Secure Wireless Infrastructures and Mobile Learning for Deaf and Hard-of-Hearing Students

Petros Belsis
Department of Marketing
Technological Educational Institute of Athens
GR-12210, Athens, Greece
pbelsis@teiath.gr

Stefanos Gritzalis
Department of Information & Communication Systems
Engineering, University of Aegean,
GR-83200, Karlovassi, Samos, Greece
sgritz@aegean.gr

Catherine Marinagi
Department of Logistics
Technological Educational Institute of Chalkis
GR-32200, Thiva, Greece.
marinagi@teihal.gr

Christos Skourlas, Dimitris Vassis
Department of Informatics,
Technological Educational Institute of Athens,
GR-12210, Athens, Greece
cskourlas@teiath.gr, vassis@teiath.gr

Abstract— **In this paper, we discuss how wireless networks and mobile learning form an attractive and helpful framework for supporting Deaf and Hard of Hearing (D-HH) students in Higher Education. The proposed multi-domain framework includes Secure Wireless Infrastructures and Personalized Educational Learning Environments (SWI_PELE). We present the collaboration of such environments and briefly discuss a pilot implementation. The framework includes a scheme of servers and incorporates wireless infrastructure, and personalized, multimedia based educational course material. We also present and discuss how the proposed architecture can support services for D-HH students.**

Keywords- Secure Wireless Infrastructures; Mobile Learning; Distributed Learning environments; Personalized learning environments

I. INTRODUCTION

Advances in mobile devices, such as smart phones, portables, WebPad, Tablet PCs or PDAs make them suitable for assistive environments. In the past, the use of assistive technology based services was restricted by the location of use e.g., campus, home, classroom, laboratory. Lately, mobile devices are changing these contexts of use and the new heterogeneous use of services includes the whole territory of campus, the town square, etc. [1]. It is interesting to see how wireless technology, including among else ad-hoc networks, mobile and ubiquitous environments, offers new possibilities for enhanced, cheap and reliable assistive technology. You can compare, for example, the today mobile phone messages' exchange or chat through mobile devices with the telecommunications services some years ago. In the past, the deaf subscriber of a telephone relay service and the operator of the phone company were, both, using a specific Telecommunications Device for Deaf (TDD). The deaf person was typing on the TDD a message, the phone company operator was reading it aloud to the appropriate hearing person, and then the hearing person's reply was given again through the operator. Eventually, the text of the oral reply was typed by the operator and it was shown on the short screen of the TDD of the deaf person.

M-learning can be seen not only as a component of distance learning realized at anywhere and anytime through mobile devices, but also as a mode of learning, which can be applied in mainstream class, mainly, for students with disabilities. The new technological framework for web accessibility "reflects" the improvements in universal design [2], personalization [3], and the related issues. Universal design refers to the design of products and the built of environments to be usable by everyone [1, 2]. Personalization could be simply defined as the process of making learning adaptive to the needs and interests of individual users, in a dynamic way [3]. Therefore, universal design and personalization can also be seen as an effort to provide instruction and learning strategies and also increase the awareness and the motivation of faculty to use these strategies in mainstreamed classes [4, 5]. Assistive learning environments can utilize / integrate these technologies and also be based on wireless infrastructures [6].

New features of mobile devices enable new possibilities for learning in assistive environments [6, 7, 8]. 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. A study on the suitability of PDAs for assistive learning is given in [9]. According to Rainger [9], the features of PDAs that enable accessibility for D-HH students include vibrating alert, flashing LED, and flashing display and/or light. Another facility of PDAs that can be useful to D-HH students is the Rapid Serial Visual Presentation (RSVP), where each letter of a word is briefly shown in sequence.

Lately, there is a lot of interest in developing environments utilizing various types of assistive and other technologies.

