Strategic Role of Tertiary Education and Technologies for Sustainable Competitive Advantage

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Chapter 9
E-Learning, Fuzzy Methods, and Sign Language Video to Enhance Teaching for Hearing Impaired

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ABSTRACT

This chapter discusses the e-learning methods that were used within the Dedalos project for the teaching of English (as a second language) to deaf and hearing impaired people through the use of Sign Language. Firstly, special educational e-content was developed using modern digital and animation technologies, which was divided into educational levels in accordance to the special needs of the deaf and hearing impaired students. In addition, this special educational content was embedded in a newly developed e-learning environment aiming at the distance training of the aforementioned target group. Apart from the educational material, special evaluation tests were embedded in the e-learning environment towards the assessment and evaluation of the skills of the students. Finally, an intelligent taxonomy system was used for setting the e-content to the right level as well as for the realization of the evaluation process. The procedure can be used in tertiary education.

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INTRODUCTION

Despite the rapid evolution of ICT services and products, only a small percentage of these are used in linguistic training and even a smaller percentage of ICT services and facilities are used to support the linguistic training of disabled students and especially of the deaf students and the students with hearing disabilities (Drigas, Kouremenos, & Vrettaros, 2008).

Unfortunately, until quite recently, the majority of the ICT services targeted the common citizens and users and excluded people with disabilities and other sensitive community groups. This fact provokes and creates the phenomenon that is commonly known as "digital divide", or in other words, the exact opposite of e-inclusion, which is supported internationally by several policies, organized actions and also by projects such as the Dedalos project (UNESCO, 2002).

The promotion of the English language as a second language for Deaf and hearing impaired people whose first language is the sign language is the main objective of the Dedalos project. For this, special pedagogic methodology of distant linguistic training was designed and used as well as innovative educational e-content, suitably adapted to this special group of people. The whole process includes audits and evaluation of the linguistic skills of the e-students. The educational e-content has been designed to be divided into different levels according to the knowledge of the student. The system has been designed to evaluate the student and set the pedagogic material at the corresponding level using an intelligent taxonomy system. Particular emphasis was given to the quality and innovation of the educational material of self-paced learning where new animation and digital video technologies were extensively used into the Sign Language of each participating partner-country (Tavangarian et al., 2004; Rosenberg, 2000; Lewis, 2003; Drigas & Koukianakis, 2006).

Finally, the promotion of equality of the deaf and hearing impaired people through their participation in the European Community was another important element of the project. Nowadays, the English Language as a second language constitutes an important resource and asset in the professional field, for all individuals. It is a common ascertainment that the deaf and hearing impaired people face adaptation problems in their social activities, especially in the European countries, where English is used as the main communication language. The ICT sector uses mainly the English language and the vast majority of information on the Internet is in English, while the terminology used in the economy and e-commerce sector demands the effective mastery of the English language.

THE CHARACTERISTICS OF GSL (GREEK SIGN LANGUAGE)

The Greek Sign Language (GSL) is a natural visual language used by the members of the Greek Deaf Community, which counts several thousands of native and non-native signers (Antzakas & Woll, 2002; Lampropoulou, 1992). It is used widely in the Greek deaf community and the estimation for GSL users is about 40,600 (1986 surveys of Gallaudet University). There is also a large number of hearing non-native signers of GSL, mainly students of GSL and families of deaf people (Lampropoulou, 1997; Bellugi & Fischer, 1972). The recent increase of mainstreamed deaf students in education, as well as the population of deaf students scattered in other institutions, minor town units for the deaf and private tuition may well double the total number of secondary and potential Sign language users (Kyle & Woll, 1985; Efthimiou & Katsoyannou, 2001). Official settings where GSL is being used include eleven deaf clubs in Greek urban centers and a total of

fourteen deaf primary, secondary and tertiary educational settings (Logiadis & Logiadis, 1992; Brien & Brennan, 1993; Wilcox et al., 1994).

PRESENTATION OF THE 'DEDALOS' PROJECT

The basic objective of the 'Dedalos' project is to support the equal rights of deaf people for their access and real participation in professional training (Phipps, Sutherland & Seale, 2002). Moreover, the main aim of the project is the promotion of the English language as a second language for the deaf and hearing impaired individuals through distant linguistic training using innovative educational material (e-content) suitably adapted to the needs of this special group of people. In the present Leonardo Da Vinci 'Dedalos' project the following steps were followed:

1. Development of an e-learning environment for the deaf and hearing impaired people, adapted to their special needs via their sign language. The environment has been designed and is based on the use of the advanced teleconference services of the Internet (network virtual classrooms) and offers a number of facilities and services that support education and training via an easy and user-friendly way, in the form of lifelong and continuous education and training for the deaf people.
2. Design and development of electronic informative and adaptive material (e-content) for the deaf and hearing impaired people on the Web. This informative material includes text and video (multimedia) and aims at the teaching of the English language. The material has been designed to be translated in its entirety in the sign language via streaming digital video according to the e-content specifications of the A.I.C.C.
3. Design and use of innovative e-learning methods for the Linguistic Training of self-paced learning. Processes of synchronous learning and collaborative methods of asynchronous self-paced learning were used (Moore, 1989; Moore & Kearsley, 2011; Naeve et al., 2006; Lytras, 2007; Lytras & Sicilia, 2005).
4. Design and operation of an application for lifelong and distance training of the English language. In this application, all the aforementioned actions and developments were designed and coordinated so that the desired outcome of training is available to the deaf community for application and evaluation that will lead to the final improvements of the central as well as of the subsidiary design and developments. Taking into account the circumstances in Greece, deaf people do not have the proportional financial resources in order to be equipped with suitable material and technical systems for the use of e-learning. This being the case, the project aims at the creation of centers of distance training into the deaf / hard of hearing associations so that through the proportional material – technical equipment and parallel training of the teachers of deaf people, the services of the new Information Society will be provided to the deaf and hearing impaired people.

AN E-LEARNING PLATFORM FOR THE DEAF AND HEARING IMPAIRED INDIVIDUALS

The E-Learning Platform

The 'Dedalos' environment has been designed using asynchronous services for the delivery of the educational material as well as modern and asynchronous services of communication and

collaboration, trying to exceed the exclusions that are related with the time and the place of training but also to satisfy the needs of deaf and hearing impaired students with a variety of possibilities of equipment and communication.

Furthermore, the model of the visual classroom has been designed using videoconference services through images, at the same time with the possibility of realization of cooperative real-time activities (whiteboard, application sharing, file sharing).

Apart from the designed visual classroom model, the model of supported self learning is also in use. A basic rule that should condition the systems of tele-education for self learning is the control. This means that the educated person is simultaneously able to use the course but is also able to intervene in the flow and its structure. In this designed model the strategy is learner centered.

The designed services that are provided by the environment are categorized into three fundamental axes:

- **Visual Order:** Line of courses in real time with the possibility of interaction through the Internet.
- **Self-Instruction:** Access (search and recuperation) to training and informative material for various cognitive and more general subjects that interest teachers.
- **Cooperative Learning:** Communication and attendance in thematic circles of discussions and development of cooperative activities.
- **Files:** You can upload files to the server. Students do not have access to these files unless you link them to another part of the site (more on that later). A file can be text documents, sound files, spreadsheets, and more.
- **Grades:** There is the ability of grades of tests, quizzes and projects that students have done.
- **Questionnaire:** The Questionnaire module allows users to complete online feedback style forms using a variety of user input methods.
- **Scorm/AICC:** The Scorm activity allows you to include a Scorm lesson in e-learning platform. Scorm is a common system for putting together online learning experiences, and there are many packages that can export activities in a Scorm format.
- **Survey:** You can add pre-built surveys to the class. These are typically used for online, distance learning courses.
- **Wiki:** You can add a Wiki to you class. A wiki is similar to a blog (Web log or journal), except everyone can contribute, edit, comment, etc. In general, wiki posts are not approved by a central administrator, so the content can be built very quickly (don't worry – the teacher can always edit any wiki page!).
- **RSS Feeds:** The e-learning platform supports outgoing (out of Moodle) RSS feeds. This option needs to be enabled by your administrator. Once enabled, RSS is available in the Forum and Glossary modules. RSS is a technology where visitors to your site can choose to have the site send new postings to an RSS aggregator (a collector). RSS allows a user to build a custom news service. When users "subscribe" to your RSS-enabled page, they will get new postings from forums and/or new entries in glossaries without having to visit the e-learning site every day. The end user does need a way to collect the news-feed, called an aggregator. Some aggregators

can be found at: http://www.bloglines.com/ (Web based), http://www.fastbuzz.com/main.jsp (Web based), or you can put RSS into a search engine to find more. Fortunately, MOST of the current browsers (Firefox, Safari, Netscape Navigator, Internet Explorer) allow RSS feeds to appear directly in the browser.

The E-Content

The purpose of the discussed special e-learning environment could be summarized as teaching – tutoring deaf students in order to meet the ESOL level 1 and level 2 standards (developed by the Department for Education and Skills [DfES] and the Basic Skills Agency [BSA]). One could figure out that each of these two levels consists of the same five sections namely A, B, C, D, and E. Their semantic differential is located on the language skills acquisition each level defines as necessary and appropriate.

An abstract e-learning schema of the final system is the following: The learning process consists of three phases. Each individual deaf student must successfully complete each phase in order to proceed to the next. Also, a fundamental assumption is that there exists a (logical - obvious) priority list containing all sections in a certain ascending order.

Section Priority List:

1. Letter recognition and alphabetical order
2. Spelling - vocabulary
3. Grammar - sentence structure
4. Reading
5. Writing

The e-learning process is presented in length in the next paragraphs. Moreover, some key issues are being analyzed.

Phase 1: Acquiring the necessary language skills for each individual section. Per section questions or questionnaires are interchanged with corresponding instruction/lesson sessions. This process ends only after the deaf individual completes all sections successfully. In case an accurate assessment (according to statistical thresholds) of the student's language level cannot be reached, more questions are employed.

