Not Interested in ICT? A Case Study to Explore How a Meaningful m-Learning Activity Fosters Engagement Among Older Users

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Abstract. Mobile devices are increasingly being used in lifelong learning. However, while older learners are active members of the lifelong learning system, little research has been aimed at understanding how m-learning can provide them with successful learning experiences. In this paper we address the question if m-learning can foster the acceptance and uptake of mobile technologies among a group of older people unfamiliar with ICT. Following a participatory design approach, 20 participants who were enrolled in a literature course created routes of geolocated questions about a fiction book they were reading and answered them in the real location using the *QuesTInSitu* application. Results indicate that their m-learning acceptance improved as their anxiety around use of technologies diminished. These findings question previous research in which use of mobile technologies tended to increase older users' anxiety and reduced their acceptance of technology. Participants described the experience as playful, enjoyable and useful.

Keywords: M-learning, context-aware, lifelong learning, older learners.

1 Introduction

M-learning (mobile learning) and LBS (Location Based Systems) have mostly been used for supporting learning in formal educational contexts (primary, secondary and high school). In addition, the technologies enabling these systems, such as mobile devices and GPS (Global Positioning System), are increasingly being used in lifelong learning. However, there is a lack of research when it comes to understanding the relationship between older lifelong learners and m-learning. Sharples, in [1], discusses that the use of mobile devices in lifelong learning is *"an extended and holistic process of developing skills and understanding"*, because mobile technology fosters innovative scenarios. Johnson, et al. and Shapira et al. [2-3], propose that emerging technologies have to be those ones that provide more integration of formal with

informal learning, and those ones that support lifelong learning allowing students to access learning at times and places that are personalized and appropriate for them. We claim that mobile devices and LBS are suitable tools to support lifelong learning activities also among older users.

Context-aware m-learning activities are aimed at supporting learning in specific places, such as parks, the city etc. The learner's situation within a context-aware u-learning environment (i) can be sensed, used to conduct an activity, and to offer adaptive supports; (ii) provides supports in the right way, right place, and at the right time; (iii) enables seamless learning within a predefined area; and (iv) is able to adapt the subject content to meet the functions of various mobile devices [4]. Lonsdale, Baber, Sharples, and Arvanitis [5] indicate that time and location may be the most important and fundamental parameters for recognizing and describing a learner's context. Sharples indicates that situated activities involve learners' reflection, and as a consequence learners have to integrate the current experience with previous knowledge and to construct new interpretations. Accordingly, the technology to support these activities should be mobile, draw on information provided by location-based sensors and related to the learner's situation with the learning task at hand [1].

This paper addresses the relationship between context-aware m-learning and older people (60+), which appears to be an innovative and relevant scenario. Previous research has mostly focused on evaluating the benefits of geolocation technologies and mobile devices to support healthy ageing and independent living [6-8], two key aspects in an ever-growing ageing population. However, in this paper we aim at understanding if m-learning activities can foster the acceptance and uptake of mobile technologies among a group of older people who are not interested in ICT. Considering that, the question arises: *How should context-aware m-learning be deployed so as to provide fruitful outcomes for older learners who are not familiar with ICT?* We addressed this question in an experiment conducted with older people recruited from an adult school that offers a variety of free courses supporting lifelong learning, following a co-design approach. During the study, participants worked with the researchers and used mobile devices and LBS with the aim of co-designing an m-learning activity related with their literature course.

The goals were to design and realize an m-learning activity that consisted of a route of geolocated questions based on the facts occurred in a novel that they had previously read in a dialogic literary gathering offered by the adult school. Subsequently, the group of learners completed the route *in situ* by answering the questions created by their colleagues, knowing their position, score and feedback *in situ* and in real time using smartphones. The dialogic methodology empowers all the participants to have the same rights in decision making, collaboration and co-design. These methods are in line with the statement of [1] who claims that lifelong learning should be primarily collaborative rather than competitive, and should emphasize the role of the learners as designers of their own learning activities.

In the paper, we propose that adopting a co-design approach to create and perform the context-aware m-learning activity enhanced the m-learning acceptance among our participants and reduced their anxiety towards emerging and unfamiliar, technologies.In the following sections, we present the experiment and provide details about the educational activity, the methodology applied. The evaluation and results of the experiment are described. Finally we present the main conclusions of the study.

