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PERSONALIZED AND CONTEXTUALIZED LANGUAGE LEARNING: CHOOSE WHEN, WHERE AND WHAT

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Mobile and ubiquitous learning facilitates language learners to continue their learning process outside the formal classroom, when and where they desire. While more and more learning resources are accessible via a mobile device, there is a challenge in providing access to appropriate personalized learning resources. This paper describes the PALLAS system which enables real life language learning scenarios by providing personalized and contextualized access to learning resources via a mobile device. The support provided to the learner includes tasks that are personalized and contextualized and tasks that are set by the teacher. Access to learning resources through integration with a Content Management System is also provided. An evaluation framework for mobile language learning systems and an evaluation of the system by three language teachers are included. The main contribution of this work is personalized and contextualized learning resources, where the resources are composed of a variety of sources. Some of the topics addressed in this paper focussed on personalization appears in (Petersen & Markiewicz, 2008).

Keywords: Mobile learning; personalization; learning resources; evaluation.

1. Introduction

The rapid growth of mobile and ubiquitous learning technologies have opened up new avenues and learning arenas for learners. Learners are now able to access learning material anytime, anywhere, while they are out and about. While access to learning resources is improved significantly, additional challenges arise. Personalization and contextualization of learning resources have recently been the focus of several articles, e.g. (Syvänen, Beale, Sharples, Ahonen & Lonsdale, 2005; Chen, Li & Chen, 2007; Paredes, Ogata, Yano & Martin, 2005; Petersen & Markiewicz, 2008).

Personalization of learning systems is an effort towards making education more learner-centered. The essence of this is that it is the system that conforms to the learner rather than the learner to the system (Green, Facer, Rudd, Dillon & Humphreys, 2005). Personalization in education is considered very broadly where the learner can create learning experiences in diverse locations, collaborate with experts in the areas of personal interests, track and review their own learning across the diverse sites and learning stages and access learning resources in the form and media relevant to their language skills, abilities and personal preferences. Personalization is not only about new ways of distributing learning resources, but also about finding ways to understand the skills, resources and interests of the learner outside the classroom.

The term mobile learning has become popular to denote learning that is conducted while the learner is on the go or when the learner is mobile (Sharples, Taylor & Vavoula, 2005). Mobile learners often have varied learning backgrounds and levels and thus mobile learning systems should be adaptable (Chen & Kinshuk, 2005). Thus, we believe that personalization can add value to mobile learning. Mobile learning also involves providing access to learning resources and providing learning support for the mobile learner using diverse technologies such as mobile, ubiquitous or embedded devices. Since the learning can take place in a variety of places and situations, there is a need to support learning via different modalities and the possibility to choose the learning resources from a variety of sources.

Language learning has been an area where technology, in particular mobile technology in recent times, has been popular. Use of mobile technology for learning English as a foreign language has been popular. Initially, mobile-based language learning services focused on providing instant help in either obtaining the meaning of a word (Morita, 2003) or help in pronouncing a word. Little or no emphasis was given to providing personalized learning. More recently, improved support has been provided by partial personalized learning such as supporting pronunciation of specific sounds for specific user groups, e.g. (Uther, Zipitria, Uther & Singh, 2005).

In this paper, we describe a prototype system, PALLAS, a personalized and context-sensitive foreign language learning system for real life situations using mobile devices. It provides support to a mobile language learner by providing personalized and contextualized access to learning resources. The main focus of this paper is on the personalization of learning resources that is provided to a mobile language learner. In our work, we consider personalization of learning resources as a part of contextualization and distinguish between personalization and contextualization. Contextualization has been defined as using any information that can be used to characterize the situation of an entity (Dey, 2001). Personalization has been defined as customizing to individual learners, based on an analysis of the learner's objectives, current status of knowledge, learning style preferences and constant monitoring of progress (Sampson, Karagiannidis & Kinshuk, 2002). In a series of seminars conducted at the NESTA Futurelabs in the UK on personalization, one of the key entitlements in a personalized system has been identified as the possibility to mobilize learning resources (Greenhill, Green & Perry, 2004). For our work, we consider personalization of learning resources as providing learning content, activities and tasks to the learner according to the learner's needs and interests and presenting it to the learner rather than the learner having to look for it. The PALLAS system described in this paper considers dynamic and static parameters for personalization where the dynamic parameters are updated automatically by the system and the static parameters are provided by the learner.

Learning anytime and anywhere poses requirements on the learning resources to be adapted to the learning situation. Since the learning takes place outside the classroom, the learning resources must be appropriate to reflect real life situations and the usage of the language in such situations. PALLAS supports language learning in real life situations; thus, we have incorporated learning resources from several sources including the curriculum from the formal classroom learning, text books as well as modules provided by the teacher to ensure that the learning resources or the choice of learning resources offered to a learner at any time are appropriate for the learning situation.

The main contribution of this work is personalized and contextualized learning resources, where the resources are composed of a variety of sources. In this paper, mobile language learning is illustrated using a scenario. The system is evaluated by one of the two main user groups of the system, language teachers. The rest of this paper is structured as follows: Section 2 provides a background to mobile and situated learning and personalization and context and how other authors have used these concepts; Section 3 describes a mobile language learning scenario; Section 4 discusses the design considerations for PALLAS: how personalization and contextualization is done in PALLAS, the role of the teacher and the learning resources available from PALLAS; Section 5 provides an overview of the PALLAS prototype system; Section 6 presents an evaluation framework for mobile language learning systems and an evaluation of the system by language teachers; Section 7 describes the related work and Section 8 concludes the paper and discusses our plans for the future.

2. Background

In this section, we provide a background and discuss some of the theoretical aspects of the concepts that are related to our work.

2.1. *Mobile and situated learning*

Mobile learning was initially defined as learning that is conducted while the learner is on the go or when the learner is mobile (Sharples *et al.*, 2005). This is a technology focused definition of mobile learning, where the learner and the learning process can be seen as supported by mobile devices such as a mobile phone or a PDA. More recent views of mobile learning focus on the learner rather than the technology and argue that there are dimensions other than technology that should be considered (Sharples, 2006; Vavoula, Scanlon, Lonsdale, Sharples & Jones, 2006). Mobile learning has also been considered learning anytime and anywhere, introducing the dimensions of time and space. Such notions of mobile learning are more suited to our approach where we consider the learner who is mobile.

Mobile learning emphasizes the active involvement of the learner where formal learning is complemented by informal learning. This is well in line with the constructivist thinking where the learner needs to experience and apply concepts and relate them to their existing body of knowledge. In particular, social constructivism (Vygotsy, 1978), which focuses on the social context that shapes the construction of knowledge is important in language learning. Learning languages is strongly influenced by situations, (Ogata & Yano, 2004) and language and culture are inextricably linked, and although a learner may chose not to take an interest in the culture, the language cannot be isolated from the culture that embraces it (Tang, 1999). This fits well within the concept of situated learning proposed by Lave and Wenger (1991). They argue that learning as it normally occurs is a function of the activity, context and culture in which it occurs i.e., *learning is situated*. This contrasts with most classroom learning activities, which involve knowledge that is abstracted and out of context. In mobile learning, a learner can have the possibility to extend her learning process beyond the boundaries of the classroom and continue her learning process in contexts that are suitable for her learning and can stimulate and engage her with the learning process. A combination of the concepts of mobile and situated learning will enable a learner to be able to continue her learning process in any situation that can benefit the learning process and at the same time maintain the learner's context of learning by ensuring a connection with teachers, the study program or the curriculum of study as well as peer learners. Maintaining a connection and engaging with teachers and peer learners gives the learner an opportunity to practice the language, an important component of situated learning defined as participation in "communities of practice" (Wenger, 1998). Lave and Wenger propose that learning takes place in communities of practice and that learning is a change in learners' participation in these communities, from legitimate peripheral participation to a full member.