978-0-7695-4825-8/12 $26.00 © 2012 IEEE
DOI 10.1109/PCi.2012.66

New possibilities are also offered by pervasive -/- ubiquitous -/- mobile computing for information retrieval, and information and knowledge management. Mobile devices enable access to information, independently of location, while personalized services enable the adjustment of services and interfaces to various demands. Though, a lot of challenges emerge from any effort to integrate these devices in educational scenarios to support people with disabilities. For example, wireless (pervasive) infrastructures in the educational context are characterized by rapid changes in their topology. Students and teachers move around the campus and various activities must be supported, e.g. giving lectures in the mainstream class, attending in parallel classes, working in the laboratory, participating in exams etc. Among else, people with specific difficulties may benefit from: a) pervasive -/- ubiquitous -/- mobile computing, b) specially designed devices and cheap, general purpose wireless devices and c) software that aim at overcoming the disabilities of various groups [5, 7]. Therefore, it is believed that the new networking paradigm that emerged with the appearance of wireless computing can boost the performance of systems in which they get applied [10].

The remainder of this paper is organized as follows: In Section 2 we briefly present background issues and requirements, which form a basis for our approach. Section 3 discusses the architecture of SWI_PELE. Special emphasis is given to security issues related to the intercommunication between different learning domains and units. Section 4 presents an evaluation of the pilot implementation of SWI_PELE. Section 5 presents some conclusions. Future activities are also discussed.

II. BACKGROUND ISSUES AND SWI_PELE ARCHITECTURE REQUIREMENTS

D-HH students are bilingual e.g. written Greek language, which is the language of instruction, and Greek Sign Language (SL). Unfortunately, there is no direct link between SL and the technical code used in the written form. Therefore, the D-HH student has to do 'recoding' between the interpreter's signing and concepts and terminology used in teaching. This means that the interpreter not only uses mouthing and finger spelling but also creates 'conceptually-based signs' [11]. The D-HH students must agree and decide to adopt an 'everyday' sign for a technical term. Therefore, video-recording of presentations, and further study and analysis of the multimedia material can improve understanding of concepts and adopting of the proper interpretation of technical terms.

Slides-based presentation combined with the use of video in SL and pictorial diagrams offers the possibility of a step-by-step understanding of the content of learning units.

Knowledge of written language plays an important role in education and inclusion of D-HH students. Makarena and Lampropoulou [12] found that Greek D-HH graduates from secondary school lack sufficient written language skills especially in relation to syntax. They also found that "Deaf adults, regardless of their level of education, use in their writings stereotype phrases and verbs in active voice, while when it comes to syntax, they prefer the Subject-Verb-Object structure" [12]. We have also to agree when they say: "written materials must be modified to accommodate several skill levels - from (deaf) clients who need very simplified, iconic materials with little or no reading required, to those who are comfortable reading elementary English, to those who can read more advanced English".

Therefore, we must include slides-based presentations -/- lectures, videos in SL, etc, into the syllabi and arrange parallel, "assistive" classes and meetings so that the D-HH students can study before the presentation and afterwards.

In the following, we give the main requirements of the proposed framework of Secure Wireless Infrastructures and Personalized Educational Learning Environments (SWI_PELE).

1) Access control management

Common, shareable content forms a basis for the services offered to the D-HH students and the various user communities. Access control according to the specified needs is given to the following common, shareable resources:

- Multilingual (SL is supported and video in SL is included), multimedia (text, images, video), interactive dictionary of terminology, examples and concepts. We set different access levels that depend on the user's role, e.g. moderator, student, writer-/-teacher and interpreter.
- Learning Objects and e-books. These resources are collaborative and we set three levels of access for them: editors, writers-/-teachers, and readers.

For specific sensitive activities, such as examinations in the laboratory and access to administrative services, it is essential to manage access rights and enforce access control based on roles; for flexibility and simplicity we have used the Role Based Access Control Model – RBAC, the standardised model which allows the assignment of permissions to resources according to the role that the user is granted to. For example, all students are granted similar permissions (Access specific resources).

Another issue is to prevent information disclosure; for this requirement, encryption is the solution. Due to the fact that the devices have limited capabilities, we have used a shared key approach [13]; each device has a key installed to communicate with the server. The server identifies all the shared keys for the participating devices. This ensures a minimization of resource consuming, since in mobile devices the battery lifetime and CPU usage are limited.

2) Distributed management

There are two major perspectives of Learning supported by the Networked Academic Communities: decision making and distributed management. These perspectives are related to concepts that are identified to play an important role in Network Learning (e.g. see [14]): simplicity of learning environment, collaboration (among students, among teachers, among students and teachers), administrative-/-technical support, domain, institutional policy on networked learning, size of target groups, size of class, quality of networked learning, number of tutors per class, student satisfaction. Decision making can be based on various techniques e.g. cognitive maps. Special emphasis must be given to the security management issues.