2 Related work

2.1 Older people and geo-positioning systems

Previous works exploring the use of geo-positioning systems by older people have mainly focused on e-health applications. For example, Boulos et al. [8], showcase a number of projects in which tracking systems are used to support older people with special needs. Many of these systems combine the use of wearable health sensors and GPS embedded in mobile phone, to report geographical position and health information to the health professionals.

The use of GPS in leisure, social and learning scenarios have largely being overlooked in HCI research with older people, despite the growing awareness of the importance to promote active, besides healthy, aging [9]. The potential of geo-positioning technologies to support social interactions has been explored by Righi et al. [10] who conducted a rapid ethnographical study to explore the acceptance and use of these technologies among older people. Initial results revealed a set of potential scenarios for use of geo-positioning technologies, in which sociability, informal and non-utilitarian interactions were proven to be key elements. The use of location-based technologies in leisure settings by older people have been explored also by O'Neil et al. [11], who investigated older people's experience with a location-based mobile multimedia system in a rural nature reserve setting. Participants reported to be enthusiastic about the potential offered by such technologies but they claimed that they system should provide them with richer interactions and contents, and the experience ended by older people proposing several improvements to the system.

These studies suggest that the use of geo-positioning technologies during an informal m-learning activity is a scenario worth exploring, and that this scenario should adopt an approach in which the older people take an active role in the design of the activity's contents.

2.2 Technology acceptance and older people

As some authors have pointed before, technology can be a source of stress among older users, but when it is correctly introduced is perceived as useful for improving the physical and mental health of older learners [12]. Nycyk & Redsell claim that: *"the effective delivery of computer training to older adults is still a problem. They can feel stressed as their family and peers use technology that they cannot, and they feel bewildered when attempting formal computer training that teaches at a fast pace"*.

An experiment done by Shapira et al. [3] showed *that ICT* contributes to older adults' well-being and sense of empowerment by affecting their interpersonal interactions, promoting their cognitive functioning and contributing to their experience of control and independence. The purpose of their research was to test the psychological impact of learning how to use computers and the Internet in old age, hypothesizing that such activities would contribute to seniors' well-being and personal sense of empowerment. Employing a quasi-experimental research design, they offered a course, conducted in small groups, in computer operation and Internet browsing to 22 older adults (~80) who went to day-care centers for the elderly or resided in nursing homes. A comparison group of 26 participants was engaged in other activities. Both groups were administered measures of physical

functioning, life satisfaction, depression, loneliness and self-control at pre- and post-intervention four months later. The main results showed a significant improvement among participants in the intervention group in all measures except physical functioning, whereas deterioration in all measures was detected in the comparison group.

We have used the study done by Wang et al [13] "*Investigating the determinants and age and gender differences in the acceptance of m-learning*" as a main reference for our study. These authors highlighted the need of researching the factors that affect user intention to use m-learning. Their study was based on the unified theory of acceptance and use of technology (UTAUT) [14], which integrates elements across eight models of information technology use. They adapt the UTAUT model, proposing their own research model with determinants factors of behavioral intention to use m-learning. The study of Wang et al. was focused on investigating the determinants of m-learning acceptance and to discover if there exist either age or gender differences in the acceptance of m-learning, or both. After conducting an experiment with 330 participants, the results indicate that *performance expectancy, effort expectancy, social influence, perceived playfulness, and self-management of learning* were all significant determinants of behavioral intention to use m-learning. The authors found that age differences moderate the effects of effort expectancy and social influence on m-learning use intention, and that gender differences moderate the effects of social influence, and self-management of learning on m-learning use intention. The determinants factors proposed by Wang et al. in their research model have been considered in this study to understand the m-learning acceptance of older people.

2.3 *QuesTInSitu*: an m-learning app for assessment in situ

QuesTInSitu is a web-based and mobile app designed and built to support assessment *in situ* activities based on tests [15]. On the one hand, authors can use this system to create their own routes of geolocated questions; on the other hand learners can answer the questions, receive feedback and score *in situ* by using a smartphone and sharing their position. The aim of *QuesTInSitu* is to study the application of handheld devices to open up possibilities for creating more appropriate context-aware activities for lifelong learning. Our view is that new assessment types can be integrated within learning in ways that motivate students and support their learning. There are a lot of educational resources that are associated to specific locations, and learning and assessment activities in these locations (*in situ*) can be beneficial.

