Chapter 4

Where is my time? Identifying productive time of lifelong learners for effective feedback services

Lifelong learners are confronted with a broad range of activities they have to manage every day. Hence, learning activities from lifelong learners are disrupted. The difficulty to find a suitable time slot to learn during the day has been identified as the most frequent cause. In this scenario, mobile technologies play an important role since they can track suitable moments to accomplish specific learning activities in context. Sampling of learning preferences on mobile devices are key benchmarks for lifelong learners to become aware on which learning task suits in which context, set realistic goals, and set aside time to learn on a regular basis. The contribution of this chapter is twofold: first, a classification framework for modelling lifelong learners' preferences is presented; second, a mobile application for sampling of experiences is piloted aiming to identify which are the preferences from lifelong learners regarding *when*, *how* and *where* learning activities can be integrated.

This chapter is published as:

Tabuenca, B., Kalz, M., Börner, D., Ternier, S., & Specht, M. (2014). Where is my time? Identifying productive time of lifelong learners for effective feedback services.In *Communications in Computer and Information Science*. In Computer Assisted Assessment. Research into e-Assessment (pp. 149-161). Springer International Publishing.

4.1 Introduction

Choosing time and learning opportunities effectively is one of the major challenges for lifelong learners as confirmed by recent statistics (Eurostat, 2012). This survey shows that the participation in lifelong learning activities in Europe decreased between 2006 and 2011. Participants in this survey mention access, time, place, and lack of personalization as barriers to accomplish learning activities. Kalz (2014) stresses the importance of supporting self-direction and self-organization of lifelong learners with regard to using new technologies. Lifelong learners face the challenge to combine their professional activities with learning activities and engage simultaneously with family times to ensure a balance of adults' responsibilities, overall wellbeing and their personal development. However, finding an appropriate balance between different life domains is neither easy nor instantaneous (Metzger and Cleach, 2004). We have recently conducted a study in which lifelong learners reported that their learning experiences are disrupted, arguing the difficulty to find a suitable time slot to learn during the day as the most frequently reported reason by the participants (Tabuenca et al., 2013). Moreover, learners highlighted the importance of smartphones to support more constant learning experiences. Hence, there is a need to integrate learning activities in daily life. The European Commission (2007) enumerates eight key competences that are fundamental for each individual in a lifelong learning society. One of them is *learning to learn*, i.e. the ability to organize one's own learning through effective management of time and information, and becoming aware of one´s learning.

Providing in-context support and feedback for lifelong learners is key to identify the best learning moments, identify available resources in each context, self-organize their learning day, and set realistic goals. Lifelong learning not only implies setting aside regular time for learning during the day, but also combining learning activities with daily life activities. Mobile devices can facilitate users to track learning preferences in context (Tabuenca et al., 2012b). Hattie and Timperley (2007) state that effective feedback answers three questions: *where am I going?*, *how am I going?* and *where to next?*. To provide support for lifelong learners we are currently developing mobile tools and services to provide feed forward feedback (answering the question *Where to next?*) targeting the process and self-regulation level.

As a method for the development and data collection we have chosen the Experience Sampling Method (ESM) (Hektner et al., 2007). Sampling of learning experiences in context provide an important benchmark for lifelong learners to identify productive times during the day and to scaffold their learning day on top of these moments. ESM is a psychological method that asks participants to stop at certain times and make notes of their experience in real time, gathering direct and contextual objective measures and situated subjective measures. A good portion of ESM research has been done exploring both the structure of classrooms as well as students' and teachers' subjective experience in them, by linking variations in attention, interest or challenge to specific instructional practices or conditions (Leone and Richards, 1989; Crocker et al., 2003). Likewise, contextual ESM has been used to understand daily information needs of people in longitudinal studies (Church et al., 2014). ESM responses measure what the person decides to communicate about his inner states whenever he is prompted a question. It is well known that we tend to be biased and edit out responses according to social desirability (Hektner et al., 2007). For instance, what does it mean if I score 4 in a 5-Likert scale on the question "*how busy are you in this moment?*" where 1 corresponds to "very busy"? This measure can be quite different depending on the habits or culture of the person who answers. Nevertheless, these reports are significantly more powerful and accurate when they are self-reports (since I only take myself as a reference to measure how busy I am in this moment). Hence, ESM facilitates an intimate and exhaustive account on how people go about their daily existence (Hektner et al., 2007). Mobile technologies provide an interesting opportunity for users to evaluate situations based on "stimulus variables in the natural or customary habitat of an individual" (Hormuth, 1986) since they are reported in our own personal device.