It is not infrequent that a node looses connectivity while attempting to connect with the server; on the other hand, nodes on the residing area may also be indentified and act as a mediator in order the transmitted information to reach its destination. This can be done using advanced algorithms,

which allow the nodes in the network to act collectively as a distributed server [6, 8]. The idea behind that approach is the following: each device with its neighbouring devices, participate in the ad-hoc network; all together the devices act collectively as one server. Some nodes take a specific role to monitor the retaining of communication and act as leader nodes, or members of the Connected Dominating Set (CDS).

In our case, the nodes have the possibility to contact the wireless access point. However, when there is one available node, or when there is no communication with the central node, the nodes send their information to the closest member of the dominating set. These nodes forward information to each other until the information reaches the destination. If a node is about to cease functioning due to low battery resources, then it passes all the information it carries to its nearest node. In specific time intervals, and by calculating several parameters of the nodes such as battery life expectancy, the dominating set is reformed so that the network maintains constant connectivity. In that manner, the mobile network acts as a collective distributed server.

3) Integration of the IT infrastructures

Finally, the proposed architecture provides the integration of the IT infrastructures among learning domains or units, as well as the improvement of the collaboration of the learning environment with other ones. Common, shareable content must include: multilingual-multimedia interactive dictionary, learning objects, and collaborative e-books.

III. SWI-PELE ARCHITECTURE

The proposed architecture can support various learning environments and domains. It is a scalable, distributed architecture that consists of a wireless network, which spans along the campus. The network includes different subnets which communicate, each with its local policy enforcement and authentication module. In Figure 1 an overview of the secure multi-domain framework of learning environments and infrastructures is illustrated. A beacon enables each device to identify whether it resides within the campus boundaries and to enable transmission of sensitive information such as the student's identification number or other personal details. For access control enforcement and authorization in distributed environments, the architecture uses a standardized policy language able to capture role hierarchy relationships based on the Role Based Access Control Model (RBAC) [15].

In the following, two representative use cases are described in order to demonstrate the services provided by the architecture:

The first case concerns a D-HH student, who needs to access some basic notes regarding the teacher's presentation or a previous learning unit stored in the multimedia database. The student sends a request from her/his mobile device, e.g. a PDA, to retrieve the data from the database. S/he can also retrieve video in SL. 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. Complementary, similar use cases include the access of dictionary entries and the access of learning objects and e-books.

The second case concerns student's participation in examinations or student's 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 that have been granted to the learner for the specific activity. First, it requests a validation of the learner's id. Public key encryption techniques need to be applied [13]. Upon request from the server, each device sends its id encrypted using the pre-installed shared key. If the device is stolen the student simply informs the faculty, and its shared key is considered non-valid.

In particular, using the learner's public key and the server's private key, the two parties may authenticate each other, and they can exchange a (shared) session key which will be used to encrypt all further communications. This is being done since use of private key encryption techniques for the transmission of all messages would demand a lot more computational resources. The learner's device is also able to identify whether it resides within the class and the lab or whether it resides in an unknown environment. Identification is performed with the aid of a beacon that sends signed messages identifiable by the learner's device when compared to a number of stored signed messages. Thus, we prevent unauthorized transmission or reception from the device when it resides outside pre-settled space boundaries. After authentication has been performed and the session key has been exchanged, all communications can be encrypted end to end from the database to the learner's device using Transmission Control Protocol/Internet Protocol (TCP/IP) and secure protocols such as the Secure Sockets Layer (SSL) protocol. SSL is used to establish a secure and encrypted communication channel between two Internet connected devices, providing a high degree of confidentiality. When a new request is sent to the database, the policy module is invoked, which examines the request, the requester's role, and the privileges which have been recorded in the policy. This procedure is supported by most of modern devices which support effectively at least 128-bit key length encryption.

IV. SWI-PELE SERVICES

An organizational scheme for supporting teaching and personalized services using SWI_PELE framework is illustrated in Figure 2. The participation in the mainstream class and the parallel, "assistive", classes is supported by the wireless infrastructure offered to students with special needs. Two categories of students are concerned here: hearing and D-HH students. Three other important actors are also described: teacher, teacher assistant, and interpreter. The proposed organizational scheme can support bilingual teaching, synchronous e-learning and m-learning, and communication. In the following, we analyze the role of actors and the components of the proposed architecture.

