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

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Abstract— Lifelong learners are confronted with a broad range of activities they have to manage every day. In most cases they have to combine learning, working, family life and leisure activities throughout the 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 keep track of the most 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 manuscript is twofold: first, a classification framework for modelling lifelong learners' preferences is presented based on a literature review; second, a mobile application for experience sampling is piloted aiming to identify which are the preferences from lifelong learners regarding when, how and where learning activities can be integrated. Both framework and pilot provide an important scaffold for lifelong learners to identify productive times during the day with mobile technologies.

Keywords: lifelong learning, experience sampling, mobile learning, self-regulated learning, reflection

1   Introduction

Chosing time and learning opportunities effectively is one of the major challenges for lifelong learners as confirmed by recent statistics of the European Commission [1]. 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 stresses the importance of supporting self-direction and self-organization of lifelong learners with regards to using new technologies [1]. Lifelong learners face the challenge that they have to combine their professional activities with learning activities and must engage simultaneously with family times to ensure a balance of adults' responsi-

bilities, overall wellbeing and their personal development. However, finding an appropriate balance between different life domains is neither easy nor instantaneous [2]. We have recently conducted a study concluding that lifelong learner's learning experiences are disrupted and finding a suitable time slot to learn during the day is the most frequent difficulty reported by participants [3]. Moreover, learners highlight the importance of smartphones to support more constant learning experiences. Hence, there is a need to integrate learning activities in daily life. The European Reference Framework [4] enumerates eight key competences that are fundamental for each individual in a lifelong learning society. One of them is "Learning to learn", being 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 keep track of learning preferences in context [5]. Hattie and Timperley [6] differentiate between three different types of feedback and four different effect levels. 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).

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 and it also allows to gather 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 variation in attention, interest or challenge to specific instructional practices or conditions [7, 8]. Likewise, contextual ESM has been used to understand daily information needs of people in longitudinal studies [9]. 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 that we edit out responses according to social desirability [10]. 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 [10]. Mobile technologies provide an interesting opportunity for users to evaluate situations based on "stimulus variables in the natural or customary habitat of an individual" [11] since they are reported in our own personal device.

This manuscript 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.

2 A classification framework for modelling lifelong learners' day

In 2003, Consolvo et al. [12] explored the use of the ESM to evaluate regular phones, PDAs, paper booklets or audio recorders ("*ubicomp applications*"). This evaluation contemplates that every instance of the ESM is dispatched in three sequential events (Figure 1): receive a notification; dispatch the question (read, listen, watch); 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. [13] 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) [14] meta-information. 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 (Figure 1).

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

Receive notification   Dispatch question   Provide answer
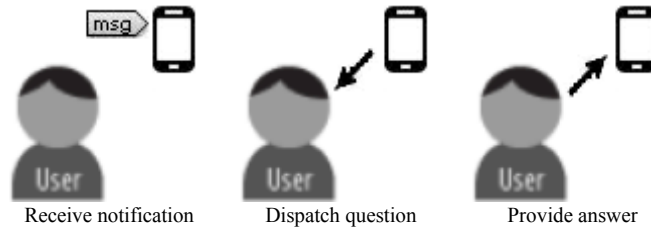
Fig. 1. Sequential events in an instance of the ESM

2.1 Receive notification

Notifications can be classified according to two different criteria:
1. Trigger time, this is the rule that identifies the moment in which the user receives the notifications. These notifications can be triggered on three different basis:
    a) 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*.
    b) Random: Notifications are triggered randomly in time, this is 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.

c) 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 (Figure 2) 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 to the University in order to ask me what do I expect to learn today*. Sampling this experience fosters lifelong learner´s capacity of reflection [5] and set reasonable goals before starting the learning day.

ii) 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 lifelong 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 did I read today.* Sampling this experience helps 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 helps 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, Near Field Communication) 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.* Sampling this experience helps the lifelong learner to identify drawbacks accomplishing learning activities, and provide direct cues of support to existing drawbacks.

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 helps the lifelong learner to model his week based on the conditions of the environment.

Fig. 2. Five dimensions of mobile context. AICHE model [14]

2. 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).