This chapter presents a classification framework that aims to support lifelong learners in their need to model the learning day by instantiating different variations of the ESM. Furthermore, results from a small-scale pilot study are presented to collect experiences and feedback about the chosen approach, the type of the preferred notifications received, and their preferred format when sampling the experiences on a mobile device.

4.2 A classification framework for sampling of experiences using mobile devices

In 2003, Consolvo and Walker (2003) explored the use of the ESM to evaluate regular phones, PDAs, paper booklets or audio recorders (*ubicomp applications*). This evaluation concludes that every instance of the ESM is accomplished in three sequential events (see Figure 4.1): 1) receive a notification; 2) dispatch the question (read, listen, watch); 3) provide an answer.

Nowadays, smartphones are equipped with several sensors that enrich the quality and quantity of the sample with contextual information. Mobile devices enable capturing different context variables and can identify the users' location (GPS), orientation (digital compass), among others. In a first analysis for distinguishing the role of context in mobile learning support, De Jong et al. (2008) have identified the main dimensions of context information used in learning applications and further extended to the context taxonomy to the Ambient Information CHannEls model (AICHE) meta-information (Specht, 2009). The AICHE model addresses context via sensors, artefacts and channels. This model approaches the context of a person or an object defined by five distinct dimensions (time, location, environment, relation and artefact identifier).

The classification framework presented in this section (See Figure 4.1) merges ESM and AICHE models to provide specific cues on how lifelong learners can model their learning day. This framework instantiates the ESM to explore the dimensions of mobile context making use of the features provided by mobile devices in each of the sequential events in the instantiation of the ESM.

4.2.1 Receive notification

Notifications can be classified according to two different criteria, i.e. time and the delivery mechanism:

Trigger time, is the rule that identifies the moment in which the user receives the notifications. These notifications can be triggered on three different basis:

- Scheduled-based: Notifications are triggered following a time pattern, e.g.*send me a notification every Sunday at 8pm asking me what was the best moment to read during the week*.

- Random-based: Notifications are triggered randomly in time, i.e. not following any time pattern, e.g.*send me 5 notifications per day asking me how do I feel in that moment.* This type of alerts can be used to identify best occasional learning moments. The fact of randomizing notifications is not only referred to the timing, but also randomizing the number of alerts sent, or randomizing the order in which a sequence is sent.

- Event-based: Notifications are triggered on the accomplishment of an event that happened in the context of the user. Hereby, the dimensions of mobile context are explored with the aim to identify ways to support lifelong learners in their goal to organize their own learning towards effective context adaptation:

  i) Location. Mobile devices are equipped with capabilities (e.g. GPS or Bluetooth) that make them aware of the current location of the user, e.g. *send me a notification every time I arrive at the University in order to ask me what do I expect to learn today.* Sampling this experience might foster lifelong learner´s capacity of reflection to set reasonable goals before starting the learning day (Tabuenca et al., 2012b).

  ii) Artefact identification. Mobile devices are equipped with capabilities (e.g. Near Field Communication readers or Quick Response code reader) that enable them to identify tagged artefacts in learner´s context. E.g. *every time I approach with my mobile device the (NFC) tag attached to my German grammar book, send me a notification asking me how many pages I did read today.* Sampling this experience might help the lifelong learner to track his pace of reading while learning the German language and set aside time to learn on a regular basis.

  iii) Time. Mobile devices provide calendar functionalities that facilitate the configuration of notifications triggered on the accomplishment of time conditions. E.g.*two weeks before I have an exam-appointment in my calendar, send me a notification asking me to rate from 0 to 10 how prepared I am for the exam.* Sampling this experience might help the lifelong learner to monitor his perceived knowledge on a subject, and make a plan to prepare the exam with enough time.

  iv) Relation. This dimension captures the relation an entity has established to other entities, and describes social, functional and compositional relationships.