Another theory that is closely related to situated learning is situated cognition, which is a theory of instruction that suggests that learning is naturally tied to authentic activity, context and culture and that learning and cognition are fundamentally situated (Brown, Collins & Duguid, 1989). For example, learning a language is widely believed to be easier by immersion than through textbooks alone. The theory of situated congnition suggests that the learning resources be authentic and learner-centered (Ogata, 2008).

Two mutually complementary didactic approaches have been proposed as applications of situated learning theory: congnitive apprenticeship and anchored instructions (Tretiakov & Kinshuk, 2003). The congnitive apprentice model of learning is proposed as a set of practical steps where the teacher initially models the processes and strategies and then provides guidance to the learner as necessary, such as scaffolding, and then fading as the learner's skills improve (Brown *et al.*, 1989). Anchored instruction is based on the principles that learning and teaching activities should be designed around an "anchor" which may be a case study or a problem situation and the learning resources should allow exploration by the learner (Cognition and Technology Group at Vanderbilt, 1990). Both these approaches have implications to the design of technology, the learning resources and the role of the teacher in the learning process.

2.2. *Personalization and context*

Personalization of learning systems is often based on making them context-aware, where the definition of context has varied from the location of the learner (Hsieh, Chen & Hong, 2007; Kuo, Wu, Chang, Chang & Heh, 2007) to learner's leisure time and individual abilities (Chen *et al.*, 2007). According to Dey, context is defined as any information that can be used to characterize the situation of an entity (Dey, 2001). Thus, information that is required to provide personalized learning resources to a language learner can also be considered as a part of the context of the learner. We subscribe to the notion that context is built up of a number of aspects as proposed by Kofod-Petersen and Mikalsen (2005). In their taxonomy, they have identified *task context* which captures the user's activities and goals; *social context,* which describes the user's relationships and roles; *personal context,* which encompasses the mental and physical properties of the user; s*patio-temporal context,* which represents concepts such as time and location and e*nvironmental context,* which deals with the surroundings and the entities present. A framework for the context of a mobile learner in an ambient intelligent environment is proposed in (Petersen & Kofod-Petersen, 2006).

In the mobile learning domain, context is viewed as dynamic, as being continually constructed through negotiation between communicating partners and the interplay of activities and artefacts (Syvänen *et al.*, 2005). Unlike the context for traditional learning, the context for mobile learning evolves according to the interactions of the learner. Earlier work on context in educational systems considered the interaction of the learner with the system only (Patel, Russel, Kinshuk, Opperman & Rashev, 1998) and not with other learners or people that can support her learning process. Factors that have to be taken into account in personalization for a mobile learner, in addition to the learner's individual profile, include the evolution of the behavior of the learner, the variables affecting the learning such as the social aspects and the uncertainty of the domain or the learning environment such as something happening unexpectedly (Viola, Giretti & Leo, 2007).

In (Chen *et al.*, 2007), personalization is considered as similar to context awareness where the context of a language learner is defined as the learner's location, learning time, e.g. around Christmas time, learning abilities and leisure time. In their application, the learner's location is considered the most important parameter.

For example, if a learner is located in a specific place such as a restaurant or a shop around Christmas time, words that are related to christmas have a higher priority than words that do not relate to Christmas. A broader view of personalization is considered in (Paredes, Ogata, Yano *et al.*, 2005), where a multi-modal approach was proposed for personalization of ubiquitous learning applications. A user model describes the learner's personal data such as name, gender and address and the learner's interests and experiences; a usage model describes the learner's usage behavior such as the interaction history with the system; an application model describes information about the applications within the system such as stereotypes of users and an environment model describes the learner's location or physical context, the device type and hardware and software aspects.

3. Scenario

In this section, we describe how we envisage the use of PALLAS through a scenario. This scenario was designed to identify the initial functional requirements of the system.

Mina is a student in Trondheim attending a beginner's class in French. One day, on her way home from school, she passes the farmers' market. She does not know the French names for vegetables, so she takes her Smart phone and starts the language learning application PALLAS. She selects French and enters the keyword "grønnsaker" (the Norwegian word for vegetables). Mina is presented with a short text in French describing the different vegetables. The difficulty level of the text is based on Mina's profile in the language learning application, which has been built automatically based on her previous interactions with it. After she has finished reading the short text, she looks at the glossary connected to the text. The glossary contains the French names and pictures of the different vegetables. When she has finished reading through the glossary, Mina selects the "Glossary test" option. This starts a test based on the glossary words. When Mina accesses PALLAS via her desktop computer later that day, she is notified that she should practice more on the vegetable glossary.

One day while passing by the art gallery, her location-aware Smart phone starts to beep. Mina sees a notification from PALLAS telling her that the art gallery has a French art exhibition. She visits the exhibition which also allows her to get in contact with some French people that she could practice her French with. Whenever Mina has problems understanding a French word, she queries PALLAS' built-in dictionary.

4. Design Considerations

This section of the paper provides an overview of the design considerations for PALLAS. First, we consider general design considerations for systems that support language learning. Then, we describe how personalization and contextualization is supported in PALLAS, the role of the teacher and the learning resources available in PALLAS.

4.1. *General*

There are several approaches for language teaching and learning, (Milton, 2002), and guidelines for the designing of teaching systems and resources have been around for many years, e.g. (Hubbard, 1992). Guidelines are proposed for personalized learning resources such as the learning material to be appropriate for the age of the learner, to fit the language level of the learner, that the system provides enough time for the learner and that feedback should be provided to the learner responses.

For the mobile learner, as the learning becomes more personalized and contextualized, the technological challenges in designing learning support is bigger. The devices that support the learner are more personalized. Sharples *et al.* identified some of the design issues for such learning support in (Sharples, 2000) and (Sharples, Corlett & Westmancott, 2002). Such technologies should be highly portable, unobtrusive, available and must adapt to the learner's needs and context. Unlike the design of computer-based teaching systems, there are other implications in using mobile devices. Some of these are discussed in (Naismith, Lonsdale, Vavoula & Sharples, 2005). When the learner is mobile, she may have small time slots to engage in learning and thus would like to conduct "small chunks of learning".

In designing PALLAS, we have not considered a specific learning process that may be followed by the learners. We intend PALLAS to be flexible and easily adapted to the learning process desired by the learners or by their teachers. However, in order to adhere to the ideas of Lave and Wenger in Situated Learning, we support basic capabilities to help learners maintain their learning context and to keep track of the learning process so that learning via the mobile devices does not take place in isolation from the broader learning program that they follow. A learner's learning history is maintained, which allows the learner to start from where she left the previous time. They are also informed about additional learning content that may be related to their current learning context and activity. For example, in the scenario, Mina is able to conduct a test on her vegetable glossary and feedback is provided to her about her performance.

