 software developers. 8 participants and 4 healthcare professionals and test (4 patients) processes	Interviews; prototyping; questionnaires; cultural probes; workshop: pre-printed posters, paper prototyping, drawing, GUI design, rehab program information; usability tests; GUI communication
103.	(Cortellessa et al., 2020)	Co-design a support tool to facilitate remote support to patients, by exploiting TV-based transmission of data and video-interactivity between health-professionals, patients, caregivers, and family members	Around 90 people aged 60 and more years old, health care professionals with specific expertise in dementia and cognitive decline, and informal caregivers	Focus groups

104	(Banbury et al., 2020)	Using group videoconferencing the aim of this study was to 1. Co-design a health literacy, chronic disease self-management (CDSM) skills, and social support intervention for older people; and 2. Evaluate the intervention's effectiveness for improving health literacy, CDSM, and perception of social support	Adults aged 50 and over who had a least one chronic condition. Experimental group: (n = 52); control group: (n = 60)	Health Literacy Questionnaire (HLQ) application; Health Education Impact; questionnaire (heiQ) application; semi-structured interviews; focus groups
105	(Huisman et al., 2020)	Redesign of a small-scale care facility as a guideline for decision-makers	Residents and members of the client council (n = 27); healthcare professionals (n = 19; 17 female and 2 males; age range 22– 61); board and staff members (n = 8); researchers and experts (n = 7)	Semi-structured Interviews; site visit; workshop
106	(Qi & Gu, 2019)	Collaborate with elderly villagers to develop a community and assess social, cultural, economic skills. (Re) build a Post-Disaster Community	The research team, including social work educators, architects, front line social workers, and villagers. 2º stage: 21 older residents.	Participant observation, oral history, asset-mapping. Focus groups and workshops, field notes, in-depth interviews
107	(O'Donnell et al., 2019)	Improve care delivery to frail older patients in acute care settings, using co-design with public and patient representatives	10 Patients - older people with acute care (N=6), advocates for frail older people (N=2), 1 family carer, 1 frail person with a degenerative disability	Workshops
108	(Chadborn et al., 2019)	Deliberate on the Benefits and Risks of Smart Health and Smart Homes	Participants were recruited from several organizations including: Vulnerable Adults Provider Network (Nottingham Community and Voluntary Service), Age-Friendly Nottingham Steering Group,	Survey; workshops

			Nottinghamshire County Council, Nottingham City Council, Self Help UK, and Healthwatch Nottingham; in order to have a sample composed by minority etnic communities, disabilities…;staff or volunteers of organizations which engaged with older people. In total, 34 people attended these two preparatory meetings. The age range was 60 to 70 years old.	
109	(Wang et al., 2019)	Identify older adults' perspectives regarding ambient/active assisted living (AAL) and artificial intelligence technologies, and gauge interest in participating in a co-design process	31 older adults aged between 67 and 94 years old	Focus group: perspectives on technology usage; survey by questionnaire – demographic aspects
110	(Grace & Horstmanshof, 2019)	Evaluation of a regional dementia health literacy program	The evaluation involved the following participant groups: 1. Those diagnosed with dementia and their families and corers - 13 people (the Project Officer, one service provider, and 11 people with dementia and their family or carers) participated in the workshops, eight people with dementia and their family or carer participated in the evaluation; 2. Members of community social groups of older people who had not been diagnosed with dementia. Semi-structured interviews were conducted by phone with 13 group members; 3. GPs and other health-care providers and services. Of the 24 surveys distributed, 22 responses were received	Survey bv questionnaire; semi-structured interviews; co-design workshop; piloting and evaluating the dementia support kit