Mobile devices are equipped with capabilities (e.g. social network apps, messaging) that enable them to identify and/or cluster in groups other entities, and the type of connection they have with the lifelong learner. E.g. *every time my colleagues are online in the campus social network, send me a notification to ask me whether I had any problem making my homework so I could login in that moment and discuss it with them.* Sampling this experience might help the lifelong learner to identify drawbacks accomplishing learning activities, and provide direct cues of support.

v) Environment. This dimension captures tasks and actions happening in the environment. Mobile devices are equipped with sensors (e.g. compass, GPS) and apps (e.g. forecasting weather or traffic jam) that make them aware of the context in the environment of the user. E.g. *send me a notification when the weather forecast for the weekend is rainy so I can borrow a book from the library and stay at home.* Sampling this experience might help the lifelong learner to model his week based on the conditions of the environment.

Delivery mechanism. Notifications can happen in the background, when the notification can be dispatched in a different context in which the notification is received. Nevertheless, ESM notifications must happen in the forefront so the sample can capture the specific lifelong learning context when/where they are received. Notifications in the forefront must call user´s attention. Mobile devices feature three main types of delivery mechanisms, namely, visual (e.g. icon, blinking light, adjust brightness, etc.), audible (e.g. beep, tone, etc.) or tactile (e.g. vibration).

4.2.2 Dispatch question

There are different ways to prompt questions using mobile device. Hereby, we distinguish the following: **Content**. The content of the messages can be designed with the purpose of alerting the student about the date of the exam, informing on the study-hours needed for the current week or reporting the grades. As cited before, Hattie and Timperley (2007) state that effective feedback service must answer three questions: *where am I going?*, *how am I going?* and *where to next?*. Probably the feedback will be more productive the more customised is to the receiver (e.g. *a suggestion from the teacher to improve my performance based on my grades*), rather than generic information (e.g. *Hei! today is a good day to learn!*)

Prompt format. Questions can be formulated in different formats:

- Text. Text is the most compatible format across mobile device. They are not only implemented in regular mobile phones (e.g. SMS), but also in smartphones (e.g. chats, online questionnaires) or PDAs.

- Rich text format. Rich text format is an extension of text prompts, but formatted with special font (type, size, colour etc.), images and/or multimedia (audio, video). These features need to be carefully combined so they do not impact the participant's ability to read.

- Sensor data facilitates the enrichment of the questions with context data. E.g. *Today is a rainy day suitable to stay at home, do you feel like posting an entry in your sew blog?*.

- Complex control. Visual environments facilitate the implementation of prompts that aim to describe and collect complex concepts like relations, clusters, orders etc. Instances of complex controls are:

  i) Multiple/simple choice questions implemented with text and/or images. E.g. *select which learning activity do you prefer to do while commuting to work by bus: (1)listen; (2)read; (3)write; (4)watch videos.*

  ii) Rankings facilitate ordering of items based on a specific criterion. E.g. *based on your current priorities rank your learning goals for the coming month: learn German; iOS development; statistics; research methods.*

  iii) Mapping items facilitate matching of concepts from different groups. E.g.*how much time did you set aside for learning this week? Match your time availability (commuting to work; after dinner) to your weekly learning goals (German grammar; C# programming structures for iOS development).*

  iv) Sliders facilitate collection of a specific value within a range of them. E.g.*rate your overall progress of the week in statics towards your goal of being able to analyse data with ANOVA test (0 to 100%).*

Timeout is the time that the question is available for the learner to be read. Most of the questions are only relevant when they are read within a specific range of time.

