

LEARNING IN THE CITY: CONTEXT FOR COMMUNITIES AND COLLABORATIVE LEARNING

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INTRODUCTION

Intelligent environments and cities have become a popular topic in recent literature. The island nation of Singapore has often been mentioned as an example of an intelligent city for its visionary IT2000 project where Information Technology permeates every aspect of the society; at home, work and play (1). The European project IntelCities was aimed at providing citizens more services and increasing their participation in city planning (2). The Mobile Bristol project in the UK takes the concept further by investigating how mobile devices and pervasive information technology can be used to enhance the ways in which residents and visitors experience and interact with their physical environment and with each other in urban and public spaces (3). This project extends the services from mobile devices to an environment consisting of a context-sensitive digital landscape that could be enriched by the people that inhabit the environment, where the people are creative collaborators.

The concept of Ambient Intelligence is often used to describe intelligent environments where human beings are surrounded by intelligent interfaces supported by computing and networking technology that is embedded in everyday objects such as furniture, clothes and the environment (4). The environment should be aware of the presence of a person (the user) and perceive the needs of the person and respond intelligently to these needs. It should be able to adapt to the needs of the user in a relaxed and unobtrusive manner. Such an environment encompasses a combination of paradigms such as Ubiquitous Computing (5), Pervasive Computing (6) and Artificial Intelligence (7). The Ubiquitous Computing aspect addresses the notion of accessibility of the technology, where the technology and connectivity is available through everyday objects that are in the user's environment. Artificial Intelligence techniques provide the context awareness to establish the user's needs and the appropriate response and the Pervasive Computing aspect supports the architectural aspects to realise the situation.

We consider an environment that supports learning, where the city becomes an active arena in the learning process and learning could be situated in an appropriate context (8). Language learning is a subject area where such an environment would contribute to the learning process. A language learner has the need to complement the classroom learning with experiences outside of the classroom. It is important for a language learner to learn in an appropriate cultural context, i.e. within a culture where the local language is the one studied (9). Learning is supported by collaboration and the interaction with others (10). Thus, it is important for the learner to interact with communities that exist in the cultural setting and practise the language with native speakers, fluent speakers and peers. In fact conversation has been identified as an important issue in effective learning (11). Thus language learners often find themselves in mobile situations where they are outside of their formal learning arena, such as the classroom, and interacting with communities other than classmates and teacher. We refer to such a learner as a mobile collaborative learner. An environment that supports collaboration and facilitates interaction among people is desirable for language learners.

One of the main challenges in providing intelligent support to learners is the establishment of the learner's context. The context could include a number of aspects such as the learner's competence level as well as more personal information. Most of the work done in this area is based on modelling an individual learner's context without considering the learner's interaction with other people, e.g. (12). We consider a mobile collaborative learner's context where the learner is mobile and interacts with others in continuing her learning process. In this paper, we analyse the context of a mobile collaborative learner in an ambient intelligent environment by using a simple scenario. We focus on the learner's interaction with various communities and how these interactions affect or influence the context of the learner, for example what do the others know that could help the learner or how are people reacting to the learner. Another important aspect is how the context could adapt to the different mobile situations that the student could be in. We examine the literature on context models in the area of context aware computer systems to see if the

context model for a mobile collaborative learner in an intelligent environment can be supported by the currently available models. We also elaborate on the aspects of a mobile collaborative learner that we believe will have a significant impact on the context of the learner.

This paper discusses the context of a mobile collaborative learner in an ambient intelligent environment. We are currently in the early phases of this work. We use scenarios for our analysis and aim to obtain a better understanding of the needs of mobile collaborative learners so that we can model the context of the learner appropriately. Through our analyses, we also hope to have a better understanding of the context and the challenges for modelling the context of the learner. Eventually, we hope to be able to model a set of situations that could be used for reasoning about the context and providing the appropriate learning support for the learner.

This work uses an existing knowledge-based context model to evaluate if this model is applicable to mobile collaborative learners. We believe that the analysis presented in this paper highlights some of the issues in modelling the context for mobile collaborative learners. We also hope to identify weaknesses and strengths in existing context models and hope to provide some directions for better support for modelling the context of mobile collaborative learners.

