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Personalized self-assessment for deaf and hard–of–hearing students

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Abstract: This paper describes teaching and learning services provided to Deaf (D) and Hard-of- Hearing (HH) students in Higher Education, using pilot Personalized Learning Environments (PELEs). Utilization scenarios are used for the presentation of such services. One type of service offered to D-HH student is personalized self-assessment, which is implemented using W-PARES, a Web-based assessment system. Before self- assessment testing, D-HH students need to understand in depth the questions of self- assessment tests. For this reason, D-HH students can either attend a mainstream class using PDAs or PCs to adapt presentations according to their needs, or they can attend a parallel "assistive" class, where there is a Sign Language interpreter. The self-assessment process includes two phases: a phase of ordinary self-assessment, where a set of questions is randomly selected from a Question Base and an adaptive self-assessment phase, where questions are personalized to each student. The tests explanations provided to D-HH students before the assessment process, as well as the self-assessment tests results, are recorded and a preliminary follow up is conducted. Moreover, self-assessment tests results of D-HH students are compared with corresponding results of hearing students.

Keywords: Teaching and Learning Services Provided to Deaf

1. Introduction

Assistive Technology (AT) in the e-learning and mobile learning (m-learning) context could mainly refer to devices, assistive computer programs and computer-based services used by students with disabilities to help them perform tasks and activities. Assistive Learning Environments utilize AT in educational scenarios to support students with disabilities. Wireless technology, including among else ad-hoc networks, mobile and ubiquitous environments, offers new possibilities for enhanced, cheap and reliable assistive technology. Assistive computer programs can be executed on PDAs; ad-hoc networks of PDAs can offer access to databases of interest; PDAs can ensure communication between users through e-mail, chat, etc. The new networking paradigm that emerged with the appearance of wireless computing can boost the performance of systems in which they get applied (Belsis et al., 2008).

A wireless Personalized Learning Environment for supporting Deaf (D) and Hard-of- Hearing (HH) students, at first should provide authorized access and privacy

preservation (Skourlas et al., 2009; Vassis et al., 2008; 2009), since sensitive educational information and data are managed e.g. answers to specific assignments and exams tests, marks, assessments and evaluation (of lectures, students, teachers, and learning cases). Secondly, it should support and provide constant connectivity for as long as possible, and decentralization of processing and communication tasks. This can be done using advanced algorithms which allow the nodes in the network to act collectively as a distributed server (Malatras et al., 2005). Lastly, it should support integration of the IT infrastructures among learning domains or units and improvement of the collaboration of the learning environment with other ones.

Various teaching and learning services should be supported by a Personalized Learning Environment. One type of service is students‟ self- assessment. This type of assessment gives students the opportunity to detect their strength and weaknesses and monitor their learning progress. It also facilitates the understanding and revision of educational material. Adaptive self- assessment dynamically adjusts tests to students‟ performance level. An adaptive self-assessment test is considered to be a “personalized” test. The objective is to improve a student’s learning state incrementally. When questions are quite near students‟ level, students do not feel bored and their self-esteem is stimulated. This is quite important for disabled students, who need encouragement to try harder; otherwise they quit.

W-PARES is a Web-based assessment tool, which extends the previous 2- tier PARES tool (Kaburlasos et al., 2004; 2008). W-PARES can be used for the administration of computerized assessment and self-assessment tests in various topics of a curriculum and can provide either adaptive or non-adaptive tests. An accurate estimation of student’s level of competency is provided, which is useful for both teachers and students.

This work reports on the exploitation of wireless Personalized Educational Learning Environments (PELE) for the self- assessment of D-HH students and the comparison of the experimental results with the self-assessment results of hearing students. Previous work that has been reported includes a brief description of the architecture of Personalized Educational Learning Environments (PELE) (Skourlas et al., 2009) and some experimental results from a first evaluation of the system (Marinagi et al., 2010).

The remainder of this paper is organized as follows: Section 2 discusses basic issues on personalization and user profiles. Section 3 briefly presents utilization scenarios and describes the types of services offered by PELE architecture. The self-assessment case is examined. Section 4 presents the experimental results, comparing D-HH students‟ self-assessment results with hearing students‟ results. Finally, section 5 gives some conclusions and discusses future activities.

2. Personalization and User profiles

Personalization could be simply defined as the process of making computer- based Information (Retrieval) Systems adaptive to the information needs and interests of individual users, in a dynamic way (Skourlas et al., 2009). The personalization process mainly concerns data collection about the users and analysis of the collected data to create user models (Pierrakos et al., 2003).