Question design. Consolvo and Walker (2003) described three variables when designing questions in ESM: order, i.e. whether the prompts´ order should be fixed or random; dependency, i.e. whether a prompt is presented depending on what the user reported in a previous question (*e.g. every time I report low learning performance, trigger an instance asking me to report on my regular sport activity so I can see whether there is a direct correlation*); probability, i.e. whether there is a need to assign probabilities that a question will be asked.

4.2.3 Provide answer

The answer refers to the externalization of learner´s experience in a mobile device. We distinguish the following components as relevant items for the classification framework.

Timeout. The time the user has to answer the question.

Answer format. Mobile devices today are equipped with text editors, audio and video recorders or photo camera. Likewise, the proliferation of apps to survey data (e.g. personal response systems, questionnaires) facilitates lifelong learners a wide range of input formats to record their experience. Lifelong learners not only learn by analysing the data answered in subsequent iterations of the ESM, it is also expectable that the single fact of externalizing an answer will trigger a different cognitive process depending on the format of the answer. For instance, reporting an answer with an audio-speech (Nielsen et al., 2002) implies a different cognitive process than the one triggered by answering to a multiple-choice-question. Question and answer within an instance of the ESM do not necessarily need to have the same format. Answers reported in an ESM can be:

- Quantitative. Refers to data that can be quantified in a specific number. Sliders, rankings, mappings and sensor data are instances of items to collect quantitative data. E.g. *report how many hours you did invest this week on physical activities.*

- Qualitative. Refers to data aimed to collect descriptions, sensations, features or abstract characteristics. Open answers in text, audio or video recordings are instances of items to collect qualitative data. E.g. *every time I pass an exam, record a power video to motivate you for the next one.*

Sensor data facilitates the enrichment of the sample with context data so lifelong learner´s report can be correlated with variables that a mobile device can capture.

E.g. *every time I run and report a good performance, record the local temperature to find a correlation with weather conditions.*

Acknowledgment checks can be used to indicate whether the question was read or an answer was given.