111	(Fanjoy & Bragg, 2019)	Local community college and immigrant-serving agency collaboration with a group of retired immigrant women to co-analyze data and co-create initiatives	25 participants aged between 50 to 89 years old; a sub sample of 10 woman from the larger sample	Semi-structured interviews; three-month participant observation; co-design sessions
112	(Harrington et al., 2019)	Analysis of 5 health-related workshops with older African Americans living with low income	African American (predominantly) older adults with low incomes, living in the senior village of study, aged between 65 and 79 years old	Demographic questionnaire; co-design workshops: collage activity; camara to document their health-related issues; card sorting; “how might we” group exercise with provided verbs such as “reduce”, “increase”, “make”, “improve” and “provide”; brainstorming session; paper prototyping; follow-up interviews
113	(Pappne Demecs & Miller, 2019)	A visual and interpretative phenomenological analysis of older residents’ engagement with tapestry weaving	A community of one regional not-for-profit residential aged care facility in Queensland’s Sunshine Coast Australia participated; active participation varied daily; overall 30 participants engaged throughout the project	Workshops; Involvement in designing and developing artwork; Interpretative phenomenological analysis - generated images, photographs, and drawings; participatory arts practice; visual essay (photography); Interviews
114	(Tsekleves et al., 2019)	Conceptualize healthcare delivery services, using participatory design	Groups of senior citizens in the UK and Malaysia: UK [14 participants (4 male, 10 female), living independently, 65-94; 7 (2 male, 5 female), living in sheltered, 65-74]; Malaysia [13 participants (8 male, 5 female, living independently, 62-86; 15 (3 male, 12 female), 26-28]	Speculative Design - put end-users in an imaginative future
115	(Mincolelli, Giacobone, Marchi, & Imbesi, 2019)	Encourage independent ageing through the use of ICT	12 families composed by self-sufficient and non-self-sufficient seniors over 65	Focus groups; direct interviews; questionnaires; workshops (brainstorming, journey map, empathy map); usability test with an interview
116	(Nevay, Lim, & Gowans, 2019)	Assess e-textile prototype co-designed with older adults and capture data	12 older adults experienced interactive e-textile prototype, "Dundee Conversation Quilt" (female, aged between 70 and 95 years old)	Survey; workshop: prototype evaluation and crafting activity

		concerning social wellbeing		
117	(A. P. King, 2019)	Co-designing Mobile Collection Points with Older Persons to Promote Green Attitudes and Practices in Hong Kong	This research project was fully supported by two local recycling companies, whose directors participated in our participatory design workshop. 5 participants with age ranging from 36 to 71 years old.	Workshop
118	(A. C. Nielsen, Rotger-Griful, Kanstrup, & Laplante-Lévesque, 2018b)	Co-creation of eHealth solutions for service delivery to older persons with hearing impairment	In total, there were recruited 36 PHIs, 10 SOs, and eight AUDs through online questionnaires to participate in the three rounds of focus groups. All key stakeholder groups participated in the first round of focus groups to frame insights and visions for future eHealth-assisted client journeys. Only PHIs participated in the last two rounds of focus group; recruitment focused on people aged 60+ years old; exclusion criteria for PHIs were the use of current hearing aids for more than 5 years and the nonuse of hearing aids within the last month	Online questionnaire; focus groups – Card sorting, journey map, mockup evaluation, interactive prototype evaluation
119	(Guell, Panter, Griffin, & Ogilvie, 2018)	Co-design a meaningful physical activity typology for later life	Purposefully sample of 27 women and men, aged 65-80 years, classified as belonging to a professional or manual occupational class, living alone or cohabiting, in urban or rural neighborhoods in Norfolk, UK, and by physical activity level. The EPIC-Norfolk study coordination team initially mailed 32 potential participants, and 22 agreed to take part; another 8 were invited in the second round of recruitment to fill under-represented categories (inactive,	Semi-structured interviews; workshops; phone interview

			manual occupational class, and oldest age group), of whom 5 responded positively. A year on, 27 participants were contacted, of whom 13 were able to attend a participant workshop. Six expert stakeholders were also recruited to attend the workshop and to be interviewed	
120	(Cinderby et al., 2018)	Co-designing Urban Living Solutions to Improve Older People's Mobility and Well-Being	Older adults with 55 or more years old	Participatory mapping; photo diary elicitation; individual interviews
121	(Hee Rin Lee & Riek, 2018)	Co-designing assistive robots to promote successful aging	Two types of participants: older adults and aging researchers (e.g., geriatricians). Older adults: There were recruited nine older adults through snowball sampling, local events, and word of mouth. Six older adults were from a Midwest town in the United States and three from Southern California. Their ages ranged from 62 to 85 years (mean age = 69 years old.;there were recruited three geriatricians with MDs, one clinical psychologist with a Ph.D., and one epidemiologist with a Ph.D. All five researchers are affiliated with an aging research unit at a US-based medical school	Collaborative map-making; artifact analysis – examine existing robots' photos and videos; envisioning robots for aging – choose the right robot
122	(Cahill, McLoughlin, & Wetherall, 2018)	Identify and validate the requirements for new assisted-living technology facilitating wellness, independence, and social participation, for older people domiciled in	11 older adults (mean age 79.36 years), 7 family members, 5 experts in ageing/dementia, 1 ICT expert, 4 nurses, 5 representatives spanning two "care for the elderly" day services, 3 representatives from a post-acute care	Interviews; questionnaires

