

PALLAS: Personalised Language Learning on Mobile Devices

Sobah Abbas Petersen
NTNU, Trondheim, Norway.
Email: sap@idi.ntnu.no

Jan-Kristian Markiewicz
NTNU, Trondheim, Norway.
Email: janmark@microsoft.com

Abstract

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 personalised learning resources. Personalisation and contextualisation are often used as synonyms. In our work, we distinguish between these two concepts and consider personalisation as a part of contextualisation. This paper describes the PALLAS system which enables real life language learning scenarios by providing personalised and contextualised access to learning resources via a mobile device. The dynamic and static parameters for contextualisation and personalisation of language learning resources are discussed.

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. Personalisation and contextualisation of learning resources have recently been the focus of several articles, e.g. [1], [2] and [3].

Personalisation of learning systems is an effort towards making education more learner-centred. The essence of this is that it is the system that conforms to the learner rather than the learner to the system [4]. Personalisation 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. Personalisation 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 [5]. Mobile learners often have varied learning backgrounds and levels and thus mobile learning systems should be adaptable [6]. Thus, we believe that personalisation is crucial for 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. Learning via such technologies is not intended to replace classroom learning; rather such technologies, if leveraged properly, can complement and add value to existing learning models, [7], such as the socio-constructivist approach to learning [8].

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 [9] or help in pronouncing a word. Little or no emphasis was given to providing personalised learning. More recently, improved support has been provided by partial personalised learning such as supporting pronunciation of specific sounds for specific user groups, e.g. [10].

In this paper, we describe a prototype system, PALLAS, which provides support to a mobile language learner by providing personalised and contextualised access to learning resources. The main focus of this paper is on the personalisation of

learning resources that is provided to a mobile language learner. In our work, we consider personalisation of learning resources of as a part of contextualisation and distinguish between personalisation and contextualisation. Personalisation of resources is considered as providing content 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 personalisation where the dynamic parameters are updated automatically by the system and the static parameters are provided by the learner.

Mobile Language learning is illustrated using a scenario, which is also used to evaluate the system. The rest of this paper is structured as follows: Section 2 discusses personalisation 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 and how personalisation and contextualisation is done in PALLAS; Section 5 provides an overview of the PALLAS prototype system; Section 6 outlines the current status of the work and provides a brief scenario-based evaluation of the current system; Section 7 describes the related work and Section 8 concludes the paper and discusses our plans for the future.

2. Personalisation and context

Personalisation of learning systems is often based on making them context-aware, where the definition of context has varied from the location of the learner [11] and [12] to learner's leisure time and individual abilities [2]. According to Dey [13], context is defined as any information that can be used to characterise the situation of an entity. Thus, information that is required to provide personalised 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 et al. [14]. 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; *spatio-temporal context* which represents concepts such as time and location and *environmental 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 [15].

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 [1]. 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 [16] and not with other learners or people that can support her learning process. Factors that have to be taken into account in personalisation for a mobile learner, in addition to the learner's individual profile, include the evolution of the behaviour 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 [17].

In [2], personalisation 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. A broader view of personalisation is considered in [3], where a multi-modal approach was proposed for personalisation 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 behaviour; an application model describes information about the application and an environment model describes the learner's location or physical context, the device type and hardware and software aspects.

3. Scenario

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 doesn't know the French names for vegetables, so she takes her Smartphone and starts the language learning application PALLAS. She selects French and enters the keyword "grønnsaker". 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 Smartphone 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

In this section we consider the general design considerations for systems that support language learning and how personalisation and contextualisation is supported in PALLAS.

4.1 General

There are several approaches for language teaching and learning, [18], and guidelines for the designing of teaching systems and resources have been around for many years, e.g. [19]. Guidelines are proposed for personalised 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 personalised and contextualised, the technological challenges in designing learning support is bigger. The devices that support the learner are more personalised. Sharples et al. identified some of the design issues for such learning support in [20] and [21]. 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 [22]. 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”. So, it’s important to keep track of the learning process for any learner so that the learner can start from where she left the previous time.

4.2 Personalisation in PALLAS

In our work, we distinguish between contextualisation and personalisation, where we consider personalisation as a part of contextualisation. In PALLAS, contextualisation 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 Figure 1, where a symbol is shown to the right of the parameter to indicate the dynamic parameters; 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 [6].