Various experiments in real formal educational contexts (with secondary and university teachers and students) were analyzed to understand the benefits and limitations of using *QuesTInSitu* for doing assessment in situ activities. The results of the scenarios show how *QuesTInSitu* is useful for giving support *in situ* during the realization of an assessment *in situ* activity. The strategy of giving in real time and *in situ* the questions, the feedback and the score is an essential aspect that helps students to understand better the content of the questions of the test-route [15-16].

In this study we use *QuesTInSitu* as an enabler of an innovative *in situ* learning scenario where older learners co-designed, and conducted a context-aware m-learning activity which is meaningful for them.

3 Description of the experiment

We draw on the study of mobile learning acceptance of [13] to understand how *performance* and *effort expectancy*, and *playfulness* affect the participants' m-learning acceptance. Working towards this goal, we carried out an m-learning activity with a group of older learners (average of 65 years old) enrolled in an informal literature course. The goal of the activity was to get the older learners (who reported not to be especially interested in using ICT) design a context-aware m-learning activity by creating a route of questions about a book they had chosen and read.

In the following sections we describe the activity, its design process and the data gathering methods for the evaluation.

3.1 Educational context

We have conducted the study in an adult educational center (Escola d'adults de la Verneda Sant Martí[1]) that promotes social inclusion of adults through lifelong learning. The center applies an adaptation of the dialogic learning methodology in their courses [17]; this means that all participants' opinions have the same value and are discussed by the group. The participants who took part in the study were all enrolled in a literary gathering course where they read and discuss classics of the Catalan literature. There is no teacher or instructor in the course but rather a participant who volunteers to organize the discussion.. The book "La plaça del diamant" by Merçè Rodoreda was chosen, because its actions take place in a district of Barcelona, the city of the lifelong learning centre, and because the participants were very interested in this novel.

3.2 Description of the m-learning activity, its design and implementation process

The participants read the book and/or watched the film adaptation, and we asked them to come up with questions about the book that were related to areas of the district of Gràcia in Barcelona. The questions were defined by the 20 participants in two workshops, which we summarize below. After the co-design of the activity, 11 participants (divided in two groups) did the m-learning activity in situ by interacting with smartphones. Finally, in a last session with the whole group, we share a last discussion in order to gather opinions with regards to their personal experience during all the process.

Co-design workshops

The two workshops (1h 30 min each workshop), held during the same month, aimed at defining the route of geolocated questions related to the selected book. We asked them to voluntarily form two different groups (A, B). During the first workshop the participants in one group had to create questions that would be answered by the participants of the other group during the activity *in situ*. The criterion for selecting the questions was how related they were to a specific physical space: the real position should give the participants a clue to answer the questions. It is important to mention

[1] http://www.edaverneda.org/edaverneda/en

that during this first workshop we did not introduce the use of mobile devices but rather handed paper maps to the participants for them to explore the location of the *in situ* activity and to facilitate the brainstorming of questions.

During the second workshop, participants had to select 10 questions from those proposed in the previous workshop, and create a route by positioning the questions on a specific location on a map. In this case, we provided Apple iPads and Google Maps to re-explore the area of the district selected and find the most suitable locations for the selected questions. We then uploaded the routes to *QuesTInSitu*.

Activity in-situ

Participants and researchers went to the district of Gràcia in Barcelona. Group A explored and answered the route designed by Group B, and vice versa. Only one mobile phone was assigned to each group because participants refused to carry smartphones individually arguing that they wanted to discuss the questions collaboratively with their team mates. Furthermore, the majority of them said to be afraid of using the devices. Participants had 1h 30 min to plan the best strategy for completing the route, and answering the questions in the correct locations. At the end of the activity a questionnaire was administered and their opinions about the experience were gathered in informal conversations.

Debriefing

A 1h debriefing session was conducted one week after the activity *in situ* took place. In this occasion the data gathered and analyzed were presented and discussed with all the participants of the literature course. Additional comments from participants were also gathered.

Fig. 1 shows the participants during the different phases of the activity (workshop 1 and 2, and the activity *in situ*).