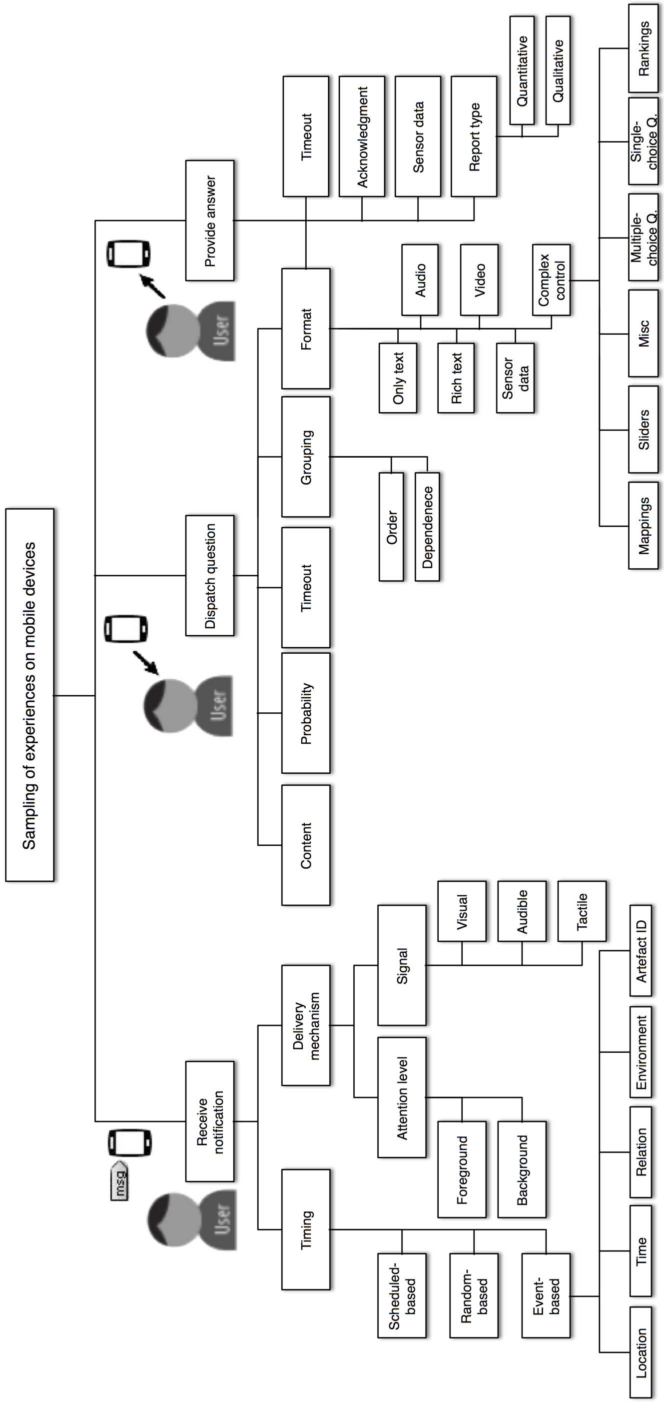


Figure 4.1 Classification framework for sampling experiences using mobile devices

4.3 Qualitative study

4.3.1 Introduction

The qualitative study presented in this section instantiates the framework of the previous section with the aim to make participants aware of their learning preferences, and evaluate which type of questions and answers they do find more suitable in their context. This study took place in a workshop at the Joint European Summer School on Technology-Enhanced Learning 2013 (JTELSS 2013) in Limassol (Cyprus). This event offers a learning environment where participants get opportunities to develop research skills, increase their knowledge base, engage in debate, have access to experts in the field, and discuss their own work.

A hands-on workshop presented the ESM as a method of research in the field of lifelong learners, showed existing tools and piloted an app for sampling of experiences. This pilot was guided by the following research question:

RQ1: What are lifelong learner's preferences, requirements, and needs for ubiquitous support? Including the following sub-questions:

(a) When do lifelong learners prefer to be alerted to report about learning preferences, requirements and needs?

(b) How do lifelong learners prefer to be alerted to report about learning preferences, requirements and needs?

(c) Which formats do lifelong learners find more suitable to report about learning preferences, requirements and needs?

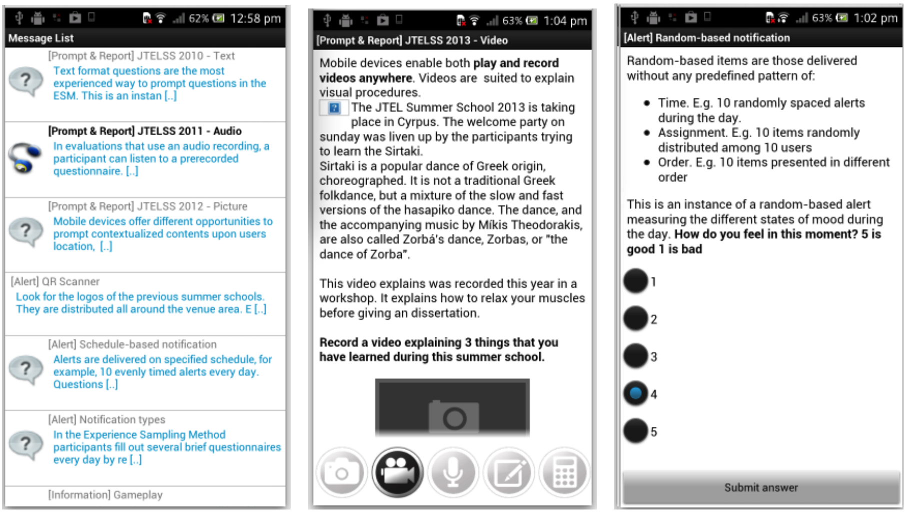
4.3.2 Method

Participants

The experiment involved 12 voluntary and non-rewarded participants. They were all researchers in the field of technology-enhanced learning, five of them were women and the average age was 29.