The rest of this paper is arranged as follows: Section 2 describes the scenario that will be used in our discussions, Section 3 discusses mobile collaborative learning, Section 4 gives an overview of work done in context aware computing and describes a context model that can be applied to our scenario, Section 5 discusses the social and environmental contexts for a mobile collaborative learner, Section 6 applies the context model to our scenario, Section 7 addresses a possible methodology for realising intelligent environments and Section 8 summarises and presents our ideas for future work.

SCENARIO

Astrid is a German student that is new in Trondheim. She has just started the “Norwegian for Beginners” course at the university and is hoping to get to know the city of Trondheim and learn some Norwegian as soon as possible. The city of Trondheim has a number of services to support newcomers to the city and to help them in learning Norwegian. Astrid has registered to these services and provided information about her interests such as history and outdoor life.

Astrid walks around the city hoping to learn some new Norwegian words and to learn more about the city. She has her mobile phone with a camera and voice recording capabilities and she activates the services that she has registered on to. She is presented with an augmented

map of the city that helps her to find audio traces that others have left behind. She arrives at the city square where there is a farmers’ market on Saturdays. She is intrigued to see the different kinds of berries and uses the glossary service via her mobile device to learn the Norwegian names for the products in the farmers’ market. When the glossary service is activated, she is also informed that a certain chapter in her Norwegian textbook relates to the subject that she’s looking up in the glossary service and she is asked if she wishes to view that chapter. As she walks around the square, her current location on the augmented map is highlighted and her mobile phone gives an audio signal to inform her that audio files that have been left behind by previous visitors are available in that location. She activates the audio trails to listen to the experience of previous visitors. She is very excited to hear that one of the previous visitors had actually been picking some cloudberries, (a wild berry that is abundant in marshes in mid-northern Norway), just outside Trondheim and had left directions to that place. Astrid leaves an audio recording of her impressions of the city centre.

She receives a message on her mobile phone that there will be a concert by a local group in the square starting in 10 minutes. She notices that several people have started gathering around a stage on one side of the square. Astrid moves towards the group to find a place with a good view of the stage. She is keen to share her city experience with her classmates from the Norwegian class. She activates a service so that other users of the system and who are in the vicinity would know that she is in the area. In a short while, another German student Helga sends her a message saying that they could meet up.

MOBILE COLLABORATIVE LEARNER

Learning is a social activity and is a source of social structure. Wenger characterises social participation as a process of learning and, hence a community as an important component of learning (13). We define a community as a *loosely coupled ensemble of people that interact in some way*. Some dimensions for describing communities for learning are discussed in (14).

Language learners often find themselves in mobile situations. Mobility is often expressed in terms of time or space (physical location) (15). Learners are also mobile with respect to a community where they are in contact with one community but may not have the possibility to interact with some other communities or moves from one community to another. We believe that access to people or communities that support the learning process is important. *A learner that is mobile and collaborates with other people as a part of her learning process is a mobile collaborative learner.*

Learners often interact with a number of different communities, at various times, for different reasons, see

Figure 1. For example, Astrid interacts with her class of Norwegian students which can be considered as a community of learners. The peer learners share their experiences and discuss common problems and learn from each other. Thus, collaboration with Astrid's community of learners outside of the classroom is beneficial for her to continue her learning process. From a social perspective, since Astrid is new in the city, they might also be the people that she meets first and becomes her friends.

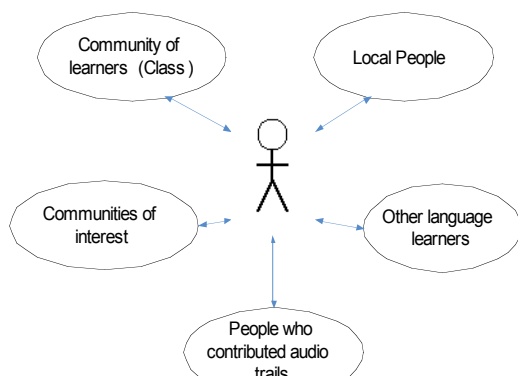


Figure 1 Learner interacts with several communities

Astrid may interact with other language students in Trondheim who may be from different countries. This is a community of interest and may share similar experiences and could support each other with their individual experiences. She may also interact with Germans living in Trondheim to speak German and to share some German cultural activities and this could be considered as a geographical community. She may interact with people that share similar interests as her such as history or outdoor life, e.g. she interacts indirectly through the audio trail with someone who had been picking cloudberries. Finally, she would like to interact with the local people of Trondheim to practice her Norwegian with native speakers and to learn about Norway and the city.

