Establishing user requirements for a mobile learning environment

Conference or Workshop Item

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Abstract

This paper presents the rationale, challenges, successes and results of activities to establish the requirements for a mobile learning environment. The effort is part of a European-funded research and development project investigating context-sensitive approaches to informal, problem-based and workplace learning by using key advances in mobile technologies. The techniques used include user observation, participatory design workshops and questionnaires. Analytic techniques include UML and the Volere shell and template.

1. The MOBIlearn Project

MOBIlearn is a worldwide European-led research and development project exploring context-sensitive approaches to informal, problem-based and workplace learning by using key advances in mobile technologies. The goals of the MOBIlearn project are stated as:

'…the creation of a virtual network for the diffusion of knowledge and learning via a mobile environment where, through common themes, it is possible to demonstrate the convergence and merging of learning supported by new technology, knowledge management, and new forms of mobile communication … A subsidiary goal is to develop deeper understandings of the social processes and interactions that arise when connectivity reaches a critical point, so that we are alert to the possible emergence of 'ambient intelligence' equivalents of the widespread take-up by users of SMS.' [4, p 7]

To accomplish these goals, we must develop a thorough understanding of:

- the opportunities presented by the new mobile technology
- its (potential) impact on the way people perform tasks
- its (potential) impact on human social processes and interactions
- how these in turn are changed or modified by the technology

To fully explore these areas of understanding, the project has adopted a human-centered perspective on system design, which will provide tools, methods and techniques to enable such an in-depth analysis of work practices and human perceptions of the technology's value. MOBIlearn uses ISO 13407 as an overarching model for the project, but at a more detailed level we have adopted socio-cognitive engineering [6, 7] as our guiding approach. Neither of these specifies the techniques to be used at different stages, so we have been free to adopt whichever ones suit our circumstances most closely.

There are three strands of investigation in the project: health (being investigated by The Open University, UK), MBA students (being investigated by Zurich University, Switzerland), and museums (being investigated by Universita Cattolica, Italy). For all three strands we began by producing scenarios. These scenarios contain a narrative, describing the situation where a user is engaged in a task. Their purpose is to set the scope of user goals, to explain to others about activities in the mobile learning domain, and for other stakeholders to explain to the project what they want. The scenarios fulfill a dual function. The first is to assist in the process of envisionment [1]. The second was to begin considering basic requirements, and they have formed the basis of a set of general requirements which are common to all three strands. For example, the need for the system to be able to establish context (e.g. where am I?), the need for multi-modal input, the need to be aware of others (for collaboration) and user-controlled interaction so that learners feel empowered.

In the next section we introduce the two main techniques we use to establish user requirements: the Volere shell and Volere template, and UML use cases. Then we introduce the three strands of the project: museum, MBA and health. Due to space limitations we consider only the health and the MBA strands in any detail. Finally, we present some conclusions.

2. Volere shell and template

We have decided to use the Volere shell [5] as a common mechanism for capturing requirements as they emerge from requirements gathering activities. Doing this will maintain consistent and compatible requirements across the three scenario strands. A description of the shell entries is shown in Figure 1. Using this shell encourages the originator to clarify the requirement and to consider a number of issues associated with it which might otherwise be overlooked. Using the Volere shell has a number of advantages:

1. If all requirements are documented using this format then we will have consistent information for each requirement together with traceability information to track where the requirement originates, and where it appears in later documentation such as UML diagrams.

2. Having requirements documented in a consistent manner will facilitate the identification of common requirements across scenario strands.

3. The format is clear and simple to follow.

4. The format encourages the originator of a requirement to study the detail of the requirement (description), to justify it (rationale) and to consider how it relates to other requirements (dependencies/conflicts).

5. Completing the 'Fit Criterion' field requires the originator to think about how the requirement can be tested or evaluated. This will feed directly into our evaluation activities and support the work there.

6. Volere shells can be stored in a database for easy search and retrieval. As the number of requirements grows, this database will be updated.