A. The role of actors

In the organizational scheme illustrated in Figure 2, five different actors participate:

Teacher: S/he offers courses in the mainstream class and in the parallel, "assistive", classes. During the lecture the teacher loads educational material, uploads the multimedia presentations' slides stored in the media server, and gives the lecture using the interactive whiteboard. S/he is responsible for the terminology of the course which is included in the

dictionary, and also contributes to the collaborative learning objects, and the e-books. S/he can answer questions sent to the assistant from the disabled students.

Teaching assistant: S/he communicates (chat based communication) with D-HH students for question-answering, during the lecture. We must mention that it is not necessary for the assistant to know SL. During the lecture or the laboratory part, s/he can support D-HH students to access e-books and entries in the multimedia dictionary, and s/he can help students to understand in depth. S/he has some essential duties as well: Everything written on the interactive whiteboard is saved, the lecture is recorded, and all of this educational material is loaded into the media server to be given to students for further study. S/he also is in charge of the scheduling of the necessary resources: e.g. interpreters and note takers (human resources).

D-HH student: The D-HH student is trained to use the mobile devices while attending the theoretical and the laboratory parts of the course, in the mainstream or the parallel classes. Multimedia user manuals/documents are also given to inform and encourage these students to participate in events of the academic life in the campus. In order to access presentation slides and dictionary entries, the D-HH student uses mobile devices e.g. PDAs and tablets. S/he can adapt user interface according to personal preferences and needs, and access information and educational multimedia material locally or remotely. During the enrollment, the D-HH students fill forms with personal information details to have personalized access to the multimedia information (lectures, dictionary, SL video are included). Personal information is stored into the Students Database, where privacy is ensured.

Interpreter: S/he co-operates with the D-HH students, the teacher, and the other participants to support communication. Unfortunately, the shortage of human resources in Higher Education limits the presence of interpreters in the mainstream class and the laboratory. Successful experiments were carried out to establish communication between the mainstream class and parallel classes, and communication between two parallel classes where there is only one interpreter.

Hearing student and Hearing (volunteer) Note Taker: In the mainstream class D-HH and hearing students attend the lectures. In the parallel classes for D-HH students, the hearing students are encouraged to attend. The role of the note taker is complementary. S/he takes notes, apart from the existence of the interactive whiteboard, which saves presentations and text written by the teacher. Note taker is the ear of the D-HH student and the eye of the blind student.

B. Functional Components

Figure 2 illustrates the establishment of a scalable environment including various components-servers. In the following, we briefly describe the role of servers:

1) Servers of collaborative Multimedia Educational and Learning material

This server offers a framework [14] for supporting Networked Academic Societies towards the collaborative development of courses and educational material. We studied an abstract architecture for a "general-purpose" framework which forms a basis for the collaborative learning. A distributed multimedia database of lessons, assignments, small projects, selected bibliography and bibliographic data, grey bibliography, e.g. dissertations, and educational material, e.g. notes, presentations is hosted. It is important to stress that videos in Greek SL are given. At the moment fifteen (15) modules-courses are prepared to be included and demonstrate the possibility of distributed services. The database system incorporates:

i) Aims and scope of lessons, content of learning units, presentations including slides, videos and diagrams, pictures, bibliography, assignments and small projects for each learning unit. All of the units, lessons, and courses are accessed through mobile devices such as portable PCs, PDAs, and smartphones (see Figure 2).

ii) An easily adaptable interface for the needs of special groups of students is supported. This experimental interface follows the 'universal design' principles.

2) Servers for supporting the inclusion of D-HH students in the mainstream class

During the lecture, a live connection to the web can be conducted. Therefore, the D-HH students can easily access in a synchronous mode the PowerPoint slides of the teacher's presentation in their mobile devices, see teacher's notes and also previous slides of the ongoing presentation. D-HH students can watch related video in Greek SL in the case that there is not any interpreter available in the class.