		residential homes and/or assisted-living communities	service, and 2 representatives from a residential home	
123	(Sabater-Hernández et al., 2018)	Co-design approach for developing a community pharmacy service to enhance screening and management of atrial fibrillation	The range of age of the 8 individuals (7 women) who participated in the focus group (n = 4) and the interviews (n = 4) varied between 70 and 88 years old. Three participants had a diagnosis of AF (an additional one was unsure); including 2 with an implanted pacemaker, and 5 had hypertension (2 participants with both AF and hypertension). One had neither condition but had a family history of hypertension	Focus groups; semi-structured interviews
124	(Lorraine James & Saville-Smith, 2018)	Designing housing decision-support tools for resilient older people	Older people and representatives of community organizations and providers of services for older people	Brainstorm sessions; prototype development; tool testing and refining
125	(Vácha & Kandusová, 2018)	Propose complex solutions that would use modern technology to deliver better services for elderly citizens of Prague in an efficient and integrated way	20 citizens over 65 living in their own home - half of them were using some assistance in their homes and the other half none or only informal help; elderly in social relief center (n= 5); family members (n= 15); representatives of health and social services (n = 5); politicians and municipal officers (n= 7)	Workshop; analyse of existing technology;
126	(Righi et al., 2018)	Design digital technologies using co-design taking into account non-digital practices	Total of 450 active older people (aged between 55 to 80 years old)	Semi-structured interview; workshops: personas, scenarios, storytelling, cooperative prototyping
127	(Townsend, Sadkowska, & Sissons, 2016)	Develop a collaborative collection of clothes that meet and highlight the aesthetic and emotional needs of older women	10 women aged between 55 and 75 years old	Product preference discussions; semi-structured interviews

128	(Goeman, Dickins, Iliffe, Pond, & O'Keefe, 2017)	Co-design a discussion tool to facilitate negotiation of risk between health professionals, people with dementia, and carers	20 healthy older people (M = 73.3 years); 7 people living with dementia (M = 66 years), carers, health professionals, and staff	Interviews; focus groups
129	(Sadler et al., 2017)	Report on the development and preliminary evaluation of a novel intervention to promote resilience after stroke	Interviews: 22 stoke survivors with 60 or more years, carers and health professionals	Interviews
130	(Blackwell, Lowton, Robert, Grudzen, & Grocott, 2017)	Critique the use of experience based co-design in the particular setting of emergency departments (Eds), adding to the growing literature on the application of co-design approaches to quality improvement work and thereby laying a foundation for future applied work in this area; present evidence specifically about palliative care needs in the ED from older patients, their families and staff	15 ED staff; 10 patients and their family caregivers	Telephone interviews; co-design event
131	(Pedell et al., 2017)	Enable the exploration and evaluation of emotions with older adults around personal alarm systems and their wider context of use as a means of	Older adults who had experience with personal alarm systems with age ranging from 85 to 91 years, and those who did not have experience with personal alarm systems ranging from 66 to 79 years of age; scenario activity: 4 participants	Interviews; scenarios activity

		innovating both the function and the service offering		
132	(Panek et al., 2017)	Design and development of a new type of ICT enhanced modular toilet system which shall be able to support autonomy, dignity and safety of older persons living at home	Older people within a clinical rehabilitation setting (Rehabilitation clinic in Budapest) and Users with multiple sclerosis (MS day care centre in Vienna). Total of 74 persons, there of 41 subjects with movement disorders (primary users), 21 caregivers (secondary users) and 12 healthcare managers (tertiary users).	Questionnaires, interviews and focus group
133	(Wiklund Axelsson et al., 2016)	Explore the support needed for sustainable lifestyle changes due to obesity among persons in the third age	6 participants that experienced an on-going lifestyle change due to obesity, and be 55 years or older (age ranged from 61 to 76 years)	Multistage interviews; cultural probes; focus group; collage activity
134	(Pearson et al., 2016)	Co-design a Web-based version of ESCAPE-pain that people with chronic joint pain find engaging, informative, and useful	Survey: 200 people aged 50 years and older with chronic knee, hip and/or back pain who had participated in a trial based on the ESCAPE-pain program; focus groups : 24 participants aged between 60 and 79 years; think aloud: 8 participants aged between 60 to more than 70 years	Postal survey; focus groups; user evaluation – think-aloud technique
135	(Mehrotra et al., 2016)	Co-design and development of an embodied conversational agent that provides a social interface for older adults	Survey: 22 senior citizens (M = 67.43 years); focus group: 14 senior citizens	Survey; focus groups; presentation of paper prototypes
136	Goeman and colleagues (2016)	Address low health literacy in older people of Vietnamese background	Phase 1: 59 members of the Vietnamese community (aged 65 to 94 years old), 11 stakeholders from community health	Focus group; user evaluation; interviews