According to the theory of multiple intelligences proposed by Gardner, learners may have preferred learning styles and modalities of learning (Gardner, 1983). For example, some users may prefer to receive their learning resources as audio while others may be more visual. Thus, it is desirable for the learner to be able to have the choice of the modality of learning. Similarly, Ogata suggests that the learner must be able to access the learning resources from anywhere (Ogata, 2008). Accessibility has been listed as one of several characteristics of ubiquitous learning environments. A learner is able to access PALLAS via a desktop computer as well as a mobile device and maintain the continuity of the learning process anytime, anywhere. The learner's learning history is maintained independent of the access mode to PALLAS.

4.2. *Personalization in PALLAS*

In our work, we distinguish between contextualization and personalization, where we consider personalization as a part of contextualization. In PALLAS, contextualization is achieved using the profile of the learner and environmental parameters. The learner's profile contains information such as the learner's age, skill level, native language, interests and courses taken. Environmental parameters include location, time and day and the mobile device that is used by the learner. An overview of these parameters is provided in Table 1, where some of these parameters are dynamic; i.e. the ones that are updated automatically. The parameters that are not dynamic such as the age of the learner are updated manually by the learner. This supports two ways of adaptability by the system; by using some knowledge about the learner in a system controlled way and by using knowledge provided by the learner manually (Chen & Kinshuk, 2005).

An overview of personalization parameters that we have found in the literature and the ones that are supported in PALLAS are provided in Table 2. In addition to the parameters that we have found in the literature, PALLAS also considers the learner's native language as this can be important in determining the appropriate learning material presented. For example, a beginner may prefer to receive an explanation of a word in her native language rather than the target language. Since interactions with other people play an important role in language learning and these interactions influence the context of the learner (Syvänen *et al.*, 2005), we have included a learner's user groups or the communities that she may interact with as a personalization parameter. This, we believe, can be an important parameter in supporting collaborative and mobile language learning (Petersen & Kofod-Petersen, 2006). Other courses that are taken by the learner are also considered as this may provide additional information about the learner and may help in determining the people that may be able to help in the learning process. This could also be used to determine appropriate activities for language learning. For example, if the learner is studying French and architecture, activities that relate to the buildings in the vicinity could be suggested to the learner.

The PALLAS system is designed to provide active personalization where personalization is an ongoing process. Two assumptions have been made in order make it easier to support active personalization: (i) although the learner's personalization

Table 1. Dynamic personalization and contextualization parameters in PALLAS.

Profile Parameters	Environment Parameters
Age	Location (Dynamic)
Skills Level (Dynamic)	Date and Time (Dynamic)
Native Language	Computing Device (Dynamic)
Interests	Weather (Dynamic)
Courses	
User groups	

Table 2. Overview of personalization and contextualization parameters.

Personalization Parameters in Literature	Personalization Parameters in PALLAS
Learner's skills, learning ability	x
Learner's name, age	x
Learner's gender	
Learner's address	
Experience	x
Interests	x
Stereotype	
Device, hardware, software	x
Location	x
Access logs	x
Activity logs	x
Time	x
Leisure time	x

data, most importantly the skill level, changes over time, it seldom changes drastically within a short amount of time; (ii) PALLAS is a substantial source of the learner's language learning. The PALLAS system is based on a central server architecture and the learner's personalization data or profile is stored on the server. The learner's skill level is automatically updated every time the learner completes an exercise and the learning content delivered to a learner at any time is matched against the learner's current personal data. As mobile learners engage in small chunks of learning and are likely to do this often, it is important that the personalization data is updated after every time. The more regularly the learner accesses PALLAS, (assumption ii), the more likely it is that the personalization data is accurate.

4.3. *Role of the teacher*

Vygotsky's Zone of Proximal Development proposes that interactions with the teacher and native speakers who may be considered experts compared to the learner, can lead to an increased level of skill for the learners (Daniels, 2005). Cognitive apprenticeship (Brown *et al.*, 1989) suggests that the role of the teacher can be seen as that of a facilitator (Tretiakov & Kinshuk, 2003). The teacher supports the learner by providing a model for the problem solution (for example, this may be the case often in classroom instructions), by providing scaffolding by offering suggestions and fading as the learner's skill level increases.

The role of the teacher that is designed in PALLAS does not explicitly adhere to the congnitive apprenticeship principle. This is mainly due to the fact that PALLAS is not a tutoring system, but rather a system that provides complementary support to that of formal instructions. In PALLAS, the teacher's role is clearly that of a facilitator that defines and produces learning resources that are relevant to the learners in the various situations that they may desire to learn. This involves taking into consideration the learner's context and designing the resources accordingly. For example, in the scenario, the teacher has added a context trigger to notify Mina when she walks past an art gallery that has a French art exhibition.

The role of the teacher in PALLAS is two-fold: facilitator and administrator (not to be confused with the system administrator). As a facilitator of learning, the teacher is able to create learning tasks and exercises (e.g. quizzes) that a learner can perform, obtain (download and make available from PALLAS) learning resources that are available in third party Content Management Systems (CMS), add context triggers to the tasks, exercises and the content obtained from CMSs and link these CMS contents to the tasks and exercises as appropriate. These functions are designed to have a focus on defining appropriate learning resources to the learners.

As an administrator, the teacher is able to add learners so that they can use PALLAS, assign specific tasks and exercises to learners and select which content that should be made available to the different learners. The teacher is also able to check the scores of the learners to obtain an indication of their learning process, for example to see if there is a positive or a negative trend in the learning process and grade learners. These functionalities that can be performed by the teacher are designed towards managing her students and following their learning processes.

4.4. *Learning resources*

The learning resources available via PALLAS is intended to support a variety of real life learning situations. Anchored instructions is one practical approach to situated learning (Tretiakov & Kinshuk, 2003) that proposes that the learning activity is designed around an anchor. Analogous to this approach, we have used the notion of the learner's context to design learning resources as well as to proactively initiate or suggest a learning activity. The implications for the design of situated learning environments is summarized in (Jeong-Im & Hannafin, 2008). They identify the role of context and content as two of the aspects that should be considered in situated learning environments. The describe context as authentic, coherent, meaningful and purposeful learning activities that represent ordinary practices.

The way context is depicted in PALLAS is described in Section 4.2. One of the dynamic aspects of context is the learner's physical location. Learning content in PALLAS can be selected and/or suggested based on the learner's location. Similarly, the teacher can also define context specific content or tasks that can be triggered depending on the learner's context.

The learner acquires knowledge as well as how to use it in a variety of situations. This calls for a diversity in content and the need for it to relate to the daily situation of the learner. From the notion of anchored instructions, we see a need for learning resources that encourage the learner to explore. Thus, in PALLAS, we have decided to incorporate a number of different types of learning resources from a number of sources. First of all, the teacher is able to create content in the form of tasks or exercises that learners can perform. PALLAS also provides access to CMSs so that content from them can be made available to learners via PALLAS. One of the strengths of PALLAS is that it not only makes the contents from publishing houses, from their CMSs, available to the learners, but provides the possibility to contextualize these contents by making it possible for the teacher to add context triggers to them as well as link them to other learning resources available from PALLAS such as the content created by the teacher. Access to third party content such as maps and dictionaries are also made available via PALLAS.