A multilingual multimedia (Greek – English – Greek SL) dictionary of terminology (terms and concepts) is under construction. Students can have access to the dictionary through their mobile devices. Students can also exchange messages in real time (a "chat" based service) with the teaching assistant to ask for explanations and support. This scheme was exclusively tested and recorded for six semesters in the e-learning classes of the TEI of Athens in order to simulate real conditions and to improve our understanding of the specific needs of our students.

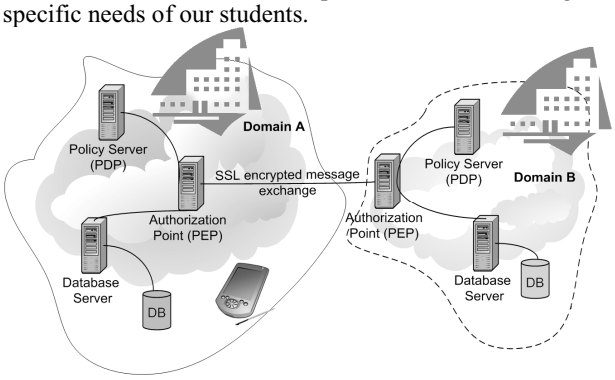

Figure 1. Overview of the secure multi-domain framework of learning environments and infrastructures

3) Personalization server

The learning content is more useful when it is personalized. This means that students are able to adapt the content to individual needs. Our experiments mainly include individual users (learners) models. These models are dynamically adaptive to the use of the system and contain personal information about the users, as provided during the registration and information related to their preferences of sources and categories. Personalized, "intelligent",

collaborative e-books are essential for disabled students. We studied a multi-layered approach – architecture for developing personalized e-books [16] focusing on the adaption and expansion of such an approach in the case of disabled students. Of prime interest for the near future are learning objects, e-books, and e-manuals to cover the needs of students in four critical sectors of services offered for inclusion: health, education and learning, communication with administrative services, inclusion in the labour market.

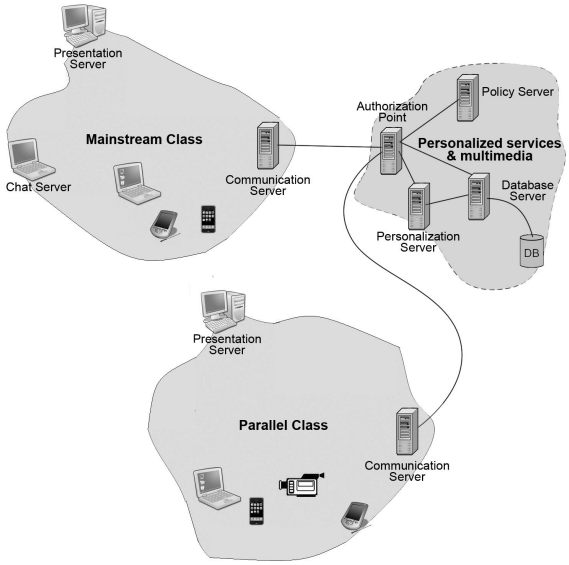

Figure 2. Organizational scheme for supporting teaching and personalized services including the mainstream class, and parallel, "assistive" classes, and servers

V. EVALUATION OF THE SWI-PELE PILOT IMPLEMENTATION

Our pedagogical and teaching activities are part of a continuous twelve years program hosted at the Technological Educational Institute of Athens. During this period, fifty seven (57) D-HH students out of sixty nine (69) ones, from nineteen (19) different departments of the TEI of Athens, have used services, mainly translation in the SL.

Table 1 displays the number of D-HH students of the TEI of Athens. The majority of the students (13/24) are enrolled in the Department of Informatics and in the Department of the Graphic arts technology. Five departments with D-HH students belong to the Fine Arts school.

In this paper, we mainly describe our activities that are related to a three years experiment (six semesters) in the Department of Informatics [5]. 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 and/or project based learning were organized for specific courses: Databases I & II, Introduction to Programming (Pascal language), Programming (C language), Object Oriented Programming (C++ language), Numerical Analysis, Operating systems I & II, Parallel systems, Management Information Systems, and Introduction to Informatics.

We use assistive technology, and especially mobile learning, for the establishment of communication between learner and teacher, and the involvement of the students in teaching and learning process, mainly, in the mainstream class. We also establish parallel "assistive" classes for students of special needs. At the same time, we organize and operate synchronous distance / face-to-face question-answering. Working Communication languages are written languages; text is provided through adaptable interface for Dyslexic people and through SL for D-HH students.