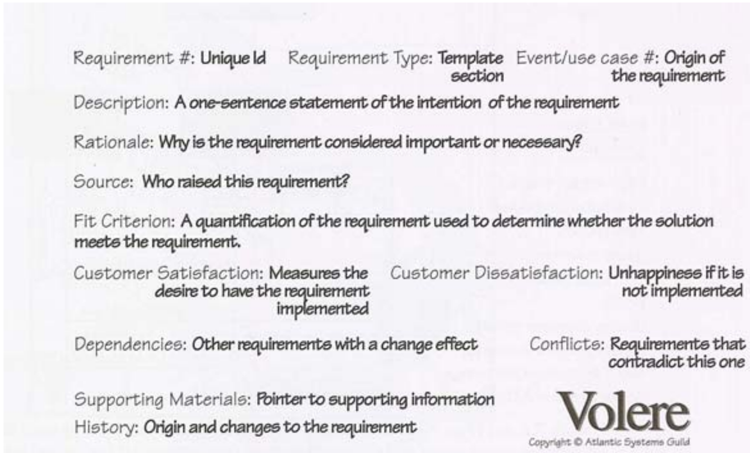

Figure 1 The Volere shell for capturing requirements

3. UML Notation

The UML (Unified Modelling Language) is a powerful, widely-used notation for capturing object-oriented models of code, business processes, relationships in the real world, and many more [see, e.g. 2, 8]. UML may therefore be used across a variety of abstractions, from early requirements to implementation. The MOBIlearn team have agreed to use UML as a common notation across work packages.

4. The Three Strands of MOBIlearn

The project is focusing on three strands: Museums, Health and MBA students.

4.1. Museum strand requirements activities

Two types of questionnaire have been created: one to capture user requirements from the point of view of the tourists, and one from the point of view of the museum's director. The first questionnaire can be seen online at www.mobilearn.org in the Public Result or directly at the address http://www.mobilearn.org/results/questionnaire/questionnaire.htm.

To date, 600 people have been interviewed directly at the Florence Museums and around the Castles of the Duchy of Parma and Piacenza, and some have completed the questionnaire on-line. The second questionnaire has been created for the museums' directors. Many of the world's most important museums have been interviewed to find out which type of mobile technology would like to implement inside their museums to offer a new type of service to tourists

4.2. Health Strand Requirements Activities

The MOBIlearn health strand is focused on eliciting requirement specifications for the design of mobile tools suitable for managing and accessing knowledge about basic and non-specialised medical situations [4, p6]. Central to this remit is the need to produce mobile tools that facilitate learning or the acquisition of basic knowledge about health related situations. In turn, the MOBIlearn health strand strives to achieve this by applying pedagogical insights about learning to understand and interpret knowledge acquisition and sharing mechanisms in health related application areas. This entails accounting for contextual and social-cultural perspectives of user interactions and operational behaviour of focused health practising groups. Towards this end, the MOBIlearn health strand examined work practices of Operational Health Practitioners (OHP) or First Aiders at The Open University (OU). Here we will describe the method used to conceptualise current and future artefacts and work practices of the OU first-aiders when carrying out occupational health or first aid duties.

In order to specify appropriate requirements for designing mobile health tools to form part of the MOBIlearn learning environment, we employed the Future Technology Workshops [9] method to capture user requirements from OU first-aiders.

4.2.1. Future Technology Workshops

The Future Technology Workshops (FTWs) approach to capturing system requirements focuses on analysing current user activities and tools whilst at the same time envisioning the future integration of technology and activities. In practice, the FTW method involves the organisation of practical workshops in which targeted users or representative user groups are encouraged to explore and explicate both current and future activities and tools involved in their operational context.

When gathering requirements for the MOBIlearn health strand, two FTW workshops involving OU first-aiders were organised during which users were encouraged to interact with various types of "low-tech" and "hi-tech" artefacts to produce models of an envisioned future system for use in first-aid activities. Following this modelling, participants (OU first-aiders) gave presentations of produced models so as to comment on their operational functions and interface features.

4.2.2. Data Capture

The method used to capture data from these two workshops included the following:-

- *Video recording of practical modelling activities*. This included the audio capture of pre-modelling discussions, and audio presentations of produced models involving role-play.

- *Audio recording of group discussions whilst modelling*. Audio recording using tapes and minidisks was used to capture verbal discussions of participants whilst they produced models and gave presentations.

- *Handwritten notes*. Personal observations were made by assistants monitoring user interactions during workshop activities. Assistants prepared handwritten notes on various aspects of their observation and interpretation of user behaviour and comments whilst producing models.

4.2.3. Data Analysis

The data gathered was transcribed in a word document. In order to elicit systems requirements for the MOBIlearn health strand, a colour coding mechanism was used to identify operational functions and interface features of envisioned tools and future activities. The definition and use of the term 'tool' in this analytical process was informed and grounded in MOBIlearn about human activities and pedagogy i.e. activity theory. In this respect, the activity theoretical notion of 'tools' embodies both physical tools used to perform human activities, for example a pencil for writing, a fork for eating or a bandage for stopping bleeding on an injury. In addition to this, activity theory recognises the conceptual aspects of tools through their mental mediating capacities, therefore a tool can also be defined as a plan, a formula or operational steps e.g. the first-aid ABC routine for assessing an injured person and context of the incident.

During data analysis, the transcribed raw (unprocessed or un-analysed) data from OU FTWs was then colour coded according to the above criteria and organised into a table that identified tools or artefacts, operational functions and interface features, indication of the source from which that data is abstracted, finally, the elicitation of anticipated systems design requirements.