5. PALLAS: System Description

This section provides an overview of the PALLAS system.

5.1. *System overview*

The PALLAS system is based on a central server architecture (Figure 1). The PALLAS Server is the main hub of communication, content storage and content distribution. The main server components are the Web Server, which can host web pages and web services, the Database Server and the Application Server. The Database Server is where all the data is stored and it contains the user profiles, content modules and system settings. The content models are used to store all the content that is either created by the teacher or imported from CMSs. The Application Server is used to run scheduled tasks such as importing content from the publishing houses' CMSs. The server uses a set of CMS Adapters to be able to interface with different content providers. Each content provider can have their own customized interface adapter. New adapters can be added to allow interaction with new content providers.

The PALLAS uses a range of third party service providers. The Map Provider gives access to map data which is useful for PALLAS' context needs. Maps are among other things used to make it easy to add location context to content. The reason why the Map Provider interfaces through the server instead of directly to the different clients is that it makes the use of maps transparent to the client application. This makes it possible, for example, to change to a different provider without changing any code in the client applications. The SMS Service Provider facilitates SMS responses to users. Finally, the server uses different Third Party Lookup Services to automatically add context information to content, e.g. a Google Search (Google, 2007), to find the address of a point of interest.

The main user groups for PALLAS are language learners, language teachers and system administrators. The main roles of the teachers are to manage their students learning activities and to provide language learning content. The PALLAS system administrators are responsible for performing administrative tasks which include giving teachers' access to PALLAS and configuring the server's content import module settings. This functionality can be provided through a web site on the PALLAS server or a client application that uses the PALLAS Web Services. The system administrators and teachers can perform their tasks using a PC with a web browser or the client application.

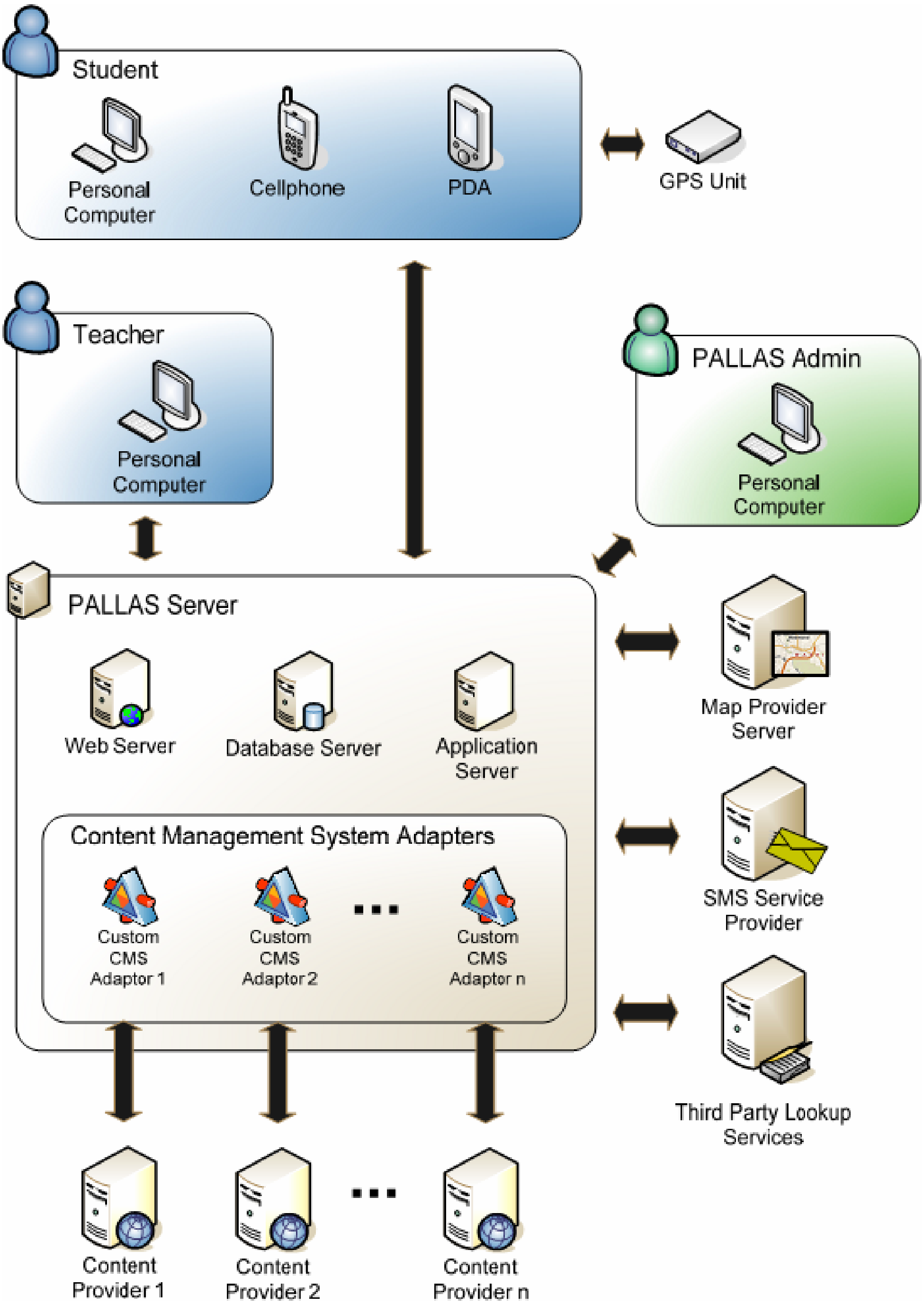

Figure 1. PALLAS system overview (© 2008 IEEE). Reproduced with permission from The Fifth IEEE International Conference on Wireless, Mobile, and Ubiquitous Technology in Education, 2008, “PALLAS: Personalized Language Learning on Mobile Devices”, by S. A. Petersen and J. K. Markiewicz.

Learners have a variety of ways to use PALLAS. They can use a desktop PC to log onto a learner portal web site on the PALLAS server or they can use mobile devices such as mobile phones and PDAs. The learner's profile is updated every time independent of the device the learner uses to access the PALLAS system. The mobile devices can use PALLAS in a number of ways: they can run a custom client application that provides all the functionality, they can use a mobile web browser as a thin client or they can query the system via SMS. If the learner is using a mobile device with the PALLAS mobile client application installed, they could use a GPS unit to automatically obtain location information.

PALLAS is implemented using Microsoft Windows technology and the .NET development platform. The mobile device that was used to test the application was a Qtek 8310 smartphone (Qtek, 2007), running the Windows Mobile 5.0 OS. The technical details of PALLAS are available from (Markiewicz, 2006).

5.2. *Mobile smart client*

The Mobile smart client performs the functions such as display of content, caching and synchronization of data. It is responsible for the presentation of the data. The main components of it are the context engine and the adaptivity engine, which make the PALLAS mobile client context-sensitive and adaptive to the user and the environment (Figure 2).