Fig. 1. (a) Using the paper maps during workshop 1; (b) Interacting with Google Maps and iPads during workshop 2; (c) Activity in situ with smartphones

3.3 Participants

A total of 20 older learners participated in the co-design of the activity and debriefing session, and 11 of them did the activity *in situ* with smartphones. The rest of

participants did not join the activity *in situ* due to mobility/accessibility problems and personal reasons. The average age of the participants was 65 years old. This group was selected as significant because only 1 of the participants had previous experience with mobile technologies; accomplishing the required condition (i.e. older lifelong learners without ICT experience) to understand if the co-design and participation in m-learning activities fostered the participants' mobile acceptance.

3.4 Methodology

We applied a mixed-methods evaluation combining the use of quantitative and qualitative data collection methods described in Table 1.

Table 1 Data collection techniques

Data source	Type of data	Labels
Questionnaires	Quantitative and qualitative answers of the participants after the experience with mobile devices during the activity in situ	[Quest]
Observations	3 researchers took note of their observations and conversations with participants during the workshops and activity *in situ*.	[Observations]
Automatic Data	Participants' marks obtained in *QuesTInSitu* during the route.	[Marks]
Workshops	Videos during the workshops (workshop1 and workshop 2).	[Videos-ws]
Activity-in-situ	Videos during the *QuesTInSitu* route.	[Video-gracia]
Debriefing	Final participants' discussion.	[Discussion]

During the workshops, researchers took note of their observations and videos were recorded to understand the behavior of the participants during the co-design of the activity. In the activity *in situ*, researchers observed the participants while using the smartphones with *QuesTInSitu* and their attitudes towards the m-learning activity. During and immediately after the activity researchers took note of their observations and conversations with participants. At the end of the activity *in situ*, participants answered a questionnaire and were interviewed. Finally, in the debriefing session, a focus group was conducted with all the participants (the session was video recorded) to address if their m-learning acceptance had improved after the whole experience.

4 Results

In this section we analyze the partial results collected from the data gathering during the three phases of the experiment, the analysis is structured in three main categories: i) aspects related to engagement with the technology, ii) aspects related to learning benefits of doing the m-learning activity, and iii) collaborative involvement.

4.1 Progressive engagement with the technology

We observed that most of the participants initially refused to interact with the devices (i.e. mobiles phone in the activity *in-situ*, iPad in the co-design workshop) showing that their *performance and effort expectancy* was negative. This behavior, which was observed at the beginning of the activities, waned as the activities progressed. For example, the following conversation with one participant during the 2nd co-design

workshop shows the hesitance of the participant towards using GoogleMap on the iPad to choose the place where to locate the questions: *[Participant]: "Do we have to use "it"?(talking about the iPad)." [Researcher]: As you want, this is not mandatory. [Participant]: "oh my god! I don't want to use this thing. (Talking to other participant) You have to use it!"* Although that participant never really used the iPad during the activity, after a while she asked the researcher to find the street she was looking for and gave instructions about where to move on the digital map. Somehow the **device was entering in the activity in a natural way, the participant was no longer disturbed by its presence**. It is important to note that in the first workshop the activity was explained and participants did not use any technological device to prepare the route of questions. It was during the second workshop when we included the use of tablet PCs to complete the design of the routes. The observations during the second workshop show this change in technology acceptance: *"Participants quickly loose interest in the paper maps and prefer to just talk about the book and the questions interacting with the iPads (comparing this behavior to that in workshop two we can see a difference: iPads seem to be more motivating since users interacted a lot more with them and applied gestures such as swipe, zoom, drag, etc.)"* [video-ws]. The following participant's comment supports the previous observation: "*The iPads enabled us to have a clear view of the place, it seemed like we really were at the place!"*[quest-user4].

In a similar way, at the beginning of the activity *in situ*, only a few participants accepted to carry the device. Most of them had never used the device before but saw it or heard about it from family members (e.g. one participant commented that her husband had a smartphone and that he used it for a lot of things, including maps), showing the importance of *social influence* determined by [17]. As the following observation indicates participant' acceptance towards the device increased during the activity: "*About halfway through the experience they (participants) relate in a very familiar and comfortable way with the device. They don't seem to be scared of it as they were in the beginning*" [video-gracia]. Participants´ increased confidence (*self-management of learning*) with the mobile device is also supported by the fact that at the beginning of the *in-situ* activity only 3 out of 11 participants offered to carry the smartphone, while after the activity 9 out of 11 participants said that they were willing to carry the device in case the activity was repeated. These observations suggest that **users were so engaged in the activity that they started interacting with the technology "naturally"**.