		living with dementia through the provision of an online resource to help individuals, their families and carers better understand and manage this condition and provide information about available dementia services	services and ethnic agencies, consumer advocacy groups and the research team; phase 2: 22 participants (M age= 61 ±10.9)	
137	Hu and Dong (2016)	Co-design a poker game to help entertainment and communication issues of older adults	Students; 2 older adults from the same family (82 and 83 years old)	information gathering; scenario discussion; issue identification; analysis of needs and requirements; envisioning; idea generation; card games
138	Goeman and colleagues (2016)	Co-design of interventions involving the Health Literacy Questionnaire (HLQ) needs assessment, followed by development and evaluation of interventions addressing identified needs	1013 clients mean age of 75 years old	Survey
139	Mohadis and Mohamad Ali (2016)	Investigate the perceptions of older workers towards persuasive principles of persuasive system design that was integrated into an application specifically designed to encourage physical activity	10 older workers aged between 50 to 64 years old	Demographics questionnaire; personas; user evaluation – think-aloud technique
140	Tobiasson and colleagues (2015)	Motivate older people with dementia to learn, manage, and enjoy exergames	22 older adults with ages ranging from the late 70s to the early 90s, their caregivers, 1 occupational therapist and 1 enrolled nurse. All participants were diagnosed with dementia in moderate to	Workshop to play exergames

			severe stages. Some were in wheelchairs, others used walking frames. Some had physical impairments due to stroke, such as limited motor function on one side of the body	
141	Brocklehurst and colleagues (2015)	Provide the opportunity to enable older people to prioritize the research agenda to improve their own oral health	Service users, carers, third sector, and specialists	Meetings; group discussions
142	Greenhalgh and colleagues (2015)	Improving the proportion of patients who receive appropriate, acceptable, and workable technologies and services to support them living with illness or disability	7 technology suppliers and 14 service providers organisations; 40 people aged 60 to 98 years old with multi-morbidity and assisted living needs; 10 workshops with 30 end-users (case participants, their carers, and third-sector advocates), 18 service provider representatives and 13 technology industry representatives	Workshop
143	Jaakola and colleagues (2015)	Promote changes in attitudes and behaviors among seniors towards mobile devices and the use of apps	17 older adults aged between 59 and 73 years old	Semi-structured interviews
144	Vines and colleagues (2015)	Elicit rich discussion and undertake co-design activities related to the three core issues the researchers wish to explore	28 older adults with a mean age of 70 years (aged between 84 and 43)	Co-design session; Invisible design film; prompt cards inspired by Questionable Concept technique
145	J. C. Campos and colleagues (2015)	Design an AAL system, which could be used to help manage space and provide relevant services to its users	9 residents in a care house with more than 70 years old; 1 psychologist and the head of the house care	Focus group; prototype demonstration and discussion; scenarios activity

146	Zaman and Winschiers-Theophilus (2015)	Identify user requirements for developing TV and Tablet Facebook Interfaces by involving them in the process	31 participants aged 60 and over years old	Focus groups; interviews; low-fidelity prototype interaction; user evaluation

Appendix 3 – Consent form of the presential co-design sessions

The following consent form is presented in Portuguese as the co-design sessions were conducted with Portuguese participants.

Departmento de Comunicação e Arte universidade de aveiro theoria poiesis praxis

Consentimento Informado

A presente declaração visa assegurar que os participantes envolvidos no projeto 'SEDUCE 2.0 – Utilização da Comunicação e da Informação na comunidade online miOne pelo cidadão sénior' com a duração de três anos, de 01 de Junho de 2018 a 01 de Maio de 2021, têm conhecimento do propósito e procedimentos da investigação.