4.2.4. Example requirement and its documentation

From this data, we were able to extract an initial set of 64 requirements which we documented in Volere shells. For example, one set of requirements related to providing diagnostic tools for first aiders. This was broken down into other requirements, as shown below.

The diagnostic toolkit needs to be:
R2.14 Portable, and therefore lightweight
R2.15 Applicable on victim's body to take readings
R2.16 Automatically activated (e.g. when lifted up)
R2.17 Taking continuous readings to assess patient as situation progresses
R2.18 Location aware

The overall requirement was documented in a Volere shell as shown in Figure 2. The requirements listed above were each also captured in a shell.

Mobilearn Health Strand
OU First-Aiders - Requirements in Volere Shell

irement #: **R2** *Requirement Type:* *Event/use case #:*

iption: Provide Diagnostic Tools

nale: Part of the duties of a first-aider is to give the emergency services a diagnosis of the problem being experienced by the victim at an incident. I to provide accurate diagnosis, it is necessary to have good knowledge and understanding of medical knowledge and terminology. Successful mentation of diagnostic tools would enhance first-aiders' tasks in this area.

e: FTWs (workshops) held at The Open University

riterion: This requirement will be fulfilled once the system can successfully diagnose ailments at a first-aid incident.

mer Satisfaction: *Customer Dissatisfaction:* Very important

ndencies: R1.2, R1.4, R1.12 *Conflicts:*

orting Materials: Documents with transcripts of FTWs held with occupational health first-aiders at The Open University

ory: None

Volere

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Figure 2 A completed Volere shell for the health strand

4.3. MBA strand requirements activities

4.3.1. Scenarios and user tests

The first set of requirement activities were based on two initial and very broad scenarios. For both of them we have produced initial detailed context of use descriptions. These include stakeholder analysis and more detail about the environment. Furthermore we developed initial UML use case diagrams based on the scenarios. These requirements are currently being refined.

Future gathering requirements will augment the work done. New scenarios will describe more specific learning episodes like "doing collaborative minutes during a lecture" or "coordinated literature research". Those scenarios should reasonably cover a) synchronous vs. asynchronous learning, b) collocal vs. distributed learning, c) formal vs. informal learning, d) learning isolated, in pairs, in small, groups, in large groups and in communities, and e) self-paced learning vs. mentored learning vs. instructed learning. Each learning episode can be cut into pieces of single learning events like "on-site discussion with the lecturer", "brainstorming", or "annotate slides from a lecture". A framework of about ten general elementary modules[1] will ensure learning events are well structured, and thus enable us to compare scenarios with each other. One aim of this activity will be to find some core requirements.

Furthermore we will redefine our scenarios and resulting requirements by a series of small or large scale user tests. Considering limited resources we will use existing and available technology, MOBIlearn prototypes as well as existing tools (e.g. group systems) to convert scenarios into possible usage scenarios. In many cases we will not have any support of mobile technology and might be forced to simulate the technical parts of a scenario. Test participants will be recruited among undergraduate students who will be presented with our user tests during their normal courses.

4.3.2. Data Capture

In the first place we will describe the scenarios step-by-step and then augment the discussion with the resulting requirements.

In user tests we will mainly gather qualitative data by personal interviews, direct observation, workshops[2], achieved content[3] and questionnaires. On a smaller scale we will also gather quantitative data resulting from system log files and questionnaires. Direct data collection from executive MBAs might be challenging due to their time-limiting professional commitments.

4.3.3. Processing Data Gathered

Data will be text based or converted into text. It will be necessary to filter out relevant data by criteria which have to be defined. A next step will be to structure data (see footnote) and condense it into an amount which can be overseen. The processing of data will lead to creation, addition or changes in the context of use, in Volere shells and in the UML use case diagrams.

4.3.4. Data Analysis

Data analysis will have two intentions. One is to check significance of old requirements, the other will be to gather new requirements. From user tests we expect basic insights in non-functional requirements. Quantitative data will be analysed by formative statistical methods.

One challenge will be to keep an overview over the requirements themselves, the history of requirements, the context of how the requirements were coming up and in what context they are relevant etc. Using a database of Volere shells will help us meet this challenge, but it is difficult to know how many requirements we will eventually identify.