Materials

The ESM pilot (Figure 4.2) was developed adapting an existing open-source tool for educators, researchers and learners: ARLearn (Ternier et al., 2012b). Two participants used their own mobile devices. The rest borrowed smartphones for the experiment.



(a) List of items (b) Question prompted in video and answer reported in video (qualitative report) (c) Question prompted in text and reported in 5-Likert scale (quantitative report)

Figure 4.2 ESM app

Design

All the participants in the experiment had the same treatment. This experiment took place during 90 minutes distributed in the following time slots:

- Lecture. 30 minutes introducing the ESM and showing theoretical framing of the workshop.
- Field trip excursion sampling experiences. 40 minutes of practical experiment in which the participants followed the flow given in the mobile app as illustrated in Figure 4.3.

- Questionnaire & discussion. 20 minutes, brainstorming, feedback and data collection

A questionnaire gathered their learning preferences regarding mobile usage. Three questions were asking about their preferred sampling method and two about the general appreciation of the app.

Procedure

The lecture presented the guidelines to perform sampling of experiences with mobile technologies. The app whose flow is illustrated in Figure 4.2 was designed so the participants could experience the different type of notifications that can be triggered when implementing the ESM, namely, scheduled-based notifications, event-based notification and random-based notifications. The flow comprised the following items presented to the participants in the form of notifications:

- App instruction items (See single-lined squares in Figure 4.2). These items teach them how to navigate within the app, how to record audio, etc.

- ESM instruction items (See double-lined in Figure 4.2). These items were instances of the ESM in the form of notifications appearing in their incoming message box on the following bases: scheduled-based notification came two minutes after starting the app; event-based notifications came after scanning QR codes around the venue (Figure 4.2a) and after reading the scheduled-based notification (see dependencies in classification framework); random-based notification came in some moment after the first notification. For these items, participants should read the question given in text, rich-text (Figures 4.2b and 4.2c), audio, or video (Figure 4.2b). After that, they should answer in a required format that could be text, audio, video (Figure 4.2b), picture or likert scale (Figure 4.2c).

4.3.3 Results

When participants were asked when they preferred to be notified to report about learning preferences, requirements and needs, event-based notifications were preferred by 92%, scheduled-based by 42% and random-based by 0% of the participants (Figure 4.4). Participant 1 (P1) preferred “event-based” and “scheduled-based” arguing that these types of notifications are “*Easier to organize as a learner*”. Some of the