Propósito do estudo

O projeto 'SEDUCE 2.0 – Utilização da Comunicação e da Informação na comunidade online miOne pelo cidadão sénior' tem como objetivos principais: (a) avaliar o impacto de variáveis psicossociais e da sociabilidade dos cidadãos seniores mediante o uso das TIC no contexto da comunidade online miOne; e (b) contribuir para o crescente desenvolvimento da comunidade mione. Um grupo de participantes com idade igual ou superior a 50 (G1) estará envolvido no processo de *design* e teste da comunidade miOne (G1 – grupo experimental que testa a comunidade) e um segundo grupo (G2 – grupo sem intervenção, grupo de controlo) são avaliados antes e depois em relação à sua perceção sobre a Qualidade de vida (WHOQOL-BREF), redes sociais (Escala Breve de Redes Sociais de Lubben), stress (Escala de Stress Percebido) e sociabilidade online.

Recrutamento de participantes

Neste projeto, pretendemos recrutar indivíduos com idade igual ou superior a 50 para integrar os diferentes grupos:

☐ Grupo G1. Este grupo é envolvido no processo de conceção e avaliação de uma comunidade online. Serão dinamizadas sessões relacionadas com o processo criativo individual e de grupo, trabalho em equipa e jogos relacionados com os seguintes tópicos: 1. Comunidades Online; 2. E-Saúde; 3. Notícias; e 4. Turismo.

☐ Grupo G2. Este grupo não tem qualquer intervenção, sendo avaliado em dois momentos distintos a perceção sobre qualidade de vida dos participantes, as redes sociais, stress percebido e sociabilidade online – com recurso a questionários, entrevistas e observação direta.

Procedimentos:

As sessões com os grupos participantes têm a duração máxima de 1 hora e apresentam como métodos de recolha de dados, questionários e observação participante. Durante as sessões com cada um dos grupos, será prestado acompanhamento assistencial pela investigadora Liliana Costa.

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Appendix 4 – Consent form of the eye-tracking evaluation

The following consent form is presented in Portuguese as the evaluations were conducted with Portuguese participants.

Departamento de Comunicação e Arte universidade de aveiro theoria poiesis praxis

Investigação Projeto SEDUCE 2.0

Como investigadores do centro de investigação DigiMedia (DeCA/UA), convidamo-lo a participar no projeto SEDUCE 2.0 através da contribuição no teste das funcionalidades da comunidade miOne, com utilização de *eye tracker*. O projeto SEDUCE 2.0 tem como objetivos avaliar o impacto das variáveis psicossociais e sociabilidade mediante o uso das TIC no contexto da comunidade online miOne e contribuir para o seu crescente desenvolvimento.

Com o seu contributo, iremos testar algumas das funcionalidades da comunidade online miOne.

O teste de eye tracking terá duração de aproximadamente 10 minutos. Através da tecnologia de *eye tracking*, o movimento e o tempo de fixação do olhar serão gravados e as métricas utilizadas permitirão analisar a interação humano-computador. Para compreender dados de cariz qualitativo iremos proceder à gravação das expressões faciais e acompanhar a atividade com uma breve entrevista pós-teste. Desta forma, esperamos comparar as expectativas que cada utilizador tem para o miOne e as suas funcionalidades.

Lembramos que este é um teste à interface e não ao seu utilizador e que todas as informações de caracter pessoal são estritamente anónimas, o direito à privacidade é totalmente garantido. A sua opinião e contributo empírico são extremamente relevantes para melhorarmos as funcionalidades testadas.

Em caso de dúvidas sobre o estudo ou caso queira reportar alguma lacuna nos procedimentos de investigação:

Ana Veloso (961907419, aiv@ua.pt)

==========

CONSENTIMENTO INFORMADO

De acordo com as recomendações da Declaração de Helsínquia, compreendi a explicação que me foi dada sobre a investigação que está a ser realizada e que as informações recolhidas são anónimas.

Eu entendo que os resultados do estudo podem ser publicados em revistas científicas, apresentados em reuniões / eventos científicos e usados em outras atividades de investigação, sem qualquer violação de confidencialidade/anonimato. Ao participar nesta atividade, autorizo o uso de dados anónimos para a finalidade da investigação que lhe está associada e mencionada acima.

Nome Participante:_____

Assinatura Participante:_____

Assinatura Investigador: _____

_____ de _____, 2020

Appendix 5 – Eye-tracking researcher script

Departamento de Comunicação e Arte universidade de aveiro theoria poiesis praxis

March 2nd 2020

ONLINE COMMUNITY MIONE– EYE TRACKING

1. Planning a trip might give headaches... if you are not on miOne.

This year you want to go on a vacation and decided to join the 'Travel' group to ask for travelling suggestions to those who have more experience.