Personalization in the educational context can be achieved with the use of a separate personalization server and servers of distributed, multimedia, educational material (Skourlas et al., 2009). Retrieved data presented in the learner after request could be chosen using the expensive content-based filtering (and ranking)

techniques or collaborative filtering to group the users into communities according to common characteristics and interests.

Learners' models, usually, contain personal information and details about the learners, as provided during the registration, and information related to the description of the available sources and categories of the educational material (Skourlas et al., 2009). Weight parameters can be defined based on the frequency at which the user chooses the particular source or category of new educational material.

The collection of data about the D-HH students and their interests can be performed explicitly, through form-filling, and implicitly, through the logging of usage data. Machine learning methods can be used to create adaptive user models that capture changes to the user's interests (Paliouras et al., 2006). For each student, the system should maintain a "user profile", which contains information about the performance of the user and user preferences.

The following methods can be used for the assignment of the initial user profile: A profile can be manually built based on prior knowledge about the student; a profile can be automatically built based on an "assessment". This profile will be updated when the learner uses the system.

As part of the personalization of the system to each individual user, several features can be tuned based on the profile of the user. The following features can be the subject of adaptation: Set-up of the system, Font type, size and colour, Speed of highlighting, Text analysis, language skills, level of knowledge of SL, written language skills, knowledge of other languages.

Significant information about learners can include: a) Personal details e.g. age, first enrolment date, semester, class, b) prerequisite modules for specific courses, c) examinations, statistics and marks for courses (that add valuable features of the learner's profile). Such information and data are useful for classifying the students into groups and improves the understanding (Skourlas et al., 2009).

3. Personalized Learning Environments (PELEs) – Utilization scenarios and types of services offered

We can present and discuss various types of services, offered by the Personalized Learning Environments, using different system utilization scenarios (use cases). In order to outline specific technical requirements, two simple, representative use cases are given:

1. A deaf student within the mainstream class s/he attends or in her/his place wants to access some basic notes regarding the teacher's presentation or a previous learning unit stored in the multimedia database e.g. a PowerPoint presentation and the related notes. The student sends a request from her/his PDA to retrieve the data from the database. Since the requested resource is not a critical one, only the permissions of the requester are evaluated against the local policy and no encryption is used.

2. In the case of examinations or assignments, when a request is sent to the server, in order to authorize or not the request, the server needs to identify the learner's identity as well as to evaluate the permissions, which have been granted to the learner for the specific activity. It requests a validation of the learner's id. This can be done using public key encryption techniques.

The proposed architecture offers and supports various types of services. An organizational scheme for supporting teaching and personalized services is depicted in Figure 1.

Figure 1 illustrates a scalable, distributed architecture, which can support various learning environments and domains. The mainstream class in Figure 1 illustrates the use of the wireless infrastructure offered to D-HH students. Two important actors appear: teacher and teacher assistant. Multimedia presentations of the teacher are shown on the interactive whiteboard and everything written on it can be saved. Assistant does not know Sign Language (SL), but s/he communicates (chat based communication) with D-HH students for question – answering, during the lecture. Another interesting actor is a hearing (volunteer) notes' taker. This role is complementary and s/he takes notes apart from the existence of the interactive whiteboard, which saves presentations and written text by the teacher. Among students there are D-HH students who use PDAs or PCs. They have the choice to access more information and multimedia material locally or accessing other servers out of the classroom. It is assumed that, in the initial stage, they fill forms with personal details, for the personalized access to the multimedia information and documents and for the adaptation of the interface according to their needs. Privacy of all these personal details is ensured.

In Figure 1, a parallel, "assistive" class is also illustrated. A major difference is that, there is an interpreter in the classroom, and s/he plays a key role. In the parallel class there are no teaching assistant and notes' taker. Hearing volunteers and hearing students are included. Another interesting point is that all the presentation and the related discussion are recorded for future study. Therefore, teaching in this case is based on bilingual presentations. We have also done successful experiments to establish communication between the mainstream class and parallel classes, and communication between two parallel classes when there is only one interpreter. Therefore, the organizational scheme depicted in Figure 1 can support bilingual teaching, synchronous e-learning and m-learning, and communication.