4.2 Meaningfulness of the activities supported by ICT

The results suggest that their increased acceptance of the technology was directly related with their engagement in the activity. A strong emotional involvement was observed during the *in-situ* activity, especially when they discovered that the answers to the questions were correct. Different body gestures were displayed in those situations: they jumped on one leg, they smiled and they increased the volume of their voices. In two occasions the participants were so excited to cross the street to answer to a question geolocated on the other side of the road that they did not acknowledge that the traffic light was still green for the cars and crossed the street in a very dangerous way. This observation shows the positive acceptance of the m-learning

activity: *"There was a strong emotional involvement during the activity, and especially when they knew if the answers to the questions were correct. Different body gestures were displayed during that moment: they jumped on one leg, they smiled and they increased the volume of their voices. They were so immersed into the activity that once they forgot about the cars traffic and two of them were about to cross the street in a very dangerous way"* [observations].

The fact that the participants were interested in the book used for the learning activity fostered their engagement: during the *in-situ* activity, they chatted about the book and fantasized about the buildings in which the book´s characters might have lived. Also, when participants missed the correct answer of a question they continued discussing it while walking towards the next one. Participants punctuated with an average score of 4,72/6 the usefulness of the activity in situ to better understand the book.

For the participants, the appearance of questions *in situ* was very useful and a confirmation that they were located in the correct position. **The appearance of questions and feedback *in situ* and in real time engages the participants to observe the physical environment, improves their knowledge about the district visited and the association of the real world with the questions augments their point of view about the novel**. The following participants' comments and observations support the previous statements: **"**The *fact that when arriving at the indicated place a question would pop up, it was very ingenious"* [quest-user4]; *"It wouldn't be better to do it on paper. We saw with our own eyes the streets where the characters of the book lived, where the author developed the work."* [q-user1]; *"In the phone we could clearly see those streets that guided you to arrive where you wanted to go"* [q-user4]; "*Very interesting, because the device allowed you to know where you are every time"* [quest-user9]. Participants punctuated with an average score of 5,81/6 the usefulness of the activity in situ to know more about the district visited. The behavior observed during the activity *in situ* shows that including paper maps is useful to unite the group and improve the collaboration with the person in charge of the smartphone: "*The printed map was frequently accessed by more than one participant at a time, while the use of mobile devices was more individual*" [observations].

The following observations support how *QuesTInSitu* engaged participants and promoted discussions during the activity: "*When participants miss the correct answer of a question they continue discussing it while walking towards the next one*." [video-gracia]. This behavior shows that **despite only one member of each group carried the smartphone, all the members of the team were engaged in the activity and collaborated in the learning tasks.**

The participants reported that the context-aware m-learning activity allowed them to deepen their understanding of the story, and have a more realistic view of the scene. In addition, geolocation-based technologies in real-life contexts, such as *QuesTInSitu*, allowed them to improve their knowledge about the area visited, which is unlikely to have happened if they had only read the book, *"It wouldn't be better to do it on paper. We saw with our own eyes the streets where the characters of the book lived, where the author developed the work."* [quest-user1]. The following partial results confirm the previous statement: participants valued with an average of 5,7/6 the functionality of seeing their positions and questions over the digital map. The use

of paper map was punctuated with 5,3/6 points.

As participants indicated, ***QuesTInSitu* enables them to be sure of their position and find the nearest questions, but the paper-map was a useful complementary instrument to have a global view of the district that they had to explore**. The following observations and comments support the previous results: "One user realizes that the group of dolls on the screen changes according to the geo-positioning of the group: *'The dolls change position according to our movement!'*. She is surprised and excited." [observations]*; "The map (QuesTInSitu map) indicates correctly our situation, it can even be zoomed for a better view"* [q-user1]. As a conclusion, we observe how LBS can be combined with traditional paper maps because participants use these instruments to solve different problems during the exploratory task (e.g. the paper map provided a global view of the surrounding area, which is difficult to have in the small screen of a mobile phone - users are forced to zoom out to have a view of the surroundings but doing so they lose important details such as the name of the street; on the contrary the map on the mobile phone facilitated the recognition of their position on the map and allowed zooming functions).