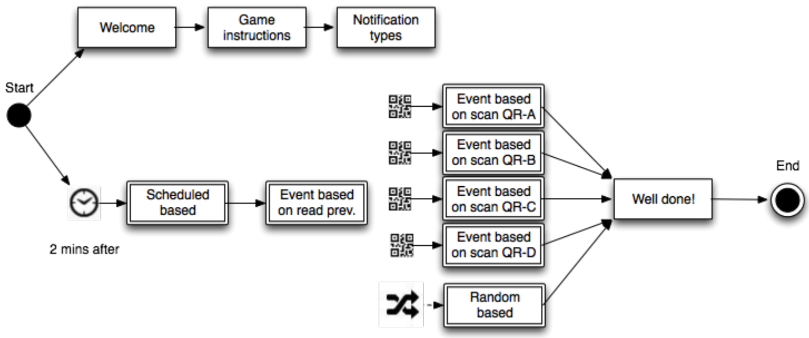


Figure 4.3 Flow of the ESM app

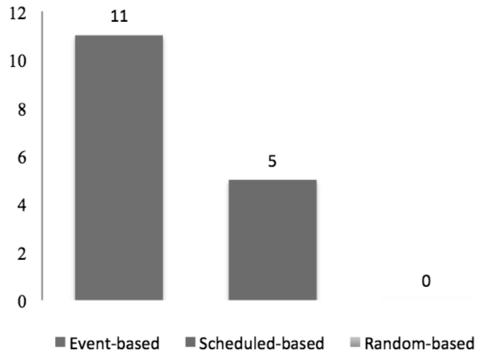
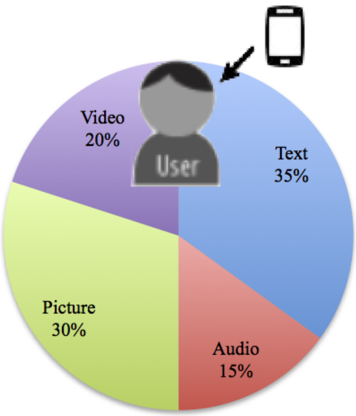


Figure 4.4 Timing preference for notifications prompted on mobile devices

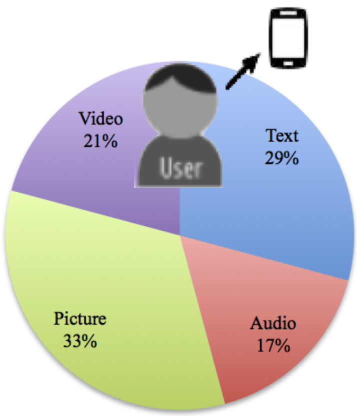
participants raised compatibility working aspects in "scheduled-based" notifications. P4: "*scheduled-based alerts would fit more my working preferences* ". One participant highlighted the bias effect of expecting a question, happened especially in "event-based" notifications, but also in "scheduled-based" notifications. P3: "*It was logical to expect a question after a particular event*". As event-based items were triggered by scanning QR codes attached to physical objects, some participants raised the proximity of attaching digital information to physical world objects. P5: "*Information shown in event-based event seemed to be closer to me*". P6: "*event-based notifications are more relevant since they are triggered as a consequence that something in my environment was happening*".

When participants were asked how they preferred to be alerted to report about their learning preferences, requirements and needs, the majority of the participants preferred texts and picture formats (Figure 4.5). Participants that selected "text" and "picture" argued the accuracy of the explanation using this format. P1: "*You get more focused info and it is easier to understand the question*". Intrusiveness aspects were detected for participants that preferred text. P2: "*It is the least intrusive way*". Some participants raised the usefulness of making knowledge understandable to someone and express their impressions with video and picture formats. P3: "*Pictures and videos convey a lot of knowledge in relatively short time*". Context or environment, were raised as key elements to decide the suitability of the notification, to the extent that some participants did not report a concrete preference. P4: "*They are all useful media formats depending on the context*". Suitability of the format text was preferred because of its facility to adapt to be read in different contexts. P5: "*I can easily adapt my time to read in a suitable moment*". P6: "*Text and pictures are better to describe an understanding*". P8 preferred text and argued "*The rest of the formats are a kind of 'invasive' mode of communication that might not adapt to the different times of the day, night*". Pictures and videos were reported as more "catchy" (P9). P10 reported text preference arguing that they are less distracting than the rest of the media. When this is about recording feelings and emotions, audios facilitate it. P12 preferred audios arguing "*personal audio recordings facilitate it in a more personal way*".