A major problem encountered is that D-HH students miss important information during presentations, because they must choose whether to watch the interpreter, the instructor, or the projected screen (slide). To face this problem, we include the slides, instructions, videos in SL, etc, into the syllabi and arrange parallel, "assistive" classes and meetings so that the D-HH students can study before the presentation and afterwards. In this way, we can achieve the important goal of the inclusion of normal students in the parallel, "assistive" class, which is dedicated to D-HH students.

Table 1. D-HH students in the TEI of Athens that participate in the on-going project. Total number of students is 28 (There are also some deaf students that do not want to participate in the program)

Department	Number
Department of Graphic arts technology	6
Department of Graphic design	1
Department of Photography and audiovisual arts	3
Department of Informatics	7
Department of Interior architecture, decoration and design	2
Department of Food technology	1
Department of Librarianship and Information systems	1
Department of Dental technology	1
Department of Civil works and Infrastructure technology	1
Department of Antiquities and works of art conservation	1
Total	24

VI. DISCUSSION AND CONCLUSIONS

In this paper, we presented the architecture of Secure Wireless Infrastructures and Personalized Educational Learning Environments (SWI_PELE) and the collaboration of these environments. A pilot implementation was briefly discussed. It includes a scheme of servers including wireless infrastructure, personalized, multimedia-based, educational course material, and supports experimental services for students with disabilities and learning difficulties. We came to the conclusion that wireless networks and mobile devices form an attractive and helpful framework for supporting D-HH students. We also concluded that bilingual teaching in the mainstream class is possible but it has its price. We proposed both the use of blended learning and personalized learning based on parallel classes and servers of multimedia lessons. Of primary interest, for the future, is the further experimentation with stereotypes of Dyslexic, D-HH students for the mainstream class and for accessing educational information and material. Research on various aspects of the user communities of learners is also planned for accessing educational information, material and bibliography.

A. *Inclusion: Some Results and a preliminary discussion*

Today, teachers in the departments are aware of the problems and the difficulties of the students with special needs. Hence, the initiative has passed to the teachers in many cases. D-HH students usually lack initiative, but things are changing: More questions/answers, participation in the presentations of homework, participation in the presentations of dissertations. The most important thing is that we established more active participation in the mainstream class so that every D-HH student attends every lab. The participation of D-HH students in the Erasmus programme has increased. Eventually, the number of D-HH graduates has also increased.

There are also some other improvements. Especially, the dissemination of information is better organized and students, lecturers, and administration are better informed. Participation of hearing students in the parallel classes has increased. There are new volunteers, students and lecturers. Participation of D-HH students in social events has increased and seven students of the TEI of Athens have organized a successful theatrical scheme since 2009. The director is a professional actor and she is a student of a school of learning the Greek SL.

B. *Ongoing activities and perspectives*

Our first priority is the development of a network of people including students, interpreters, social workers and lecturers. This network can be served by the proposed architecture to combine two directions of support, access and participation:

a. The operation of the traditional information system for storing and retrieving multilingual learning objects, lectures, and educational material, e.g. lectures, videos in SL, self-evaluation tests, and case studies.

b. The operation of a collaborative academic social network of teachers, D-HH students, other students, social workers, sign language interpreters, etc.

Future research should focus on the further integration of the various components (servers, etc) and the establishment of services for D-HH students of other departments. We intend to examine other user (learner) categories; we also intend to establish a framework not only for students 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 such as working students and rejected students in specific courses. In the future integrated system, we shall also try to specify and apply new innovative features, focusing on: 1) Automatic adaptation of the document presentation when a change in the user profile takes place. 2) Analysis of text, taking into account the profile of the student. If parts of the text are difficult, then the presentation will be adapted accordingly. 3) Suggestions (based on the user's profile and learners' performance) for further reading and / or exercises that will help the student.

ACKNOWLEDGEMENT

This research has been co-funded by the European Union (Social Fund) and Greek national resources under the framework of the "Archimedes III: Funding of Research Groups in TEI of Athens" project of the "Education & Lifelong Learning" Operational Programme.