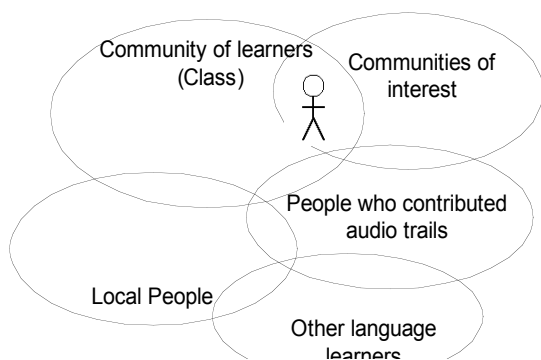


Figure 2 Overlapping Communities

While a learner may interact with several communities at any point in time, several communities may also overlap, see Figure 2. For example, there may be other language

learners and people who have contributed to the audio trails among the local people, or there may be people who share similar interests with Astrid in her class or community of learners. Thus, interacting with people in one community may facilitate the opportunity to join new communities of interest or the creation of new ones.

In the scenario, Astrid's interactions with the various communities are facilitated by technology and sometimes mediated by technology, e.g. listening to experiences from other visitors to the farmers' market through the audio trails. Artefacts in the environment, e.g. the farmers' market, as well as location-dependent services such as the audio trails influence the context of the learner. Similarly, the mobility of the learner and the interactions with different communities influence the context of the learner and the nature of these interactions define the environmental and social context.

OVERVIEW OF CONTEXT MODELLING

In mobile computing research, in particular in the work classified as *context aware*, there has been a tradition of using *location-* and *context aware* as synonymous (16), and the choice of what parameters that are classified as context is often ad hoc. Further more, as most work in developing context aware artefacts has been technology-driven, most of the emphasis has been on what is technologically feasible, and not on what might be helpful in a situation (17).

To remedy this problem, several authors have attempted to identify and define what types of information that can be classified as context. One of the best known is the definition by Dey and Abowd, where they state that: "*Context is any information that can be used to characterise the situation of an entity*" (18). This definition is very broad in the sense that it encompasses all information available in an environment. However, it does not say whether or not an entity is to be influenced by this information.

As entities are *situated* in the environment (19), and even inseparable from it (20), context characterising situations must also both influence and be influenced by an entity's behaviour. The former is captured by the definition given by Chen and Kotz: "*Context is the set of environmental states and settings that either determines an application's behaviour or in which an application event occurs and is interesting to the user*"(21).

The common denominator in these two definitions is the fact that context is regarded as a constellation of parameters that somehow define a situation in which an entity's behaviour is expressed. This is somewhat contrary to the views advocated by Greenberg. He argues that it is (most likely) impossible to enumerate the set of contextual states that exist (22). However, he later argues that a machine can, at best, only make educated guesses about the *real context* (ibid. p. 262). He implicitly argues

that, nevertheless correct definitions of context exist; similar to the notion of *Epistme* from Aristotle. However, overlooking the Epistme point, Greenberger's core argument is that context and situation assessment is a subjective matter. This argument ties in with the argument put forth by Brézillon and Pomerol, who state that context can be seen as collective *tacit* (23) knowledge (24). It is important to note that most research in context models and modelling, besides the technology-driven approach, has been focused on the syntactical relationships between different concepts and only a limited attention has been given to context from a knowledge level (25).

Following the arguments above, that context somehow describes situations and that the perception of situations are subjective, a taxonomy that captures many of the different categories used in context aware computing has been proposed (26). This taxonomy uses a knowledge intensive approach to modelling context. However, the authors do not classify contextual knowledge as a special type of knowledge, rather, they follow the argument advocated by Brézillon and Pomerol, where it is situation dependent if a particular type of knowledge is regarded as context; or "...it appears that knowledge that can be qualified as 'context' depends on the context!"(27). Although it can be argued that context is indistinguishable from other knowledge captured in a system, for pragmatic reasons it is important to impose a taxonomy *a priori* (26).