1.2. Join the group 'Travel'

Verify if participant finds the group menu
Verify if participant join the 'Travel' group

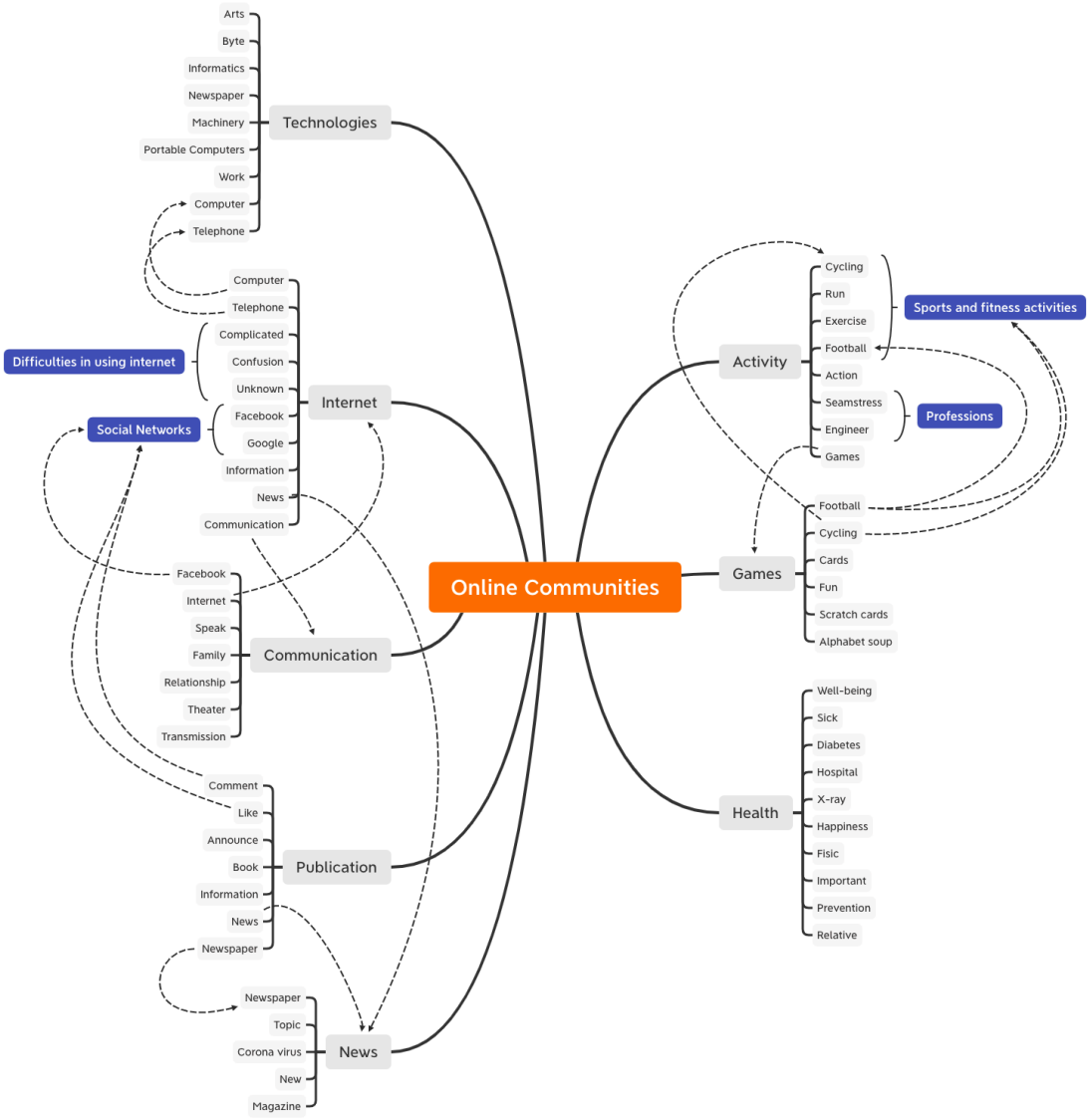
1.3. Post at the group 'Travel' the following sentence "Suggestions for a trip?"