2.2   Dispatch question

Type of question classifies the different ways in which the question can be prompted to the lifelong learner. We distinguish the following criteria as relevant:
1) Prompt format. This is referred to the format in which the question is formulated.
   a) Text. This 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.
   b) Rich format. These are extensions 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.
   c) 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%)*.

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

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

3) Question design. [12] contemplate three variables when designing questions in ESM: order, that is, whether the prompts´ order should be fixed or random; dependency, that is, 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 weather there is direct correlation)*; probability, that is, whether there is a need to assign probabilities that a question will be asked.

2.3   Provide answer

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

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

2) 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) facilitate 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 [15] 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:

    a) 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 did you invest this week on physical activities*.

    b) 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*.

3) 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*.

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

3   Qualitative study

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 do they 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:
1) 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?

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 was developed adapting an existing open-source tool suite for educators, researchers and learners: ARLearn [16] (Figure 3). Two participants used their own mobile devices. The rest borrowed smartphones for the experiment.

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 where the participants followed the flow given in the mobile app and illustrated in figure 4.
* Questionnaire & discussion. 20 minutes, brainstorming, feedback and data collection

Data was collected in questionnaire about learning preferences that included three questions asking about their preferred sampling method and two more about appreciation of the app.
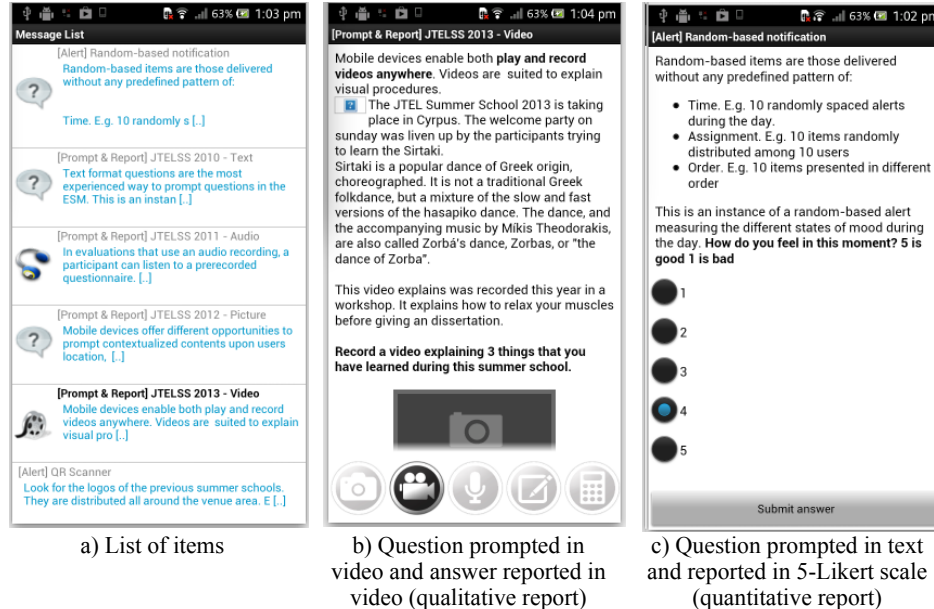

| a) List of items | b) Question prompted in video and answer reported in video (qualitative report) | c) Question prompted in text and reported in 5-Likert scale (quantitative report) |

Fig. 3. ESM for ARLearn app.

Procedure.

The lecture presented the guidelines to perform sampling of experiences with mobile technologies. The app whose flow is illustrated in figure 3 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 contemplated the following items presented to the participants in the form of notifications:

- App instruction items (See single-lined squares in figure 3). These items teach them on how to navigate within the app, how to record audio, etc.
- ESM instruction items (See double-lined in figure 3). 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 3a) 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 (Figure 3bc), audio, or video (Figure 3b). After that, they should answer in a required format that could be text, audio, video (Figure 3b), picture or likert scale (Figure 3c).
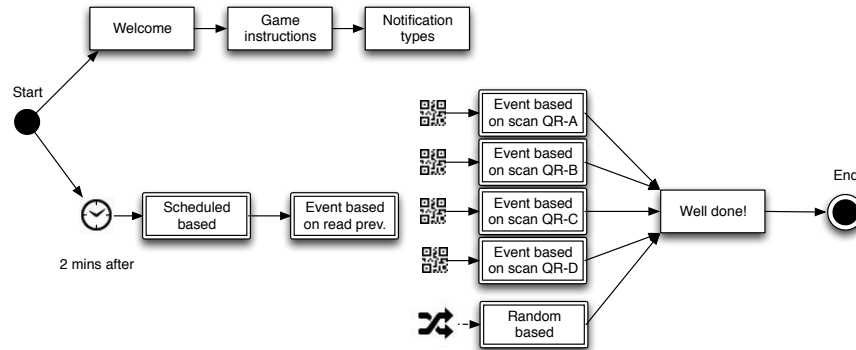
Fig. 4. Flow of the ESM app.