The context engine runs monitoring services to keep track of the context data and updates the learner profile and the other dynamic parameters shown in Table 1. It also contains context history services that allow storage and retrieval of previous context and personalization data. The adaptivity engine supports the presentation of appropriate content to the learner, and the presentation tier uses the content retriever in the adaptivity engine for this. The context engine also provides events that other modules can subscribe to. For example, the adaptivity engine subscribes to several events of the context engine for adapting the GUI or the profile of the user. A synchronization engine is used to conduct communication with the PALLAS server. It provides transparent access to the content, profile and result data and transfers cache and synchronizes data between the server and the mobile client.

The mobile client also has local storage where data that is downloaded when a network connection is available can be cached. If the learner queries PALLAS while a network connection is unavailable, then the locally stored content is presented.

5.3. *Teacher client*

The teacher client is designed to allow teachers to manage their students (learners) and the content that should be made available to them. All the data they manipulate is stored on the PALLAS server so that it is available to all the client applications. Teachers can add and delete student accounts and have access to their students' profiles. Teachers can create tasks to be performed by the students, quizzes and tests for the students, add points of interest with context triggers so that a student

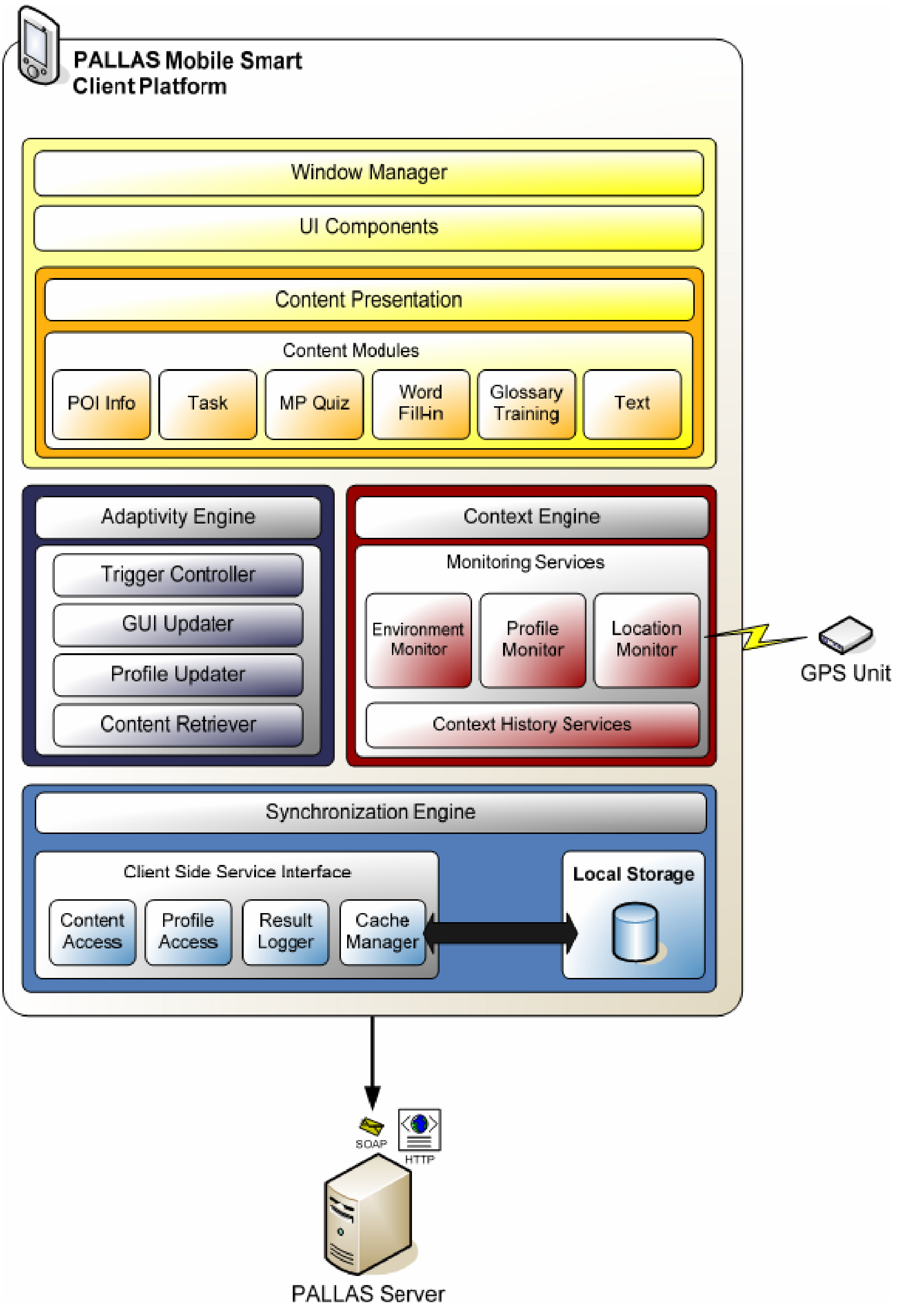

Figure 2. Mobile smart client architecture (© 2008 IEEE). Reproduced with permission from The Fifth IEEE International Conference on Wireless, Mobile, and Ubiquitous Technology in Education, 2008, "PALLAS: Personalized Language Learning on Mobile Devices", by S. A. Petersen and J. K. Markiewicz.

is notified when a context fires. Points of interest are defined by a teacher to indicate a specific event that is context dependent. For example, a museum in the city could be a context trigger. If the student is in the vicinity of that museum, the student can be notified about it. Or, the teacher could define a radio or a TV program at a specific time as a context trigger so that the student is reminded or notified about the program at that specific time.

The teacher can create language learning resources that are either public and can be accessed by other teachers that use PALLAS or ones that are private to the teacher that created the content. Figure 3 shows the PALLAS interface for the teacher. The left hand side of the screen provides a menu of capabilities available to the teacher for content creation and the management of her students. The right hand side of the screen shows how the teacher could add a new context trigger and assign it, e.g. to learners of a specific skills level. The menu of capabilities are on display constantly while the right hand side of the screen varies according to the menu item chosen by the teacher.

5.4. *Mobile client for learners*

The mobile smart client allows learners to access language learning content anytime and anywhere, via a mobile device. Figure 4 shows the main window of the PALLAS mobile client. The learner is able to select the activity that she wants to perform such as perform a query, do some tests or exercises or access the dictionary service. An activity can be selected by using the joystick on the phone or by pressing the corresponding number, e.g. 6 for the dictionary service. A context bar is displayed on the top of the window, which displays the current learner. The symbol to the right indicates if the mobile device is online or offline (note that the device is online in the figure) and the symbol to the left indicates if the current location is known (note that the location is unknown in the figure).

The learner is able to update her profile manually using the mobile client (Figure 5). The menu shows the other activities that can be performed using the mobile client.

The mobile client also displays triggers that are fired based on the context information. For example, the learner is in the vicinity of an exhibition that fits the profile of the learner (Figure 6). The symbols on the top right corner of the display indicate that the device is offline and that the location is known. Note that context triggers can fire even though the device is offline, as PALLAS has cached content stored locally on the device. Location-dependent context triggers use the Global Positioning System (GPS) and this capability can be turned off by turning off the GPS.