Figure 1 also illustrates the establishment of a scalable environment including servers (personalization server, and database server) and multimedia database of lessons, documents, and bibliography. Therefore, the scheme offers the possibility of asynchronous distance learning and personalized access to databases of educational documents and information. Teacher can use this possibility to add material: documents, assignments, small projects, examination" tests, results, etc. Personalized services to students are supported through the personalized server and the whole scheme ensures the privacy of the personal details. Data related to the usage of the system (the personalized service) can be used to change user models (profiles).

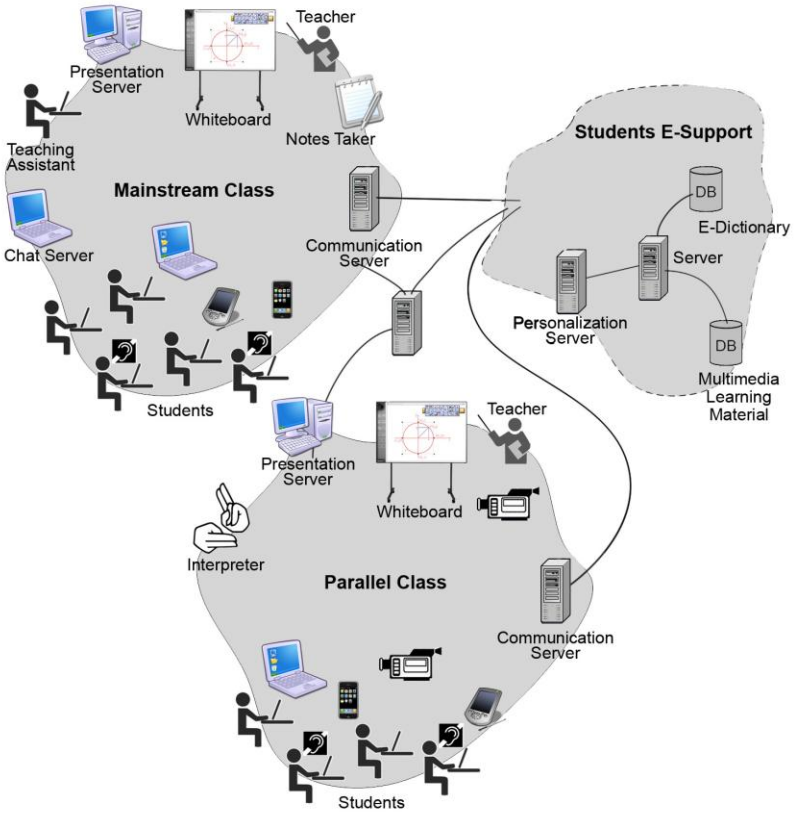

Figure 1. Organizational scheme for supporting teaching and personalized services including the mainstream class, and parallel, "assistive" classes, the personalization server, and the database server for multimedia information and educational material.

4. Experimental Results

In this paper, we, describe our activities that are related to a three years experiment in the Department of Informatics (Skourlas, 2010). In this framework, translation into SL is offered (more than 150 hours per semester for seven students of the Department that participate in the program) for various courses. Parallel classes are organized for specific courses: Databases I & II, Introduction to Programming (Pascal language), Programming (C language), Numerical Analysis.

In this framework, an expert with good knowledge of the SL, a teacher and three teaching assistants of the Department of Informatics, three students - volunteers, and seven D-HH students work in special parallel classes three times per week and they participate in a weekly meeting. Seven students with hearing problems also attend lessons in the mainstream classes. It is worth mentioning that one of the teaching assistants is a Deaf graduate of the Department of Informatics.

The seven out of eight D-HH students that participate in our activities (parallel classes) are enrolled in different semesters. Hence, there is a need to organize their enrollment into specific lessons and their attendance in specific classes and laboratories. Greek SL is the first language for one student and the preferred language for other six students. The eighth Deaf student of the department has denied his participation in the parallel classes and in the weekly meetings organized by the expert.

A first evaluation is given comparing the self-assessment tests results of the seven D-HH students (Group B) with those of four groups of hearing students (Groups A1, A2, A3, A4). Students of five groups were examined in the same course of the first semester, named "Introduction to Computer Science". Groups A1, A2, A3, A4 are hearing students of the Department of Logistics, Technological Educational Institute of Chalkis. The tests were carried out during four semesters. Table 1 includes basic information concerning the groups of students.

Table 1. Hearing students (groups A1, A2, A3, A4) and D-HH students (group B).