3.3 Results

1) Research question 1. Lifelong learning preferences, requirements and needs for ubiquitous support

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 5). Participant 1 (P#1) preferred "event-based" and "scheduled-based" arguing that these types of notifications are "*Easier to organize as a learner*". Some of the participants raised compatibility working aspects in "scheduled-based" notifications. P#4: "*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. P#3: "*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. P#5: "*Information shown in event-based event seemed to be closer to me*". P#6: "*event-based notifications are more relevant since they are triggered as a consequence that something in my environment was happening*".
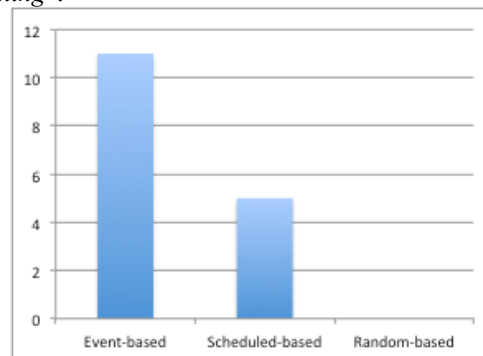

Fig. 5. When do you prefer to be alerted to report about learning preferences, requirements and needs?

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 6). Participants that selected "text" and "picture" argued focus on the information and accuracy on the explanation. P#1: "*You get more focused info and it is easier to understand the question*". Intrusiveness aspects were detected for participants that preferred text. P#2: "*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. P#4: "*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. P#5: "*I can easily adapt my time to read in a suitable moment*". P#6: "*Text and pictures are better to describe an understanding*". P#8 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" (P#9). P#10 reported text preference arguing that they are less distracting than the rest o the media. When this is about recording feelings and emotions, audios facilitate it. P#12 preferred audios arguing "*personal audio recordings facilitate it in a more personal way*".
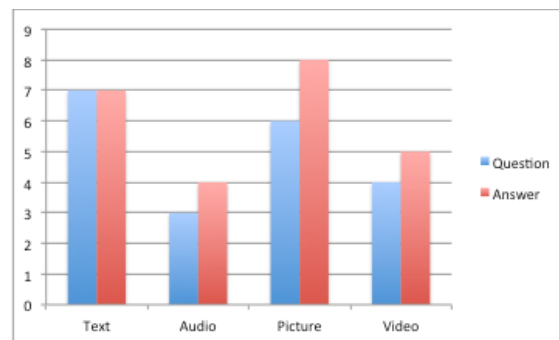

Fig. 6. How do lifelong learners prefer to be prompted? (Question). How do lifelong learners prefer to answer? (Answer)

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 6). Rapidity on creating the answer was argued as key aspect by some participants. P#1: "*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. P#3: "*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. P#3: "*Text is the simplest way*". One participant highlighted that videos are well suited recording of procedures. P#4: "*Video answers facilitate explaining a flow of information*". Audio recordings were perceived as more natural interventions when reporting. P#5: "*Audio recording is a more natural inter-*

action interface". Pictures seem to be really popular and easy to report method. P#5: "*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. P#8: "*Audios, pictures and videos are easier and faster to use*". P#9: "*I am more used to text and pictures*". P#10 preferred picture reminding that "*A picture is worth a thousand words*". Some consider pictures as easier to assimilate information. P#11: "*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 tow what you like to know from the participant*".

4   Discussion and conclusions

The European Reference Framework [4] 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 manuscript 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 [17] 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 manuscript 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) [14].

Moreover, this classification framework is instantiated in a study where 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 where participants where able to report their learning preferences in the specific context of a technology-enhanced learning summer school.