6. Evaluation

The PALLAS system is at the stage where language learning resources or content can be included in the system by the teachers and third party applications can

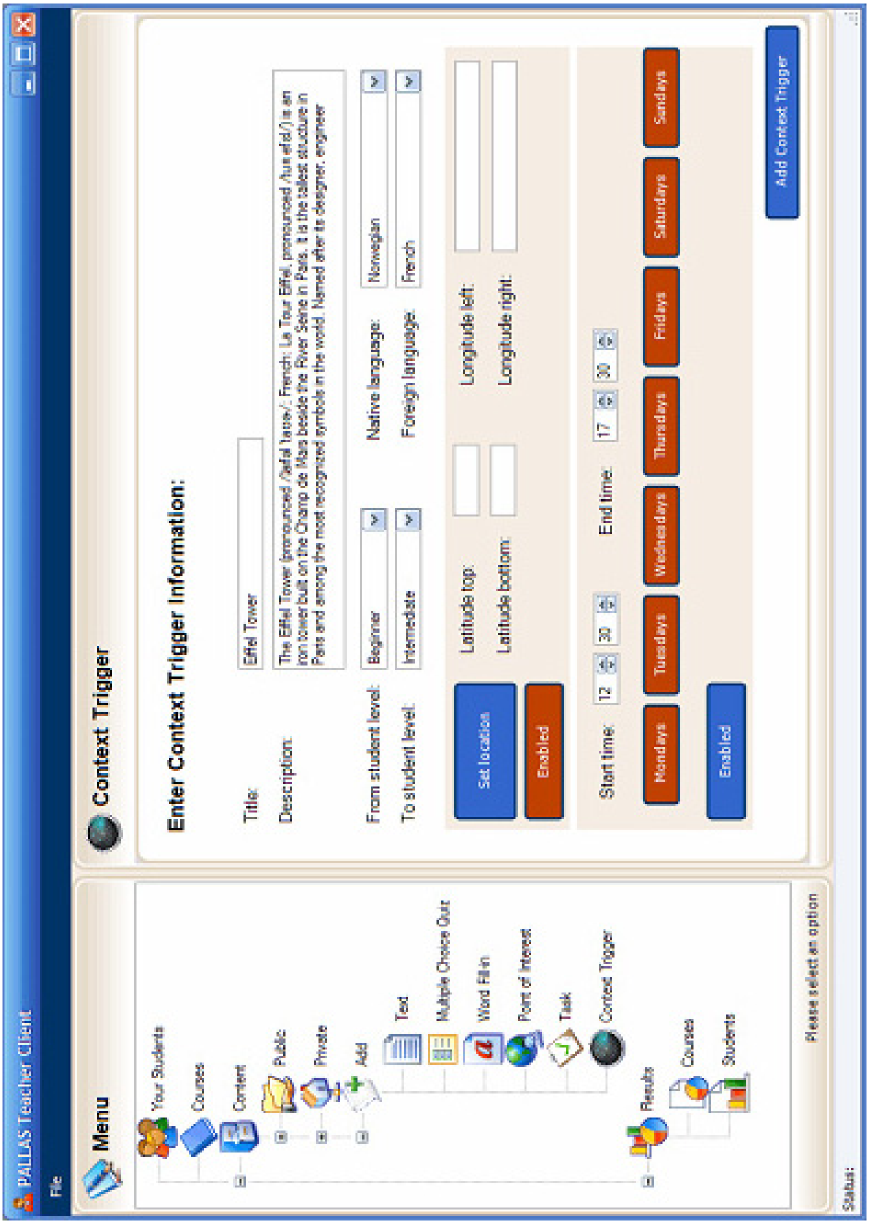

Figure 3. Context trogger: User Interface for the teacher to create Context triggers.

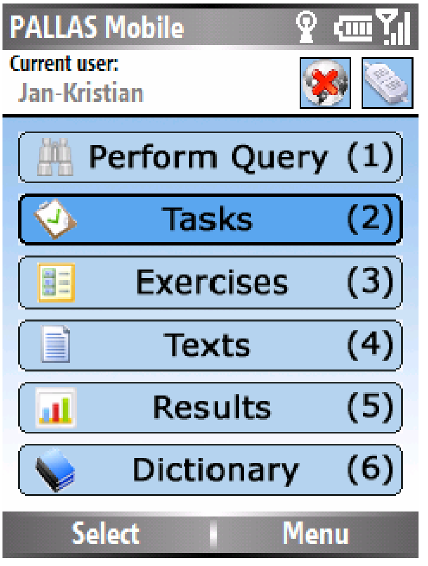

Figure 4. Mobile client: activities for the learner (© 2008 IEEE). Reproduced with permission from The Fifth IEEE International Conference on Wireless, Mobile, and Ubiquitous Technology in Education, 2008, "PALLAS: Personalized Language Learning on Mobile Devices", by S. A. Petersen and J. K. Markiewicz.

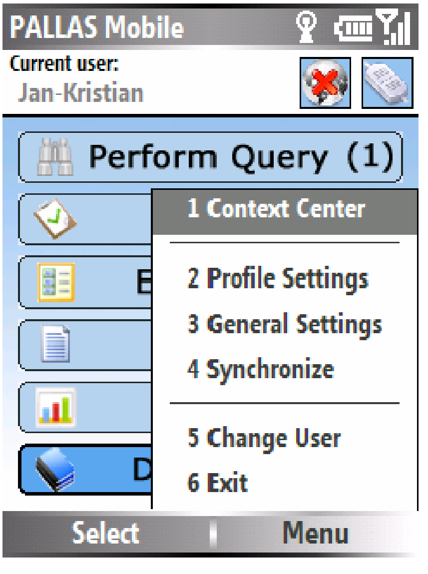

Figure 5. Mobile client: settings (© 2008 IEEE). Reproduced with permission from The Fifth IEEE International Conference on Wireless, Mobile, and Ubiquitous Technology in Education, 2008, "PALLAS: Personalized Language Learning on Mobile Devices", by S. A. Petersen and J. K. Markiewicz.

Figure 6. Mobile client: Context Trigger (© 2008 IEEE). Reproduced with permission from The Fifth IEEE International Conference on Wireless, Mobile, and Ubiquitous Technology in Education, 2008, "PALLAS: Personalized Language Learning on Mobile Devices", by S. A. Petersen and J. K. Markiewicz.

be incorporated. We have, as yet, been unable to populate the system with language learning content due to resource constraints. The main groups of users of the PALLAS system are language teachers and learners. Since the system does not currently include any content, the system has not been used by language learners and a user evaluation is unavailable. We have, however, asked three language teachers to evaluate the system from their perspective and the results of this evaluation is reported in the rest of this section.

All three teachers teach French to students of different levels of language skills, at our university. Two of the teachers teach the French language, including grammar, reading, writing and speaking, to beginner and advanced learners. Both these teachers are familiar with technologies for distance learning and have used such technologies in their classes. The third one teaches French culture and society as well as the language and teaches learners that have basic knowledge of the French language. He does not use technology in his teaching.

The evaluation was conducted as a cognitive walkthrough, where the teachers were asked to read the scenario described in Section 3. Then, they were given an introduction to the system by presenting its objectives and motivations for the work, a detailed description of the module for teachers and the user interface as well as the capabilities available for learners. The system was described using screen shots.

The teachers were then interviewed about the system and the questions were based on an evaluation framework that we have developed, which is described in the following subsection. During the interviews, the teachers were posed the questions from the evaluation framework and their answers were noted. It also included discussions for clarification of various aspects and to understand the teachers' perceptions and attitudes towards the system.