When lifelong learners were asked which formats they find more suitable to report about learning preferences, requirements and needs, the majority of the participants reported pictures and text as preferred formats (Figure 4.5). Rapidity on creating the answer was argued as key aspect by some participants. P1: "*It is faster*". Likewise as happened in previous question, some participants raised the usefulness of making knowledge understandable to someone and express their impressions with video and picture formats. P3: "*Pictures are easy to take and again convey a lot of data*". Participants seemed to be more used to text messaging. Some participants raised were more familiar reporting text samples. P3: "*Text is the simplest way*". One participant highlighted that videos are well suited recording of procedures. P4: "*Video answers facilitate explaining a flow of information*". Audio recordings were perceived as more natural interventions when reporting. P5: "*Audio recording is a more natural interaction interface*". Pictures seem to be really popular and easy to report method. P5: "*Taking pictures is a pretty common way to report with a mobile phone*". Some participants discarded the use of text of notifications because of the difficulty of writing long text messages on the small keyboards of smartphones. Even more remarkable when the smartphones are borrow and they are not the personal ones. P8: "*Audios, pictures and videos are easier and faster to use*". P9: "*I am more used to text and pictures*". P10 preferred picture reminding that "*A picture is worth a thousand words* ". Some consider pictures as easier to assimilate information. P11: "*Text content is easier to process for me*". Videos are well suited to analyze the participant, gestures, or physical reactions when reporting. P12: "*They are more indicative to see what you like to know from the participant*".



(a) To read prompts on mobile devices



(b) To report answers on mobile devices

Figure 4.5 Formatting preferences

4.4 Discussion and conclusions

The European Commission (2007) highlights the ability to organize one's own learning through effective management of time and information, and becoming aware of one´s learning ("learning to learn"), as one of the eight key competences for each individual in a lifelong learning society. This chapter presents a suitable approach for introspection and modelling the learning day in lifelong learners. Instantiations of the ESM in personal mobile devices are proposed to foster awareness and to facilitate an intimate and exhaustive data collection on learning habits in context.

Recent work (Gros et al., 2010) reviews time preferences and availability in e-learning classrooms across a 10-year period in scientific literature concluding that almost all the papers dealt with formal education and quantitatively oriented. The classification framework presented in the current chapter extends the walls of the classroom in lifelong learners to the mobile context, and proposes a suitable scaffold to identify productive moments exploring not only the quality and quantity of the time, but also the rest of the dimensions in the mobile context (location, relation, environment, artefact) (Specht, 2009).

Moreover, this classification framework is instantiated in a study in which a mobile app is piloted with the aim to make lifelong learners record and reflect on qualitative and quantitative learning preferences through the use of different features in smart phones. The experiment resulted in a successful experience in which participants were able to report their learning preferences in the specific context of a technology-enhanced learning summer school.

The work presented in this chapter represents an interesting technique for lifelong learners to get actively involved in knowing their own learning day. The ESM instantiated in personal mobile devices is very suited for lifelong learners to explore their own specific context, learning style, and available resources to model each learning moment.

This pilot has raised the following limitations: first, this pilot was tested at the venue of a summer school, which is an exceptional learning context. Real lifelong learning scenarios imply daily routines like workplaces, transitions, etc.; second, the duration of the experiment was too short. Modelling one's lifelong learning day implies a long-term experiment in which moments of the day and moments of the week are explored. The analysis on work time and learning activities from

Livingstone and Stowe (2007), stresses the lack of longitudinal studies especially in job-related informal learning. Likewise, they highlight that initiatives to achieve better work-family balance are most likely to have a positive effect on either quality of work life or workers' learning opportunities, if the full extent of these long hours is recognized more clearly.

Mobile tools are increasingly used for sampling of experiences (Church et al., 2014; Intille et al., 2003; Conner, 2013) in the last years in which different reports have reviewed existing tools for sampling of experiences (Conner, 2013; Khan and Markopoulos, 2009) classifying them by operating system (iOS, Android, etc.), the price of the app, the project where it was used, or the URL where it can be downloaded. Nevertheless, there is no scientific work reviewing existing apps featuring experience sampling on mobile devices. In future research, we will extend this work by providing a review of apps for ESM classifying them in accordance to the framework presented in this chapter and with a special focus on the use of ESM for self-regulated learning. Likewise, this research will be further extended developing mobile tools and services to provide effective feed forward feedback targeting the process and self-regulation level.