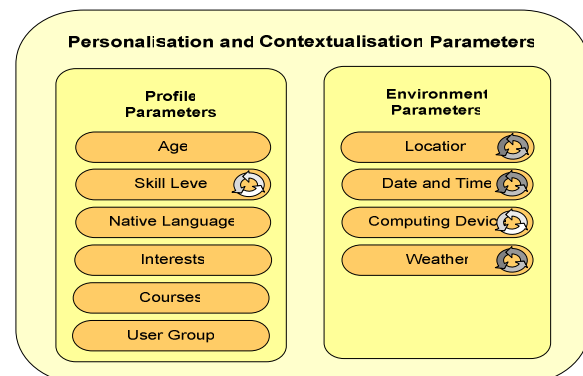


Figure 1. Dynamic personalisation and contextualisation parameters in PALLAS

An overview of personalisation parameters that we have found in the literature and the ones that are supported in PALLAS are provided in Table 1. 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 [1], we have included a learner’s user groups or the communities that she may interact with as a personalisation parameter. This parameter is essential

to support a collaborative and mobile language learner [15]. 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 weather is considered as PALLAS is aimed to be used outside of the classroom and may help in suggesting appropriate activities for the learner.

Table 1. Overview of personalisation and contextualisation parameters

Personalisation Parameters in Literature	Personalisation 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

The PALLAS system is designed to provide active personalisation where personalisation is an ongoing process. Two assumptions have been made in order make it easier to support active personalisation: i) although the learner's personalisation data, most important of which is the skills 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 personalisation 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 personalisation data is updated after every time and the more

regularly the learner accesses PALLAS, (assumption ii), the more likely it is that the personalisation data is accurate.

5. PALLAS: System description

This section provides an overview of the PALLAS system.

5.1 System overview

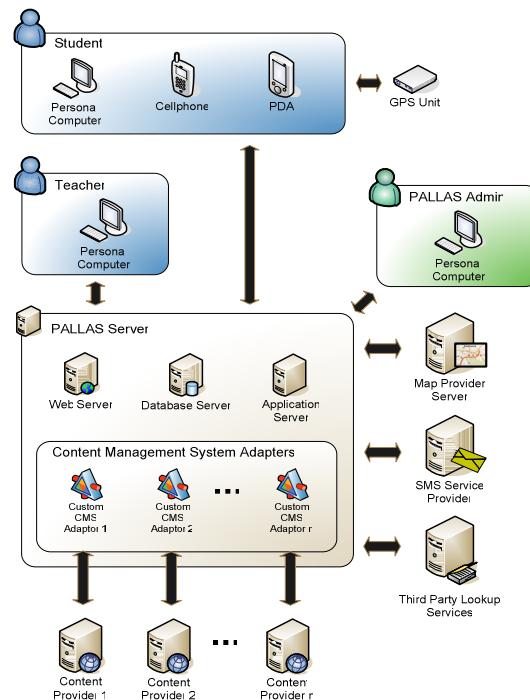


Figure 2. PALLAS system overview

The PALLAS system is based on a central server architecture, see Figure 2. 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, for data storage, and the Application Server which is used to run scheduled tasks such as importing content from the publishing houses' Content Management Systems. PALLAS supports different ways of creating and accessing learning content. A description of the learning content and how this is created and composed are beyond the scope of this paper.

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 [23], 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.

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 whichever 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 [24], running the Windows Mobile 5.0 OS. The technical details of PALLAS are available from [25].

5.2 Mobile smart client

The Mobile smart client performs the functions such as display of content, caching and synchronisation 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, see Figure 3.

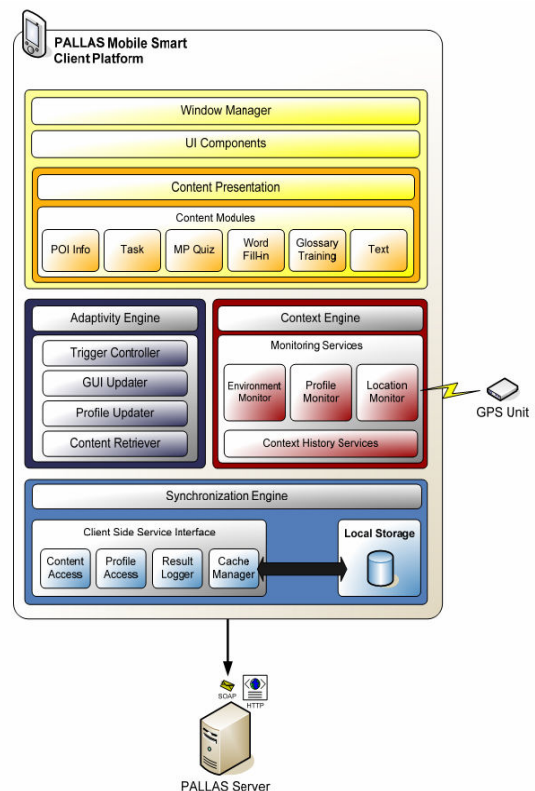


Figure 3. Mobile smart client architecture

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 Figure 1. It also contains context history services that allow storage and retrieval of previous context and personalisation 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 synchronisation 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 synchronises 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 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, see Figure 5. The menu shows the other activities that can be performed using the mobile client.