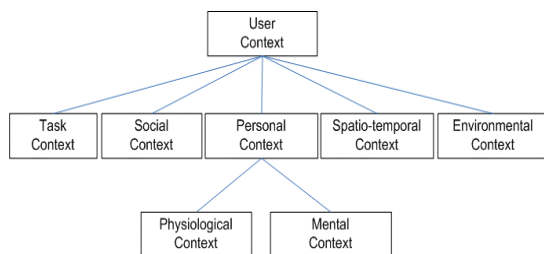


Figure 3 Taxonomy for Context Models

The top-level taxonomy depicted in Figure 3 consists of five main categories, each capturing their own part of the world that can be perceived:

- *Task context* captures the user's activities and goals;
- *Social context* describes the user's relationships and roles;
- *Personal context* encompasses the mental and physical properties of the user;
- *Spatio-temporal context* represents concepts such as time and location;
- *Environmental context* deals with the surroundings and the entities present.

For a more thorough description of this taxonomy, see (28) and (26). This taxonomy expresses the most

commonly used parameters in context aware computing. However, this taxonomy only expresses a shallow model of the social interactions and collaborations that contribute to our learning processes. It has often been argued that activities are a paramount aspect of situations, e.g. (29). Through the work presented in (30), it was demonstrated how Activity Theory (10) and (31) is integrated into the existing taxonomy to better facilitate capturing of social interactions and activities in the socio-technical systems that context aware computing is. An Activity Theory based knowledge-level view of contextual knowledge is shown in Figure 4, where knowledge about the acting subjects, the objects towards which activities are directed, the community and the rules and tools that apply to the community are modelled. Here, a community represents the people that perform the tasks. This model has been applied to assess situations in a healthcare environment as described in (32) and (33).

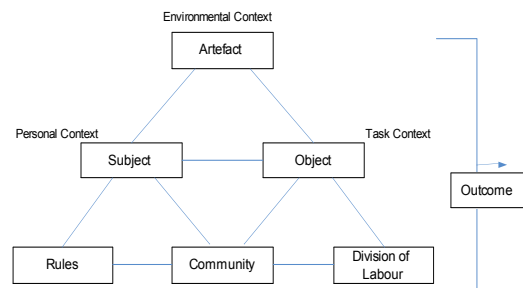


Figure 4 Mapping from Activity Theory to Context Model

CONTEXT MODEL FOR A MOBILE COLLABORATIVE LEARNER

Consider the model proposed by Kofod-Petersen et al. In addition to the personal context, most systems for learning primarily use the spatio-temporal context, i.e. location and time. Examples of such systems are CAERUS, which is an educational system for outdoor use that has been used in a botanical garden for providing location-based content (34) and a location-based educational game that is set in the modern London Docklands augmented with historical sights and sounds (35).

Two of the aspects that may affect the context model significantly are the social and environmental contexts. This is because a mobile collaborative learner in an intelligent environment interacts with people and artefacts in the environment and is supported by these. The following subsections analyse the social and environmental contexts of a language learner in the city.

Social Context

Some of the concepts that pertain to the social context that are referred to in the literature include people that are physically located near the user, e.g. Cyberdesk (36); or people known as friends and classmates of the user, e.g. MyCampus (37). The social context in the context model shown in Figure 4 is based on an individual's roles, i.e. the user's perspective. However, the social context of a mobile collaborative learner is defined by her interactions and movements among different communities. An individual assumes different roles based on who she is interacting with and the nature of the interaction. In this context model, the notion of a community is considered as a part of the spatio-temporal context. It takes the perspective that the user needs to execute a task and assumes a task-activity perspective, where the user shares a set of subtasks with other people, who represent the community. When this is considered within Activity Theory, the task at hand is valid within a time frame and is executed in a physical space. Thus, community is considered as a part of the spatio-temporal context. In our analysis of communities that are relevant for a mobile collaborative learner such as a language learner, we consider the notion of a community as a part of the learner's social context. One of the reasons for this is that the social context of the learner supports the learner in her learning process and the learner learns through the interactions with the community. However, the community may not be active in the learning process.