REFERENCES

[1] L. Burzagli, P.L. Emiliani, F. Gabbanini, "Design for All in action: An example of analysis and implementation," Expert Systems with Applications, vol. 36, iss: 2, March 2009, pp. 985-994, doi:10.1016/j.eswa.2007.10.039.

[2] C. Stephanidis (Ed.), "Universal Access in Human-Computer Interaction- Intelligent and Ubiquitous Interaction Environments", Proc. 5th Int. Conf. on Universal Access in Human-Computer Interaction (5th UAHCI) (Part II), San Diego, CA, USA, 19-24 July 2009. Berlin Heidelberg: Lecture Notes in Computer Science Series of Springer.

[3] G. Paliouras, A. Mouzakidis, V. Moustakas and C. Skourlas "PNS: A personalized news aggregator on the Web," Intelligent Interactive Systems in Knowledge-based Environments, M. Virvou and L. Jain Eds., Studies in Computational Intelligence, Springer Verlag, no. 104, 2008, pp. 175-197.

[4] C. Skourlas et al, "A Wireless Distributed Framework for Supporting Assistive Learning Environments," Proc. 2nd Int. Conf. on PErvasive Technologies Related to Assistive Environments (PETRA'09), Article No. 53, ACM Press, 2009, doi:10.1145/1579114.1579167.

[5] Skourlas, C. (presenter) "Inclusion of students with disabilities and learning difficulties at the Technological Educational Institute of Athens," Proc. 7th Int. Conf. on Higher Education & Disability, July 20-23, Innsbruck, Austria, 2010.

[6] D. Vassis, P. Belsis, C. Skourlas and G. Pantziou, "Providing advanced remote medical treatment services through pervasive environments," Personal and Ubiquitous Computing, vol. 14, no. 6, 2010, pp. 563-573, doi:10.1007/s00779-009-0273-0.

[7] C. Marinagi, F. Sarinopoulou and C. Skourlas, "Personalized self-assessment for Deaf and Hard–of–Hearing students," International Journal on Integrated Information Management, vol. 1, iss: 1, 2011, pp. 49 – 59, doi:0004.

[8] P. Belsis, D. Vassis and C. Skourlas, "Identifying and utilizing secure paths in ad hoc assistive medical environments," Security and Communication Networks, vol. 4, iss: 11, 2011, pp. 1231-1242, doi:10.1002/sec.223.

[9] P. Rainger, "Usability and accessibility of personal digital assistants as assistive technologies in education," in J., Attewell, C., Savill-Smith, Eds., Learning with mobile devices, research and development, Learning and Skills Development Agency, London, UK, 2004, pp. 131-137.

[10] P. Belsis, et al, "Exploiting Distance Learning Methods and Multimedia-enhanced instructional content to support IT Curricula in Greek Technological Educational Institutes," Proc. 6th Int. Networked Learning Conference (NLC08). Thessaloniki, Greece, May 5-6, 2008.

[11] C. Rathmann, "Inclusion of Sign Language users in Higher Education – An ethnographic point of view," Inclusion of Deaf People in Education and Society: International Perspectives, V. Lampropoulou Ed., University of Patras, Patras, 2005, pp. 159-165.

[12] A. Makarena, and V. Lampropoulou, "An evaluation of written language of Deaf adults," Inclusion of Deaf People in Education and Society: International Perspectives. V. Lampropoulou Ed., University of Patras, Patras, 2005, pp. 159-165.

[13] K. Schmeh, Cryptography & Public Key Infrastructure, New York, Wiley, 2003.

[14] A. Tsadiras and D. Stamatis, "Decisions on Networked Learning based on Fuzzy Cognitive Maps," Proc. 6th Networked Learning Conf., 2008.

[15] R. Sandhu, E.J. Coyne, H.L. Feinstein, and C.E. Youman, "Role-Based Access Control Models," IEEE Computer (IEEE Press), vol. 29, iss: 2, Feb. 1996, pp. 38–47, doi: 10.1109/2.485845.

[16] K. Chatzara, A. Mpantsos, D. Stamatis and A. Tsadiras, "Developing Personalized E-Books: A Multi-Layered Approach," IFIP, AIAI, vol. 204, 2006, pp. 425-432, doi: 10.1007/0-387-34224-9_49.