6.1. *Evaluation framework*

Mobile learning systems are usually evaluated by their users or mobile learners and the evaluations focus on the usability and usefulness aspects of the system when the systems are in use, e.g. (Naismith, Sharples & Ting, 2005; Sharples, Chan, Rudman & Bull, 2004; Sharples, Lonsdale, Meek, Rudman & Vavoula, 2007). Kukulska-Hulme recently coined the term "mobile usability" to indicate an emerging specialism in usability studies in mobile learning systems (Kukulska-Hulme, 2007). She claims that mobile learning mostly takes place on devices that were not designed with educational applications in mind. Avelis *et al.* highlights that mobile learning resources combine two very different aspects: software and learning (Avellis, Scaramuzzi & Finkelstein, 2004). Thus, the evaluation of mobile learning systems should take into account these two aspects. They proposed a framework that consists of four evaluation categories: (i) educational features, (ii) technical features, (iii) usability and (iv) content.

For the evaluation of PALLAS by the teachers, the category usability is not applicable as the evaluation did not include the use of the system by the learners. However, the other three categories that were proposed by Avelis *et al.* are relevant for our purposes. We have adapted these main categories and enhanced them by considering sub-questions for each category. In addition to these categories, we have also included attitudinal categories, e.g. (Motiwalla, 2007), to evaluate the teachers' perception of the system and to understand their general attitude towards the role of the system. Since PALLAS is aimed at providing personalized learning resources, we have also included some questions that address this aspect. We have used an overview paper (Traxler & Kukulska-Hulme, 2005) and the framework proposed by Avelis *et al.* (Avellis *et al.*, 2004) as our main sources of input in designing the evaluation framework. In the rest of this sub-section, we describe the evaluation framework that we used.

- Education: This category concerns the pedagogical aspects of the system. It includes aspects such as consistency with the current teaching and learning practices, the appropriateness of the technology for students, flexibility of learning for the students and providing feedback, target users and whether this is an effective means of providing personalized learning.
- Content: This category concerns the learning resources that have been included in the system. It considers whether the contents support the topics and activities in the curriculum, how the resources are presented and how easy the teachers think it is for them to create learning resources in the system.

- Access: This category concerns access to the system as well as the learning resources within the system.
- Device or technology: This category concerns the devices that the teachers and the learners use to access the system.
- Usefulness: This category concerns the usefulness of the system as seen by the teacher, for both teachers and learners.
- Added Value: This category concerns the value that the teacher believes the system adds to their current teaching practice.
- Strengths and Weaknesses: This category concerns the strengths and weaknesses of the system as perceived by the teacher.
- Your view: This category asks how the teacher would use a system such as PALLAS in their teaching.

The categories education, content, access and device were evaluated using a set of questions where the teachers provided their answer. The categories usefulness and added value were based on a scale of one to seven, from not at all useful to very useful and none to great value respectively.

6.2. *Analysis*

In this subsection, we report the results of the evaluation by providing an overview of the answers that were provided by the three teachers during the interviews.

For the educational aspects of the system, the teachers found that PALLAS was consistent with their teaching and learning philosophy and approaches. Two of the teachers said that the system took the learning process beyond the boundaries of the classroom, that it added content and reality to the course and that it made language learning a part of every day life. The third teacher saw it as a system that was very good, but as complementary to her classroom teaching as face to face interaction with her students was very important for her. They said that the system is suitable for all levels of users and that the teachers could adapt the learning resources in the system to the appropriate level of the students. One teacher said that it is appropriate for any student who had some basic knowledge of the language from before.

All three teachers agreed that PALLAS increased the flexibility of learning for the students and that it was a suitable means of providing personalized learning. One teacher said that the system is a companion for the students outside of their classrooms. They also agreed that the context triggers were a useful means of making the learners aware of learning resources and providing contextualized learning resources. One teacher, however, raised an interesting issue regarding personalization. He said that it was very difficult to consider personalization as a teacher and that he thinks personalization is done by the student. He also doubted the practicality of the system and described the language teaching at our university as very “book-ish” and thus wondered if the students will actually use such a system. The teacher who regards face to face interaction as an important part of her teaching said that she missed the support for interaction, such as the students being able to ask the teacher something or the teacher being able to provide direct response to a student's query.

Evaluating the contents aspects of PALLAS, the three teachers agreed that the different types of learning resources in PALLAS supported the topics and activities in the curriculum they teach. One of the teachers said that the variety that is provided by PALLAS is more motivating for the students. She also said that the system was not so suitable for teaching the grammar of the language, but to speak and write. All three teachers said that it was hard to comment on the presentation of the content without actually using the system. When they were asked if they think it would be easy for them to create learning resources using PALLAS, there were different responses. One said that it looked easy, while the other was not so sure as he was not so familiar with learning technologies. The third teacher said that the creation of resources seemed like a lot of work for the teachers and that a team of teachers should collaborate to ensure that there was adequate and appropriate material for the students. The main criticism of the contents was the lack of support for dialogue between the students and the teacher and among the students. One teacher said that the system was for passive students as it did not provide content and activities to make them speak the language.

All three teachers agreed that PALLAS improved the learners' access to learning resources. The mobile device was something that the student always carried with them and the system provided access to resources in addition to books and websites. With regards to the ease of accessing the resources in the system, one teacher was unable to evaluate it without seeing the system while another was concerned if the system provided access to enough resources.

For the category device, all teachers agreed that the PC was a suitable means for teachers to contribute learning resources to the system. They all preferred this interface to a mobile interface for a number of reasons, the most obvious of which is the screen size and the keyboard. When asked if they see any need for a mobile interface for teachers, two of the teachers did not see a need for that. The third said that she would use it if she had to and only in the case where she did not have access to a PC and as an emergency solution. In additions to the limitations of the mobile device interface, two teachers pointed out that they were paid to work at a specific time and place whereas if they had to use the mobile interface, they would feel pressured to work in their own time and at home. The PC interface helps to distinguish between work and life.

When they were asked if the mobile device was a suitable way to support the learners, they all agreed and said that it helped learners to continue their learning in new places. However, they all agreed that the learners also required access via a PC, which will help them maintain a better overview of the learning resources due to the larger screen size. One teacher said that the mobile device acts as a trigger for learning activities, which is just part of the learning process but not the complete process nor the only means. The PC interface also supports easy access to other learning resources which are available on the internet. The mobile device is also limiting because the students need a dialogue with the teacher and other learners. One teacher was very positive of the way the mobile device was utilized. She said that the system really uses the “forces” of the mobile device and the advantages that the device offers by providing access to specific personalized content rather than using the device as a medium to convey material as in books or on a webpage.

When asked about the perceived usefulness of PALLAS for teachers, on a scale of one to seven where one is “not at all useful” and seven is “very useful”, the scores were seven, six and five. The teacher that gave five said that he needs to see the system to give it a higher score. On a the same scale, the usefulness of PALLAS for the learners was rated as one score of seven and two sixes. One teacher described the system as a way for the students “to enter my world of books”. One teacher expressed concern over the proper use of the system by the learners and if they would actually take the time to use the system. She said that the system is more useful for students when they travel to the country where the target language is spoken rather than when they were in Norway.