One of the advantages offered by services available for today's mobile devices is not only to bring together people that are geographically separated, but to make people aware of what and who are nearby, empowering people to take advantage of what is available locally. It facilitates bringing together people that may not have the chance to meet otherwise. This phenomenon has been referred to as "smart mobs" by Rheingold (38). This supports the learner to continue her learning process within social interactions and collaborations rather than as an isolated learner. When considering learning in a social context, one of the most important questions is what could one learn from someone else? Some of the challenges in context modelling that arises from interactions, as discussed by Grudin in (39) are knowing what other people are talking about, how they're reacting to what is being said, what do they know and what do they have access to? The social context of a mobile collaborative learner is important for two reasons:

1. to maintain the context of community
2. to support the establishment of new communities

The communities that a learner is able to access at any time are important for the learning process. The context of the learner is now influenced by her interactions with others and thus, it is no longer confined to an individual, rather it is distributed. In addition, the context is changing constantly as the learner may interact with several communities and may also move in and out of communities, making the context dynamic as discussed

by Greenberg in (22). Establishing such a context and maintaining it becomes a challenge.

As argued earlier, communities are important for learning. Thus, a learner should have support for identifying relevant communities anytime, anywhere that can support her learning. In addition, support for establishing new communities becomes an important activity. For example, how can two or more people that share a similar interest as Astrid be brought to Astrid's attention so that they can communicate and share experiences that help Astrid improve her Norwegian? Technology should facilitate this, e.g. the audio trails left by previous visitors to the city centre informs Astrid that she could go berry picking in areas just outside Trondheim. Contact information about the contributor of that information may facilitate Astrid to meet a community of people interested in hiking or berry picking in Trondheim.

Environmental Context

The environmental context of an individual captures the surroundings such as the services that are accessible to the learner and the artefacts in the environment. An intelligent environment has services and artefacts in the surroundings that influence the context of the learner and it may be difficult to establish an overview of information sources and/or services that are available in the environment. Artefacts represented in the environment may also offer services to the learner. Examples of such artefacts in the environment include context tags providing localised information (40) and location-based digital posters that are available via a user's mobile device (37). Other types of information for the environmental context include characteristics of objects that are nearby, e.g. Active Map (41) and information based on environmental conditions such as temperature, light sensitivity or movement, e.g. (16).

In our scenario, services in the environment such as the audio trails provide useful information as well as facilitate Astrid to join other communities. The location-based awareness service that informs all the people in the city square about a concert in the vicinity, bringing together people with possibly similar interests as well as directing Astrid to a gathering of local people. The environmental context is now distributed and multimodal and requires perception in more than one way and this will no doubt pose challenges in establishing the context.

APPLYING THE CONTEXT MODEL TO OUR SCENARIO

In this section, we apply the context model shown in Figure 4 to our scenario. A subset of the world that can be perceived defines the context that is used to classify a situation. For example, some of the information that can be perceived include the location of Astrid, what and who else is in the location, activities that are scheduled

to take place in that location such as the concert and Astrid's profile such as her interests. Every situation has a goal. So, once a situation is identified, we can identify a goal.

Once a *goal* is established it is possible to identify a set of *tasks* to achieve this goal. We consider the goal, task and action part of the model; where a goal is achieved by a task and a task triggers an action, which results in the achievement of the goal, see Figure 5. In this case, the action will be to guide Astrid or support her in achieving her goal by making her aware of something or providing her relevant information. The correct sequence of actions to achieve the goal is selected by looking at a subset of the initial context, i.e. the context in which the task is to be executed, such as the location, time and the existence of communities. For example, directing Astrid to a café rather than to a crowd of people may be more appropriate if she's somewhere else in the city.

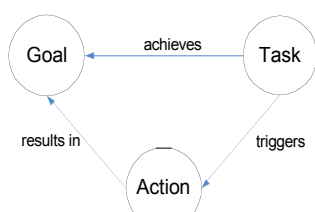


Figure 5 Goal, Task and Actions

In order to provide a service that is relevant for a learner such as providing information that will improve the vocabulary or directing her to a specific place in the city, it is necessary to establish the *goal of the learner*. The high-level goal of a language learner is to learn the language. This is too general to be able to provide an appropriate service to the learner anytime anywhere such as in the city. If we consider more specific subgoals of the learner when the learner is in the city, the learner may want to continue her language learning process outside of the classroom and learn the language by:

1. improving her vocabulary
2. interacting with the local people
3. getting to know the city and its surroundings

An appropriate task can be proposed to achieve the first subgoal if the learner's competence profile is available. This can be a service such as glossary training or dictionary. The second subgoal is not as simple as the social context of the learner needs to be established. Similarly, the third subgoal is also very vague and the list of possible tasks for the achieving the second and third subgoals may be very long. In the following subsections, we will apply the context model to our scenario to see if the context of the learner can be modelled and if this model can be used to support the learner in achieving her goal.