Verify if participant access the group.
Verify it participant can find the publication input
Verify if participant publishes the sentence at the group

Appendix 6 – Presential participants codification

Participant	Age	Genre	University of Third Age
P1	56	Male	Universidade Sénior da Gafanha da Nazaré
P2	57	Female	Universidade Sénior de Esmoriz
P3	58	Male	Universidade Sénior da Gafanha da Nazaré
P4	58	Female	Universidade Sénior da Gafanha da Nazaré
P5	61	Male	Universidade Sénior de Esmoriz
P6	64	Female	Universidade Sénior de Esmoriz
P7	65	Female	Universidade Sénior de Esmoriz
P8	65	Female	Universidade Sénior de Oliveira de Azeméis
P9	67	Female	Universidade Sénior da Gafanha da Nazaré
P10	68	Male	Universidade Sénior de Esmoriz
P11	68	Female	Universidade Sénior da Gafanha da Nazaré
P12	68	Male	Universidade Sénior da Gafanha da Nazaré
P13	69	Female	Universidade Sénior de Oliveira de Azeméis
P14	70	Male	Universidade Sénior de Oliveira de Azeméis
P15	70	Female	Universidade Sénior da Gafanha da Nazaré
P16	71	Male	Universidade Sénior de Oliveira de Azeméis
P17	72	Male	Universidade Sénior da Gafanha da Nazaré
P18	72	Male	Universidade Sénior da Gafanha da Nazaré
P19	72	Male	Universidade Sénior da Gafanha da Nazaré
P20	73	Male	Universidade Sénior de Esmoriz
P21	73	Female	Universidade Sénior da Gafanha da Nazaré
P22	74	Male	Universidade Sénior de Esmoriz
P23	74	Female	Universidade Sénior de Oliveira de Azeméis
P24	74	Male	Universidade Sénior de Oliveira de Azeméis
P25	75	Female	Universidade Sénior de Esmoriz
P26	77	Female	Universidade Sénior da Gafanha da Nazaré
P27	78	Male	Universidade Sénior da Gafanha da Nazaré
P28	80	Female	Universidade Sénior de Oliveira de Azeméis
P29	81	Male	Universidade Sénior de Oliveira de Azeméis
P30	86	Male	Universidade Sénior de Esmoriz

Appendix 7 – ‘More than Words’ concept map



Appendix 8 – AEIOU Registration

A **"Activities** includes actions with specific goals in mind, and the processes performed to achieve them".

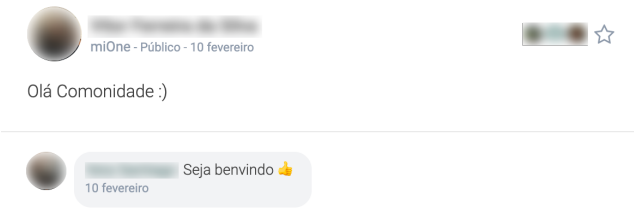
Description

Secret Rules' activity has an estimated time of 40 minutes. To start the activity, each participant receives a card, randomly, with a different role (Big Mouth, Ghost, Leader,Paparazzo, Visitor). The moderator then checks the role of the participants, gives them the sheet with the tasks to complete and says to the rest of the participants who is leader. The participants only know who the leader is but do not know each other roles and have to find the visitor. They could present themselves in the online community, making attempts to unravel the other's identities and find the visitor.

General Impressions/Observations

- The Registration and profile configurations took more time that what it was predicted at the Universidade Sénior de Oliveira de Azeméis as some participants did not have an e-mail or Facebook.
- Some participants did not understand the purpose of the activity.
- The roles were signed randomly and the 'Leader' role was given to participants that had more dificulties using the computer and the internet. Other roles depended on the Leader posts, for instance 'Big Mouth' had to comment the 'Leader' posts. When the 'Leader' had more difficulties sometimes participants with the role 'Big Mouth' were confused on what to do.
- 2 'Leaders' found the 'Visitor'.

Visual Registration



'Leader' finding the 'Visitor'.

E "**Environments** details the context and characteristics of the space where activities are being observed".

Description

'Secret Rules' activity took place at the Universidade Sénior de Esmoriz, Universidade Sénior da Gafanha da Nazaré and Universidade Sénior de Oliveira de Azeméis. At the Universidade Sénior de Oliveira de Azeméis each participant had it's own desk. At the others, participants were together in grouped tables in a L shape.