Figure 4. Mobile client: activities for the learner

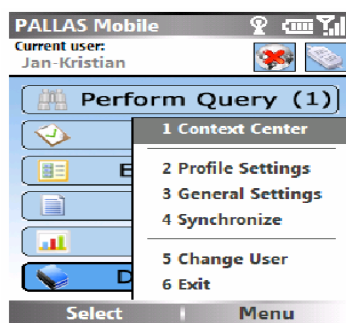


Figure 5. Mobile client: settings

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, see 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 although the device is offline as PALLAS has cached content stored locally on the device.



Figure 6. Mobile client: context trigger

6. Current status and evaluation

PALLAS was developed as a prototype system and the specifications for the system were determined by analysing mobile language learning scenarios such as the one described in Section 3. A scenario-based evaluation of the functionalities of PALLAS has been conducted and an overview of this is provided below:

- Learners have their own profiles to keep track of their progress, interests and other parameters.
- A user can update her profile manually, using the mobile client.
- A learner is able to look up words in her native language and obtain texts explaining the words either in her native language or the target language, e.g. looking up for names of vegetables in French.
- A dictionary service is supported.
- The difficulty of the learning content provided to the learner is adapted to the learner's profile.
- Possibility to define context triggers (by the teacher) based on location, e.g. the French art exhibition, or time.
- Context triggers provide automatic notifications to the learner if the learner is in the vicinity of a point of interest.

In the current version of PALLAS, the learner is able to access the system via a mobile device. However, the architecture, with a centralised storage and service interface is designed to support other clients such as a desktop computer.

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 Content Management Systems. The current version supports learning material creation by the teacher. Access to Content Management Systems and the possibility to query the system via SMS is not supported in the current version.

We plan to evaluate the usage of the system in collaboration with a French teacher at our university, where we will ask some students studying French to use it. The French teacher will provide some of the learning resources and add context triggers. We are currently in the process of determining the exact method for evaluation and designing an evaluation framework for the usage of the system.

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 [10] 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 photostudy described in [26] supports learners to learn new words using photos and by collaboration with others. Both 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 personalisation of content.

A system that has more in common with PALLAS is LOCH (Language Learning Outside the Classroom with Handhelds) [27]. 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, personalisation 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 contextualised vocabulary is presented to the learner is presented in [2], 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 [11] where the context of the learner was considered as the location of the learner.

8. Conclusion and future work

This paper describes the PALLAS system which provides support to a mobile language learner, by providing personalised and contextualised access to learning resources. In our work, we consider personalisation as a part of contextualisation. We have reviewed the literature on personalised support for mobile language learning systems and discussed in detail how personalisation and contextualisation is supported in PALLAS. An evaluation of the system is conducted using a mobile language learning scenario.

The current version of PALLAS does not support collaboration and interaction among different learners. The functionality that has been implemented provides support to an individual learner. However, personalisation and contextualisation parameters to support the social context of the learner and to model the communities that the learner interacts with have been considered. We plan to enhance the system to support collaborative learning.

We plan to continue developing the system and expanding the content available to the learners by integrating with Content Management Systems. 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.

9. Acknowledgments

This work has been conducted within the MOTUS2 project, as a research project for a Masters degree at NTNU by the second author. The authors would like to thank Sondre Skaug Bjørnebekk, Inspira AS and Monica Divitini for their support and feedback.