The resultant m-learning activity *in situ* was *perceived as a playful* educational experience by the participants. Furthermore, they reported that the activity *in situ* **improved their learning because they could put in practice their knowledge in a realistic, situated way**.

4.3 Collaborative involvement

Regarding the collaborative aspects of the activity, it is worth noting that, as it has been previously indicated, participants worked in groups collaboratively during the co-design and enactment of the activity. In the design stages, the collaboration between members of the same group is used to (1) understand the use of the technology employed; and (2) discuss the most adequate route and questions considering the book selected. **The collaborative involvement in the co-design of the context-aware m-learning activity encouraged participants' engagement in the activity and fostered participants' acceptance of m-learning and LBS.** This was due because all the participants have the same opportunity for sharing their ideas with their mates, and contribute to the design of the activity. This statement is supported by the fact that all the participants agreed that doing the activity collaboratively in groups was one of the most positive aspects of the experience. In the *in situ* phase, the group's strategy was to have a mobile-leader and collaboratively find the locations and discuss the questions to answer correctly. The following participant' comments and observations support the previous statements: *"Among us all we selected the correct answer and shouted of joy when the response was positive"* [quest-user2].

The engagement of participants in the co-design process is well expressed by the following comment made during the debriefing session by one participant: *"the activity in situ is not the only thing we have to remember! We worked a lot to create this successful activity! Thinking the questions and locations, designing the routes… we put a lot of effort but also enjoyed a lot"* [Discussion].

The analysis of partial results allows us to argue that the **participants perceived the use of mobile devices and geolocation-based technologies as beneficial for putting in practice their learning *in situ*. The activity enabled them to test their**

knowledge, observe with more realism the facts and areas cited in the book and answer questions created by peers by doing a playful activity. Their performance and effort expectancy improved gradually by naturally interacting with the mobile devices, having positive consequences in their m-learning acceptance. In the following section we discuss the main results observed during the experiment.

5 Discussion

The aim of this section is to summarize and highlight the implications derived from co-designing a context-aware m-learning activity with older learners to improve their m-learning acceptance. We use the three categories used in the previous section in order to facilitate the organization of implications and main results.

5.1 Progressive engagement with the technology

When an emerging technology is used with a group of older learners, at the beginning some of them might be scared or uninterested because they have never used it before, a similar behavior has been studied with the use of computers and older learners [18]. However, when they become familiar with the m-learning activity, especially working in teams collaboratively, their *outcome expectations–performance* and *self-efficacy* improves and their *anxiety* is reduced, "*Together we found the correct answer, and then we shouted of joy when it was correct"* [quest-user2].

As we have observed, a good strategy for designing adequate m-learning activities for older participants is to encourage a collaborative and participative approach throughout the process (conception, development of materials, enactment of the activity). The design of the activity was structured in various stages (see section 2) and the participants had to work collaboratively in groups. The analysis of the partial results show that this design helps older learners to understand how and why the technology is employed to perform an m-learning activity, and the organization in phases (workshop 1 and 2) reinforced the involvement of the participants in the creation of the routes and geolocated questions. In addition, the involvement of the participants in all the discussions and presentation of results helps them to understand the value of the technology. These data suggest that a traditional, individual experiment, or an evaluation session with emerging m-learning technologies in which older people have not been given the opportunity to create learning materials with them collaboratively, might not be the best approach for providing them with positive and meaningful lifelong-learning experiences.

5.2 Meaningfulness of the activities supported by ICT

Previous works showed that usefulness is an important construct to understand the use of ICT by older people. Usefulness has been discussed within the context of mobile phone adoption, video content-generation and social network sites [19-21]. These studies showed that perceived (lack of) usefulness in the technology can encourage (hinder) the uptake of such technology among older people. In our study, although at the beginning the participants did not consider the technology intrinsically useful,

they perceived the activity (ICT-supported) as *meaningful* for them and the activity ended up with participants showing interest to use the device if a similar scenario was proposed. This result suggests that, although older people might initially be uninterested in the technology, using it in an activity which is meaningful for them can contribute to their acceptance.