The work presented in this manuscript 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 length (in time) of the experiment was too short. Modelling one's lifelong learning day im-

plies a long-term experiment where moments of the day and moments of the week are explored. The analysis on work time and learning activities from Livingstone & Stowe [18] 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 [9, 19, 20] in the last years where different reports have reviewed existing tools for sampling of experiences [20, 21] 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 deepening into the features for experience sampling on mobile devices. In future research, we will extend this work by providing a review of apps for ESM classifying the in accordance to the framework presented in this manuscript 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.

References

1. Kalz, M.: Lifelong learning and its support with new technologies. In N. J. Smelser, & P. B. Baltes (Eds.), International Encyclopedia of the Social and Behavioral Sciences. Oxford, United Kingdom: Pergamon (in Press).
2. Metzger, L.C., Cleach, O.: White-collar telework: Between an overload and learning a new organization of time. Sociologie du travail. pp. 433–450 (2004).
3. Tabuenca, B., Ternier, S., Specht, M.: Supporting lifelong learners to build personal learning ecologies in daily physical spaces. International Journal of Mobile Learning Organsation. 7, 177–196 (2013).
4. European Commission: Key competences for lifelong learning. An European reference framework. (2007).
5. Tabuenca, B., Verpoorten, D., Ternier, S., Westera, W., Specht, M.: Fostering reflective practice with mobile technologies. In Proceedings of the 2nd Workshop on Awareness and Reflection in Technology Enhanced Learning. (2012).
6. Hattie, J., Timperley, H.: The Power of Feedback. Rev. Educ. Res. 77, 81–112 (2007).
7. Leone, C., Richards, H.: Classwork and homework in early adolescence: The ecology of achievement. J. Youth Adolesc. 18, 1989 (1989).
8. Crocker, J., Karpinski, A., Quinn, D.M., Chase, S.K.: When Grades Determine Self-Worth: Consequences of Contingent Self-Worth for Male and Female Engineering and Psychology Majors. J. Pers. Soc. Psychol. 85, 507–516 (2003).
9. Church, K., Cherubini, M., Oliver, N.: A large-scale study of daily information needs captured in situ. ACM Trans. Comput. Interact. 21, 1–46 (2014).
10. Hektner, J., Schmidt, J., Csikszentmihalyi, M.: Experience sampling method: Measuring the quality of everyday life. (2007).
11. Hormuth, S.: The sampling of experiences in situ. J. Pers. 54, 1986 (1986).
12. Consolvo, S., Walker, M.: Using the experience sampling method to evaluate ubicomp applications. Pervasive Comput. IEEE. (2003).

13. Jong, T. De, Specht, M., Koper, R.: A reference model for mobile social software for learning. Int. J. Contin. Eng. Educ. Life-Long Learn. 18, 118 (2008).
14. Specht, M.: Learning in a technology enhanced world. (2009).
15. Nielsen, J., Clemmensen, T., Yssing, C.: Getting access to what goes on in people's heads?: reflections on the think-aloud technique. NordiCHI. pp. 101–110 (2002).
16. Ternier, S., Klemke, R., Kalz, M., Specht, M.: ARLearn: augmented reality meets augmented virtuality. J. Univers. Comput. Sci. - Technol. Learn. across Phys. virtual spaces [Special issue]. 18, 2143–2164 (2012).
17. Gros, B., Barbera, E., Kirshner, P.: Time factor in e-learning: Impact literature review. eLearn Cent. Res. Pap. Ser. 16–31 (2010).
18. Livingstone, D., Stowe, S.: Work time and learning activities of the continuously employed: A longitudinal analysis, 1998-2004. J. Work. Learn. 19, 17–31 (2007).
19. Intille, S.S., Rondoni, J., Kukla, C., Ancona, I., Bao, L.: A context-aware experience sampling tool. CHI '03 Ext. Abstr. Hum. factors Comput. Syst. - CHI '03. 972 (2003).
20. Conner, T.: Experience Sampling and Ecological Momentary Assessment with Mobile Phones. (2013).
21. Khan, V.J., Markopoulos, P.: EXPERIENCE SAMPLING : A workbook about the method and the tools that support it. , Eindhoven (2009).

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