Interact with local people

Consider the subgoal of the learner: learn the language by interacting with the local people. A task that supports Astrid in interacting with the local people may be one that makes her aware of several local people. The action that is triggered by this task is to inform Astrid that there is a concert in the square starting shortly as well as inform other people in the vicinity about the concert.

If the learner wishes to interact with local people who can contribute to her improving her language, we need to know something about the type of people who are in the city centre at that time and this is not easy to establish. Also, among the people in the area, there may be non-native speakers of Norwegian or people who are just not willing to interact with Astrid. Unless all the people that are accessible (either physically or by means of technology) have registered or published their profiles, this aspect of the social context of the learner is vague. However, due to a lack of specific knowledge about the learner's context, assumptions can be made. For example, we can assume that the learner would like to meet any person that speaks Norwegian, thus making her aware of the concert that is assumed to draw a small crowd of people. In fact, by making everybody in the vicinity aware of the concert by sending a message to their mobile devices is one way of ensuring that people know about the event and encouraging people to participate in the event. This facilitates getting Astrid physically to a place or rather making Astrid aware of a physical space and an event that may attract a number of people that may be willing to interact with her. A concert can be assumed to attract people who are in a social and light-hearted mood and have the time to explore chance encounters with people who may want to share interesting experiences with them. Thus, the action of making Astrid aware of the concert facilitates guiding her to a crowd of people where she is likely to interact with some people who may help her in improving her Norwegian.

Selecting the tasks and actions to achieve a goal based on partial information and assumptions may not always achieve the desired goal. For example, the concert in the city may be for a specific audience and Astrid attempting to join that audience may trigger a negative response among someone in the audience. There is challenge in finding the optimum level of partial knowledge and assumptions that will provide the appropriate awareness to the learner.

Get to know the city and the surroundings

Consider the subgoal: get to know the city and the surroundings. This is very broad and can be further decomposed, e.g. Astrid may wish to go berry picking and might like to know how to get to the place mentioned by the previous visitor to the city centre that left the audio trail about berry picking. This subgoal

could be achieved by asking a local person about how to get there.

The model uses the notion of rules as mediating components for communities and community applies to people that work on subtasks. The model focuses on a single activity and a single community within that model. A mobile collaborative learner such as Astrid interacts with several communities at any time. The current version of the model does not take into account multiple communities and their interactions. Also, if the interactions with communities or behaviours within any community are constrained by rules and if there are conflicting rules in the different communities that Astrid interacts with at any time, this may also be difficult to model. For example, Astrid obtains information about a place where there are cloudberry near Trondheim through the audio trails, i.e. from one community C_1 . However, as cloudberry are rare and are considered a delicacy, most local people (another community C_2) will not disclose the areas where cloudberry grow. They will consider these as a family secret and may not want to disclose it to a foreigner.

Persistent Communities

Once Astrid discovers that she is not likely to get help from a local person to find cloudberry in the marshes around Trondheim, she goes back to the area where the audio trails were and decides to leave an audio trail connected to the original one left by a previous author about cloudberry picking. Astrid feels that this is important information that someone else may be interested in. This collaborative creation of audio trails could be considered analogous to weblogs or blogs (42). The people that contribute to this collection of audio trails and the people who listen to them form a community that grows and continues to exist over a period of time, i.e. a persistent community.

The model considers the context of a person as seen from her eyes, at a specific point in time, and the model consisting of a goal, task, action and community (e.g. C_1) is instantiated for that time, e.g. time T_1 . Similarly, every time a new instance of the model is created, a new community is instantiated, e.g. C_2 for T_2 and so on. Although C_1 and C_2 may be the same communities, the model does not recognise this. So, persistent communities such as the one created around the audio trails are not supported by the current version of the model.