Groups	Number of students	Semester	Department
A1	25	Winter 2008-09	Logistics
A2	12	Spring 2008-09	Logistics
A3	22	Winter 2009-10	Logistics
A4	55	Winter 2010-11	Logistics
B	7	Winter 2009-10	Informatics

W-PARES system is a Web-based assessment system, which was used for the student self-assessment process. Self- assessment was planned to include a phase of an ordinary (non-adaptive) self-assessment, and an adaptive self- assessment phase.

During the ordinary self-assessment phase a set of questions appears on students' screens. The students submit their answers within specific time limits, which depend on the difficulty of the questions. At the beginning of a test the timer starts counting down. If time expires before a student submits the answers, then the answers are submitted automatically. Each question is randomly selected from a unit of similar questions. During test design, the teacher determines the units of the Question Base from which the questions of each test will be selected. Therefore, each student receives a different set of questions, but all tests have similar difficulty and similar content. When the test finishes, the system estimates the performance level of each student. Test statistics are used for the re-estimation of test parameters, as well as student's performance level.

The second phase is an adaptive self-assessment phase. Student's current performance level is considered, in order to select the first question. Then the questions appear on students" screens one by one. When an answer to a particular question is submitted, the student's current performance level is re- estimated using all of the student's previous answers. Other parameters are also re-estimated. Each next question is adaptively selected from the Question Base, according to student's current performance and current values of assessment parameters.

After test submission, either in non-adaptive or in adaptive self-assessment tests, the correct answers are appeared on screen. Students" wrong answers are accompanied with comments that give explanations on each particular answer and/or useful links to corresponding educational material. This type of immediate feedback encourages better students' performance and supports learning process.

Groups A1, A2, A3, A4 of hearing students participated using Web browsers to access W-PARES from their personal computers at their place. The coordinator teacher first authorized a particular test and at the pre-agreed test time published the authorized test on students' machines. Group B of D-HH students participated using Web browsers to access W-PARES from the computers of the institute's laboratory, under the supervision of their teacher and an interpreter of the Greek

SL. They discussed the two test sets before the start of the self-assessment process and various explanations were given. This process was quite tiring, because the number of the questions was high. The explanations and the self-assessment phase were recorded for future analysis and a preliminary follow up was conducted. Eventually, five out of seven of D-HH students were successful in the self-assessment phases.

Table 2 summarizes some comparative results of the five groups of students. It is interesting that statistically there is no significant difference between the average marks of D-HH students and the four groups of hearing students. Even though, throughput appears higher in case of D-HH students, we cannot draw conclusions given such a small number of D-HH students.

Table 2. Self-assessment results based on two categories of students: Hearing students (groups A1, A2, A3, A4) and D-HH students (group B).

Groups	Self-assessment – average mark	Adaptive self-assessment – average mark	Self-assessment – successful	Self-assessment – throughput	Adaptive self-assessment – successful	Adaptive self-assessment – throughput
A1	5,1	4,8	15 out of 25	60%	14 out of 25	56%
A2	4,1	5,0	4 out of 12	33%	7 out of 12	58%
A3	4,8	5,4	12 out of 22	54%	13 out of 22	59%
A4	4,2	5,3	20 out of 55	36%	29 out of 55	53%
B	4,7	4,4	5 out of 7	71%	5 out of 7	71%

5. Conclusions

In this paper we presented the types of teaching and personalized services, offered by a pilot Personalized Learning Environment, suitable for D-HH students of Higher Education. Various system utilization scenarios (use cases) were utilized that outline technical requirements.

One type of service offered to D-HH student is personalized self- assessment, which was implemented using W-PARES, a Web-based assessment system. Self-assessment results were used to evaluate the understanding of educational material of a group of D-HH students and comparing with the results of groups of hearing students. Before test conduction, a teacher and an interpreter of the Greek SL gave explanations on test sets, which were recorded. The comparison proved that statistically there is no significant difference between the results of D-HH students and hearing students. In conclusion, wireless networks and PDAs form an attractive and helpful framework for supporting D-HH students.

Adaptive, personalized, web-based environments in the educational context should be designed and implemented considering studies on particular learner groups and capturing the experience of experts in the field. Therefore, for the future we intend to examine other learner categories and their individual preferences. We shall try to establish a framework not only for persons with hearing disabilities, but also for people with other disabilities e.g. problems of vision. In addition, we intend to perform a further analysis aimed at facilitating other groups with specific characteristics and needs e.g. working students, rejected students in specific courses. We shall examine automatic adaptation of the document presentation when

a change in the user profile takes place, as well as suggestions (based on the user"s profile and learners" performance) for „further reading" and / or exercises that will help the student.

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