When the teachers were asked how much value PALLAS adds to their current teaching practice, on a scale of one to six, from none to great value, two teachers gave a score of six. One teacher said that most language learning happens when you’re not studying and therefore such a system would really add value to the teaching. The third teacher gave a score of five, because he did not find any value for his students in some of the capabilities such as the glossary training.

The strengths of PALLAS that were identified by the teachers can be summarised as providing access to the student’s subject during the day, access to learning resources wherever they are and whenever and the mobile device is with the student all the time, the possibility to remind the student that they are students, the possibility to make language learning not just following a curriculum, but lifelong learning, the possibility to provide several types of exercises and information. One teacher commented that the system is very complete.

The teachers thought that PALLAS is not very useful when the students were in Norway, which is where they spend most of their study period. The limitations of a mobile device such as a mobile phone (screen size, awkward keyboard) was seen as weakness by one of the teachers. The main weakness that was identified was the lack of support for dialogue with the teacher and among learners and support for oral skills development. One teacher felt that the system was a bit impersonal and compared PALLAS to an interactive book that did not provide feedback. She also saw it as resource intensive for the teacher to provide content to the learners and thought that the threshold level of learning resources is high before it can become really useful for the learners.

When the teachers were asked how they would use such a system as PALLAS in their teaching practice, they all said that they would use the points of interest and context trigger capability to remind their students of learning activities when the students were outside the classroom or travelling. One teacher went further to elaborate that she would use the dictionary, the different types of exercises and tasks as well as the student history that is logged by the system to keep a track of the students learning activities.

6.3. *Discussion*

The evaluation given by all three teachers was very positive with very few negative comments. This may be due to the fact that it is easier to be positive about a system while evaluating concepts and the design. The teachers may have have been able to identify some of the undesirable aspects of they system if they had been using the system. Having said that, the teachers were quite critical in their evaluation and it was possible to identify weaknesses and possible extensions or improvements to the system.

The teachers perception of PALLAS was limited to the types and examples of possible content that was mentioned during the presentation of the system. So, although, PALLAS has the potential to link to a variety of content, this was not always envisaged by the teachers. For example, it is possible to connect to a phonetic or pronunciation dictionary from a third party. However, the lack of this particular content in the presentation was seen as a weakness of the system by one of the teachers.

Although we were able to conduct the evaluation, one of the challenges was to ensure that the teachers were able to evaluate the aspects of the system that did not require the use of the system. So, aspects such as the presentation of the learning resources and how easy it will be for the teachers to create new learning resources were difficult to evaluate.

7. Related Work

There are a number of applications to support language learning, most of which are very specific and designed to support very specific needs. For example, the Mobile Adaptive CALL (MOC) system described in (Uther *et al.*, 2005) is designed to help Japanese English-speakers distinguish phonemic contrasts in the English language by presenting words (audio) to the learners and asking them to select the correct word from a list of written words. The next word that is presented is determined by the error rate of the learner. The photo study described in (Joseph, Binsted & Suthers, 2005) supports learners to learn new words using photos and by collaboration with others. Saran *et al.* describes a system to support Turkish students improve their English vocabulary by sending multimedia learning content as MMS messages to the learners and the quizzes about the content as SMS messages (Saran, Cagiltay & Seferoglu, 2008). All these systems support very specific language learning needs such as improving listening skills and learning new words. Hence, they do not explicitly model the learner profile or support personalization of content.

A system that has more in common with PALLAS is LOCH (Languge Learning Outside the Classroom with Handhelds; Paredes, Ogata, Saito, Yin & Yano, 2005). LOCH was created to help foreign students in Japan learn Japanese during real life situations. The teacher assigns a field activity to the students who go outside with a handheld device to perform the activity. The students are in contact with the teacher via instant messaging or IP telephony. The students can also share their experiences with one another. While both LOCH and PALLAS are designed for use during real life activities outside of the classroom, LOCH is designed to support specific assignments that are given by the teacher. Thus, personalization issues were not addressed in the paper. LOCH uses a thin client approach by using a web-based application on a PDA, which requires a constant internet connection. PALLAS uses a smart client application which does not rely on a constant internet connection.

A system for learning English, where contextualized vocabulary is presented to the learner is presented in (Chen *et al.*, 2007), where the vocabulary is adapted based on the learner's location, leisure time, time and the learner's ability. The notion of agents is used for detecting the location and the context. Location is considered the most important parameter in determining the learning material. The system consists of a context database and a personal preference database. The details of the personal preference database were not discussed in the paper. A similar system for learning English on a campus was described in (Hsieh *et al.*, 2007) where the context of the learner was considered as the location of the learner.

An example of a system that provides access to learning resources from several sources is CUBER, where they describe an information infrastructure for a virtual university (Pöyry & Puustjärvi, 2003). CUBER provides access to online educational resources from several universities. To facilitate matching the needs of the learner with the courses on offer, a knowledge base for the course descriptions and a search engine for finding the courses is provided. It also includes an authoring interface for including metadata about the courses. While the notion of providing access to other educational resources is similar to our work, the user group that CUBER is intended for is more general than our language learners.

In (Tretiakov & Kinshuk, 2003), the authors describe a system for supporting situated learning in domain specific situations, using stories as a means of creating the learning context. A story is used as an anchor for instructions, and activities are related to stories, so that a learner can perform an activity as they are exposed to the story.

8. Conclusion and Future Work

This paper describes the PALLAS system, which provides support to a mobile language learner by providing personalized and contextualized access to learning resources. The main focus of this paper has been on personalization of learning content for a mobile language learner. In our work, we consider personalization as a part of contextualization. We have reviewed the literature on personalized support for mobile language learning systems and discussed in detail how personalization and contextualization is supported in PALLAS.

The design of the PALLAS system has been described in detail in the paper. In particular, how PALLAS conducts personalization and contextualization of learning resources, the role of the teacher in PALLAS and the learning resources that are made available to the learners has been described. An evaluation of the system has been conducted by one of the main user groups of the system, language teachers. The evaluation was conducted as a cognitive walkthrough followed by an interview. The evaluation results indicated a positive view of the system and highlighted a few ideas for enhancing the system in the future. We plan to enrich the system with learning resources so that a usability evaluation can be conducted using language learners.

We have attempted to support Situated Learning by providing contextualized learning resources to mobile learners. However, the current version of PALLAS does not support collaboration and interaction among different learners. Interaction among peer learners as well as with other practitioners of the language is an essential element in supporting the participation of the learners among their community of practice or the community of language learners or speakers. The lack of support for collaboration and interaction with other learners and teachers is the main limitation of the system. The current implementation includes personalization and contextualization parameters to support the social context of the learner and to model the communities that the learner interacts with. We plan to enhance the system to support collaborative learning so that the learners can continue their learning process by participating in communities of practice.

The architecture of PALLAS is designed to support a variety of learning content from various sources such as input from the teacher and content from publishing houses, available via CMSs. The current version supports learning material creation by the teacher. Access to Content Management Systems is currently under development; the architecture has modules to support this as CMS adaptors. However, we have not yet tested this by accessing a CMS. We plan to continue developing the system and enhancing the content available to the learners. One of the limitations of the current prototype is that it only works for mobile devices using Windows Mobile OS. If we aim for this system to be used by a large number of students or school children, it would be desirable to make the system platform independent.

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