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[1] Situation with learning context, Initiation of learning (trigger event), Internal process, Additional information, Personal externalization, Public externalization, Collaboration initiation, Reflection/ Feedback/ combination, Structured consensus or dissent, Internalization, socialisation, Moderation/ coordination, Evaluation

[2] The realization of workshops will depend on voluntary participation of students

[3] e.g. content from chat or newsgroup

4.3.5. Example requirement and its documentation

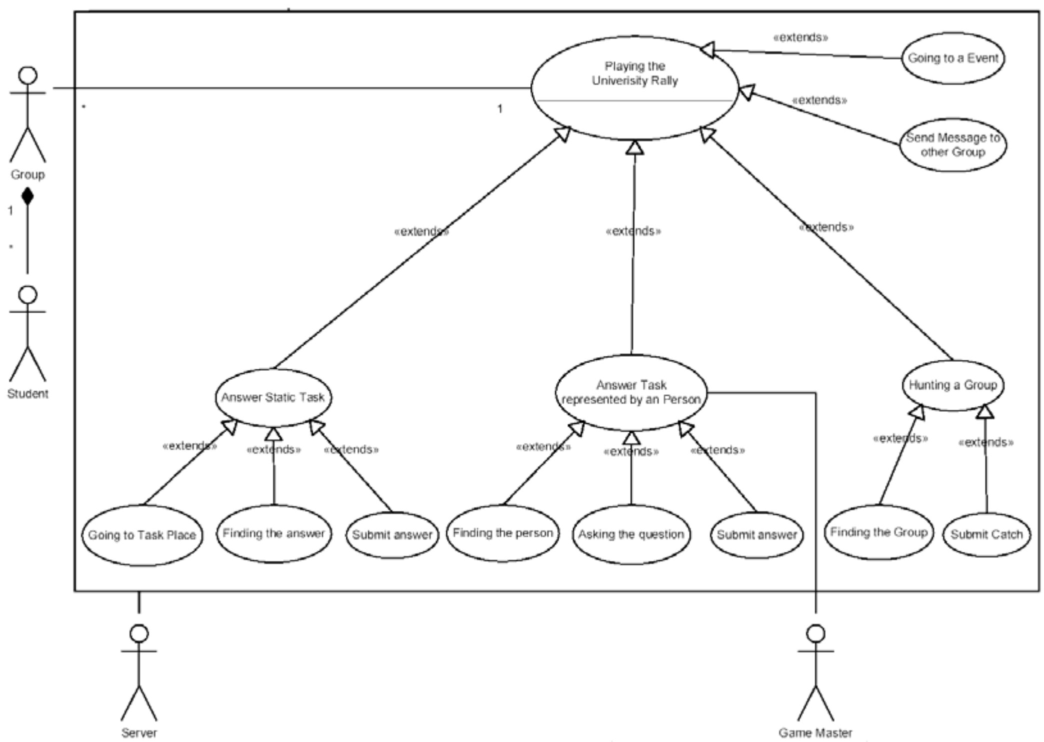

Figure 3 A UML Use Case for the mobileGame Prototype [3]

Figure 3 shows the UML Use Case for one of the informal learning scenarios. The scenario describes the usage of a location-based game running on mobile devices. The users are encouraged by the software to search out important locations and are further motivated by competing against each other and hunting other groups. Due to the high expectations of the executive MBAs we want to perfect our software as far as possible. This game gives us opportunities to test our approach for informal learning with a group of students during the orientation weeks at the beginning of their study.

The modelling of user requirements for this informal learning scenario was further complicated by the vague nature of the learning process involved. Therefore we decided to approach the problem from different points of view. We kept refining the initial scenarios and used them as a base for creating the context of use documentation and Volere templates. The scenarios were also converted into UML Use Cases by transforming their activities and actors into the UML language. This process helped us to recognize missing information in our scenarios where implicit assumptions lay hidden in the text.

We also started to build a prototypical program for this special scenario which enables us to conduct field tests with the software. This will help us identify previously unknown requirements and define the relevance of the existing requirements in a real world application.

By merging the models generated by the theoretical approach with the engineering experiences of the software prototype we are able to identify the relevant points of discussion, where our design choices will have critical consequences. After the conclusion of this process we will have the final requirements which have a sound theoretical foundation and also valuable input from real world tests.

5. Conclusions and lessons learned

Establishing requirements in a mobile environment presents challenges because the context of use is very varied and quite difficult to pin down. We have used a variety of techniques to establish user requirements for our mobile learning environment. These have been used by different partners in the project, depending on their own circumstances. For example, the Health strand has used workshops, and the Museum strand has used questionnaires. To provide consistency and comparability we have chosen to document the requirements using Volere shells and UML diagrams. Using the Volere shells has forced us to look at requirements in a rigorous fashion, and to investigate them more thoroughly at an early stage. Using UML has helped us to model Use Cases along the lines of the initial usage scenarios. This process helped us identify new requirements by structuring the text of the scenario in a model. Also it helps as a common language by reducing the ambiguity of the written text to a standardized representation, which can be also used for further software engineering processes.

We have found that Volere and UML,used in this way, are complementary, largely because the Volere view emphasises the user's perspective and concerns, whilst the UML focuses our attention on the system.

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