Rosales et al. [22] showed that conducting meaningful activities with older people using unfinished versions of products can contribute to improving the product under development. Our study supports the result of Rosales et al., since it shows that engaging participants in meaningful activity can facilitate the co-design process. At the same time, findings support that co-design fostered engagement and motivations among the participants and contributed to add meaningfulness to the activity.

On the other hand, the use of LBSs (e.g. *QuesTInSitu*) to perform a context-aware activity with older learners was perceived as beneficial because it allowed them to put in practice the knowledge acquired in the associated real context. Interacting with geographical information helps participants reflect where the questions have to be located (according with the facts of the novel). Participants prefer to combine LBS and paper-maps to perform the *in situ* activity. At the beginning of the in-situ activity, the paper map was often the center of attention and decision-making. However, as the activity progressed, the participants felt more comfortable with the mobile phone and progressively lost interest in the map. As the partial results have demonstrated the combination of traditional resources (such as paper maps) with technology helps the participants to be more confident during the activity.

Based on Wang et al. [13] and Moon & Kim [23] definitions and according to the results described in the above sections, we can claim that older learners perceived the context-aware m-learning activity as playful. These authors defined playfulness as a state of mind that includes three dimensions: the extent to which the individual (1) perceives that his or her attention is focused on the interaction with the m-learning; (2) is curious during the interaction; and (3) finds the interaction intrinsically enjoyable or interesting.

5.3 Collaborative involvement

The results showed that the collaborative involvement in the m-learning activity (co-design workshops and *in situ* activity) have contributed to increase engagement and motivation. This result partially confirms previous ethnographical research with older people [24], which showed that social aspects play a central role in the use of ICT by seniors. Furthermore, we observed that those persons (who had some previous knowledge using ICT, though limited) acted as “ice breakers” for the rest of the group. Seeing a peer to start using the technology allowed the rest to be introduced to the technology progressively (if there weren’t any “ice breakers”, those who were not willing to carry the mobile would have felt forced to use it to start the activity).

6 Conclusion and future work

This paper provides a case study showing how to involve older people, who are not intrinsically motivated to learn by using mobile devices, in m-learning activities to foster their acceptance and uptake of such technology.

The methodology employed in the activity presented in this paper can represent a good practice of m-learning for older users. Older learners participating in the case study thought that their *performance and effort expectancy* improved after doing the activity. Participants found m-learning useful and meaningful because it enabled them to accomplish learning activities putting in practice (in the real world) their knowledge by doing a *playful* activity. As discussed in the results, Pparticipants indicated that the use of mobile devices and LBS allowed them to *augment the knowledge* that they previously had about the book. Participants preferred to use the iPads to interact with Google Maps for designing and creating the routes because it enabled them to have a *more realistic view* of the learning area. In addition, the *QuesTInSitu* route mediated by smartphones was a successful activity since participants were immersed doing the tasks of finding questions, answering them in the correct place and completed the routes. Their attention was focused on answering the questions correctly, and when one of their answers was incorrect they discussed together about the other options.

The scenario and findings discussed in this paper contribute to the limited exiting body of knowledge around m-learning and older users. On the one hand, it supports that co-design is an adequate approach to enhance m-learning acceptance for older learners. On the other hand, results have shown that participants perceived LBS as useful instruments for learning *in situ*. The meaningfulness of the ICT-based activities in which older people are involved is a key aspect to foster their acceptance of mobile technologies. It is worth noting here that the replication of the same scenario with participants of different profile (e.g. different interests), would not necessarily result in an equally successful experience. In fact, the results suggest that ad-hoc activities should be designed according to the interests of the participants involved in it.

We are currently working on designing and developing a platform that supports the learning and sharing of knowledge through games created by older people [22]. The platform embraces the concept of *meaningful activities* by allowing users to create their own game. In the future we plan to further explore m-learning with older people through the use of the aforementioned platform to gain insights on which other scenarios can be used to improve the experience of older participants during a m-learning *in situ* activity. With further results, it will be possible to propose good practices for lifelong learning applying context-aware m-learning for older learners.

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