10. References

- [1] A. Syvänen, et al., "Supporting Pervasive Learning Environments: Adaptability and Context Awareness in Mobile Learning", in Proceedings of 3rd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2005), Tokushima, Japan, 2005.
- [2] C.-M. Chen, Y.-L. Li, and M.-C. Chen, "Personalised Context-Aware Ubiquitous Learning System for Supporting Effective English Vocabulary Learning", in Proceedings of 7th International Conference on Advanced Learning Technologies (ICALT 2007), Niigata, Japan, 2007.
- [3] R.G. Paredes, et al., "A Multi-model Approach for Supporting the Personalisation of Ubiquitous Learning Applications", in Proceedings of 3rd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2005), Tokushima, Japan, 2005.
- [4] H. Green, et al., "Personalisation and Digital Technologies", Futurelab, UK, November 2005.
- [5] M. Sharples, J. Taylor, and G. Vavoula, "Towards a Theory of Mobile Learning", in Proceedings of **mLearn 2005**, Cape Town, South Africa, 2005.
- [6] J. Chen and Kinshuk, "Mobile Technology in Educational Services", *Journal of Educational Multimedia and Hypermedia*, 14, 1, 2005, pp. 91-109.
- [7] L.F. Motiwalla, "Mobile Learning: A Framework and Evaluation", *Computers and Education*, 49, 3, Elsevier, 2007, pp. 581-596.
- [8] L.S. Vygotsky, *Mind in Society. The Development of Higher Psychological Processes*, Harvard University Press, 1978.
- [9] M. Morita, "The Mobile-based Learning (MBL) in Japan", in Proceedings of First Conference on Creating, Connecting and Collaborating Through Computing (C5'03), 2003.
- [10] M. Uther, et al., "Mobile Adaptive Call (MOC): A Case-study in Developing a Mobile Learning Application for Speech/Audio Language Training", in Proceedings of 3rd IEEE International Workshop on Wireless and Mobile Technologies in Education, Tokushima, Japan, 2005.
- [11] H.-C. Hsieh, C.-M. Chen, and C.-M. Hong, "Context-Aware Ubiquitous English Learning in a Campus Environment", in Proceedings of 7th International Conference on Advanced Learning Technologies (ICALT 2007), Niigata, Japan, 2007.
- [12] R. Kuo, et al., "Delivering Context-Aware Learning Guidance in a Mobile Learning Environment based on Information Theory", in Proceedings of 7th International Conference on Advanced Learning Technologies (ICALT 2007), Niigata, Japan, 2007.
- [13] A.K. Dey, "Understanding and Using Context", *Personal and Ubiquitous Computing Journal*, 5, 1, 2001, pp. 4-7.
- [14] A. Kofod-Petersen and M. Mikalsen, "Context: Representation and Reasoning -- Representing and Reasoning about Context in a Mobile Environment", *Revue d'Intelligence Artificielle*, 19, 3, 2005, pp. 479-498.
- [15] S.A. Petersen and A. Kofod-Petersen, "Learning in the City: Context for Communities and Collaborative Learning", in Proceedings of 2nd International Conference on Intelligent Environments IE06, Athens, Greece, 2006.
- [16] A. Patel, et al., "An Initial Framework of Contexts for Designing Usable Intelligent Tutoring Systems", *Information Services and use*, 18, 1-2, 1998, pp. 65-76.
- [17] S.R. Viola, A. Giretti, and T. Leo, "Learners' Profiling by Data Driven Approaches", *Learning Technology Newsletter*, 9, 2, IEEE Computer Society, 2007, pp. 11-13.
- [18] J. Milton, "Literature Review in Languages, Technology and Learning", University of Wales, September 2002.
- [19] P. Hubbard, "A Methodological Framework for CALL Courseware Development", in *Computers in Applied Linguistics: An International Perspective*, M.C. Pennington and S. Vance (Eds.), Multilingual Matters, 1992, pp. 39-65.
- [20] M. Sharples, "The Design of Personal Mobile Technologies for Lifelong Learning", *Computers and Education*, 34, 2000, pp. 177-193.
- [21] M. Sharples, D. Corlett, and O. Westmancott, "The Design and Implementation of a Mobile Learning Resource", *Personal and Ubiquitous Computing*, 6, 2002, pp. 220-234.
- [22] L. Naismith, et al., "Literature Review in Mobile Technologies and Learning", NESTA Futurelab, December 2004.
- [23] Google, "Google SOAP Search API", <http://www.google.com/apis/>, 2007.
- [24] Qtek, "Qtek Mobile Phones", <http://www.myqtek.com/europe/products/8310.aspx>, 2007.
- [25] J.-K. Markiewicz, "Personalised and Context Sensitive Foreign Language Training supported by Mobile Devices", Norwegian University of Science and Technology, June 2006.
- [26] S. Joseph, K. Binstead, and D. Suthers, "Photostudy: Vocabulary Learning and Collaboration on Fixed and Mobile Devices", in Proceedings of 3rd IEEE International Workshop on Wireless and Mobile Technologies in Education, Tokushima, Japan, 2005.
- [27] R.G. Paredes, et al., "LOCH: Supporting Informal Language Learning Outside the Classroom with Handhelds", in Proceedings of 3rd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2005), Tokushima, Japan, 2005.