TOWARDS REALISING INTELLIGENT ENVIRONMENTS

When selecting an appropriate behaviour for a situation, a reasoning process and reasoning is required. This implies that, for an ambient intelligent environment to determine the appropriate or best actions to support the mobile collaborative learner, some degree of reasoning is

required. The context for a mobile collaborative learner is dynamic; thus a hard-coded input-output system is inadequate. We believe that case-based reasoning is suitable for determining an appropriate set of actions or services in an ambient intelligent environment. Initially, because the ideas of case-based reasoning grew out from an understanding of how humans select appropriate behaviour and what tasks to execute in a given situation (43).

Case-based reasoning (44) has been used as a solution methodology in the Ambient Intelligence community for perceiving context, identifying situations and selecting a set of actions that could be executed to provide intelligent support to the user. Case-based reasoning has been used to generate recommendations based on a user's context in a mobile environment, where the user's context is encapsulated inside a case to facilitate comparison of contexts, generating recommendations based on similarities in cases and learning the user's behaviour (45). Another example is where case-based reasoning is used to adapt the behaviour of smart homes to users' preferences (46). In (47), case-based reasoning was applied in a multiagent environment to estimate the best purchase in comparative shopping. The goal of the system was to obtain a pareto optimal agreement between a buyer and a seller.

Some of the challenges in applying case-based reasoning in general, and for using case-based reasoning in ambient intelligence in particular, that have been identified are: when to trigger a new case-based reasoning cycle when working in an on-line manner; determining what to remember and when; and maintenance of the case base. While these limitations did not affect the healthcare application, some of these limitations could be significant in a learning scenario. The healthcare domain could be considered as an almost closed-world as all the information relevant for the reasoning process could be perceived. This is more challenging for a mobile collaborative learner, as it becomes a challenge to identify all the people and communities that are available that could support the learner.

As we are in the early phases of our work, we do not have real cases modelled. Thus, we plan to initiate the case base with stereotype modelling, in the tradition of Rich (48), and eventually extend the case-base, as real cases are available. By doing this, even if case-based reasoning proves to be unsuitable for supporting mobile collaborative learning, we will be left with a model of the learner that could be used for reasoning with other methodologies.

DISCUSSIONS AND FUTURE WORK

In this paper, we have analysed a mobile collaborative language learner in a city, the kinds of support that could be extended to her via mobile and personal technologies, and an intelligent environment that could facilitate the

continuation of her learning process. A language learner has the need to interact with various communities to practice the language, for example, the native speakers of a language and other learners of the language. The learner can take advantage of what and who are in the surrounding environment and enhance the learning process. In order to provide the appropriate support for the learner, it is important to be able to establish a learner's context so that appropriate and contextualised support can be provided for the learner. We have focussed particularly on support that facilitates the learner to interact with communities that can support her in her learning process.

A review of context aware computing has been provided and a context model has been used to analyse our scenario to identify the challenges that a mobile learning scenario could pose to existing context models. In the preliminary analysis conducted in this paper, we have identified some limitations of the context model. The support that can be provided by the system depends on the context model and the knowledge that is available in the model. Thus, in a mobile learning environment where knowledge about the people and artefacts in the environment are limited, the reasoning conducted by the system to determine the kind of support for the learner is required, may be based on more assumptions than facts and there is a challenge in determining the optimal level of knowledge and assumptions to provide appropriate support.

The context model is based on a single task, and actions that are performed by people belonging to a single community. Thus, when there are multiple communities that the learner interacts with and communities that overlap, the model needs to be enhanced to support multiple communities. And most importantly, the model does not support persistent communities, which are most likely to exist in an intelligent environment where collaborative design, work and learning take place. The possibility to model multiple communities that the learner interacts with and conflicts of interest among the different communities needs further analysis.

The work presented in this paper is a preliminary analysis of the social and environmental contexts for a mobile collaborative learner. We plan to continue our analysis of the context in mobile learning situations and try to enhance the existing model to support our scenario better.

Case-based reasoning as a solution methodology to identify situations based on a learner's context and selecting actions to provide the appropriate support for the learner within that context seems a promising approach that we wish to explore in our future work.

The context model described in this paper has been applied in the domain of healthcare to demonstrate how the knowledge model of context can be used in case-based reasoning to assess situations in a healthcare

environment. This model proved to be adequate to represent the context in the healthcare domain and to reason about the context to identify a situation and propose actions. However, it is still an open question if the same approach is also feasible in the mobile collaborative learning domain, where the situations are likely to be less strictly defined.

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