General Impressions/Observations

- Participants from the Universidade Sénior de Esmoriz and Universidade Sénior da Gafanha da Nazaré helped each other more than the adult learners from Universidade Sénior de Oliveira de Azeméis.
- Poor internet connection at the Universidade Sénior de Oliveira de Azeméis difficulted the interaction with miOne.

Visual Registration

Classroom at Universidade Sénior de Esmoriz.

Classroom at Universidade Sénior da Gafanha da Nazaré.

Classroom at Universidade Sénior de Oliveira de Azeméis.

"**Interactions** includes both interpersonal and person-artifact interactions. Proximity and space may also play an important role within these relationships".

Description

Analysis of participants conducted tasks, difficulties and feedback. Participants had diferent roles with differnet missions to perform in the community miOne:

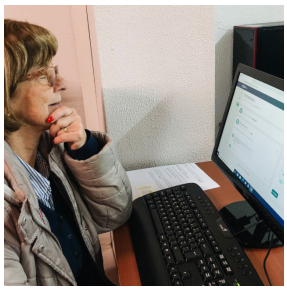
Role	Description	Mission
Big Mouth	He/She is the big mouth of the miOne com-munity. Nobody can shut him/her up and is always publishing.	Comment every post of the Leader.
Ghost	He/She is the ghost of the miOne community. It is not there to scare it is there to gossip. He/She goes to the community to know everything, but he/she never publishes anything.	React to the publications.
Leader	He/She is the leader of the miOne community, and everyone knows him.	Lead the other partici-pants in order to find the visitor.
Paparazzo	He/She is the paparazzo of the miOne com-munity, he/she is always aware of scandals and news.	Its mission is to interact and share news in the community.
Visitor	He/She is a visitor to the miOne community. He/she's new to the community, but he/she wants to make himself/ hersef known.	The others will try to find him/her, and he/she should not reveal his/her identity until then.

General Impressions/Observations

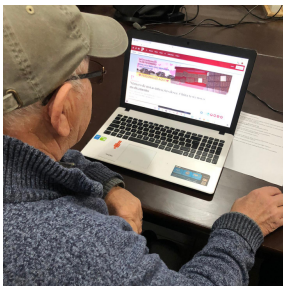
- More experienced participants finished their role tasks and helped the rest of the colleagues.
- A lot of participants had to be accompanied during all the interactions with the community. However they showed interest in interacting with the news and the possibility to create their own groups and join groups of their interest.
- Generally, participants completed the tasks for their roles. However the roles were signed randomly and the 'Leader' role was given to participants that had more dificulties using the computer and the internet. Other roles depended on the Leader posts, for instance 'Big Mouth' had to comment the 'Leader' posts. When the 'Leader' had more difficulties sometimes participants with the role 'Big Mouth' were confused on what to do.
- Some participants explored the community freely and did not followed the given instructions.

Visual Registration

Participant taking a profile picture.



Participant creating a miOne group.



Participant searching news to share at miOne.

O "**Objects** catalogues the items within the environment and how they are used. It is important to note both the central and peripheral uses of objects and how people harness them to conduct their activities".

Description

Participants used the materials designed for the 'Secret Rules' activity - a card box and deck of cards containing the main mission and visual representation of each role. Furtheremore they were given a sheet with an user story related to each role and the tasks they had to complete. The other materials needed were computers or smartphones with access to internet.

General Impressions/Observations

- At the Universidade Sénior de Oliveira de Azeméis none of the participants had a smartphone and they were using the computer of the University of Third Age. The other participants were using a personal portable computer and some of them had a smartphone.
- Most participants only looked at the information on the card and did not read the information on the given sheet.

Visual Registration

'Secret Rules' activity materials.

U "**Users** includes the people within the environment that are being observed. Key information includes their values and biases, behaviors, needs and relationships".

Description

Users were adult learners from 2 Universities of Third Age - Universidade Sénior de Esmoriz, Universidade Sénior da Gafanha da Nazaré and Universidade Sénior de Oliveira de Azeméis aged between 56 and 86 years old.

General Impressions/Observations

- There were users with different digital literacy skills. Some users did not understand the basis of computer and internet usage.
- Generally, oldest-old users showed more difficulties in using the computer and did not use social networks. One user however had more facility using it, had social networks and showed persitency in doing the activities and exploring the platform.
- Almost all of the participants had a Facebook account.
- At the Universidade Sénior de Esmoriz and Gafanha da Nazaré they all had a personal computer.

Visual Registration

Participants from Universidade Sénior de Oliveira de Azeméis.

Appendix 9 – User Journey Map