Phase 2: Acquiring language skills relevant to each section and to the section(s) lying above it. The deaf student is provided with questions relevant to a certain section and simultaneously relevant to all the corresponding prerequisite sections (of the section under consideration). Two issues are of vital importance; answers could be simultaneously right according to some sections and wrong according to others and also the part of an answer relating to a specific section could be partially right. Moreover, the question itself exhibits different, in general, degree of relevance/weight with respect to each individual section.

Phase 3: Overall verification - evaluation of the student's exact language level. Questions at this phase are more complex combining various arbitrary sections, which are chosen randomly instead of being selected in some formal way (for instance by depending on a priority table). Although these questions differ from the questions of Phase 2, their construction and internal structure is similar.

Adaptive Fuzzy Subsystem for Assessing the Learning Procedure

The fuzzy inference system is a popular computing framework based on the concepts of fuzzy set theory, fuzzy if then rules and fuzzy reasoning. It has found successful applications in a wide variety of fields. Because of its multidisciplinary nature, the fuzzy inference system is known by numerous other names, such as fuzzy-rule-based system, fuzzy expert system, fuzzy model, fuzzy associative memory and simply fuzzy system.

The basic structure of a fuzzy inference system consists of three conceptual components: a rule base, which contains a selection of fuzzy rules; a database (or dictionary), which defines the membership functions used in the fuzzy rules; and a reasoning mechanism, which performs the inference procedure upon the rules and given facts to derive a reasonable output or conclusion.

The target system under consideration is the language skill evaluation - assessment expert subsystem of the e-learning environment. The fuzzy system is then expected to be able to reproduce the behavior of the target system.

Literally, the designed expert system, which is part of the general e-learning environment, demonstrates functionality equivalent to adaptive fuzzy inference systems. Correspondingly, the proposed architecture - model is referred to as AFELS, which stands for Adaptive Fuzzy E-Learning Subsystem.

DESCRIPTION OF AFELS

Overview

Dedalos learners undertake a mini-test at the end of each module to assess their understanding of the learning points covered. The results of these tests are passed to the DEDALOS SYSTEM and subsequently to tutors via expert system, AFELS (Adaptive Fuzzy E-Learning Subsystem).

Each mini-test comprises a series of multiple choice questions and each answer option selected provides AFELS with two types of data; test data and training data. Pedagogical experts have assigned educational values to the test and training data which, in turn, allows AFELS to assess the learner understanding of the module.

The rest of this section describes these two data types and how values are assigned to them.

Purpose and Transmission of Test Data

Test data assesses how relevant a question is against one the following areas of learning:

- Letter recognition and alphabetical order
- Spelling/vocabulary
- Grammar/sentence structure
- Reading
- Writing

Test data also evaluates the answer options against the five areas of learning and specifies whether the answer is correct, partially correct or incorrect.

Once the learner has completed the mini-test, test data is silently sent to the DEDALOS SYSTEM by http for subsequent use by the tutor via AFELS.

Assignment of Test Data

First, each question is assigned a relevance value of between 0 and 4 by a pedagogical expert. For example, the question, “Which sign is in capital letters?” mainly tests the learner’s skills in section A so receives a relevance value of 4 here. It is also about an underpinning reading skill at a low level so is given a relevance value of 1 in section D. It does not test spelling/vocabulary, grammar/sentence structure or writing at all so these sections receive a relevance value of 0 (see Table 1).

Second, each answer option is assigned evaluation values. Evaluation values are also set against the five learning areas. However, the mini-tests comprise two types of multiple choice ques-

Table 1. Relevance value

Section Code	Section Name	Relevance Value
A	Letter recognition and alphabetical order	4
B	Spelling/vocabulary	0
C	Grammar/sentence structure	0
D	Reading	1
E	Writing	0

tions, single select and multi select. While the principle behind the assignment of evaluation values remains the same, a different form of the data set is sent to AFELS for each question type.

In single select questions there is only one correct answer. For example in the question "Which sign is in capital letters?" option 2 is the only correct answer and the evaluation values are assigned as shown in Table 2.

Hence,

- Is assigned to cell 2A because the answer option is correct and the question is relevant to area A - Letter recognition and alphabetical order.
- Is assigned to cell 2D because the answer option is correct and the question is relevant to area D - Reading
- 0.3 is assigned to cell 4A because the answer option 'Staff Only' is partially correct as it contains two capital letters and the question is relevant to area A
- 0.3 is assigned to cell 4D because the answer option 'Staff Only' is partially correct as it contains two capital letters and the question is relevant to area D
- 0 is assigned where an answer option was wrong but the question is relevant to the learning area
- -1 is assigned where an answer option was wrong and the question is not relevant to the learning area

In this example of a single select question where the learner selects option 2, the following string is sent to AFELS: [1.0,4,-1,0,-1,0,1.0,1,-1,0]

In multiple select questions there can be two or more correct answers. For example, in the question "Which of these are capital letters?" there are three correct answers (options 2, 3, and 6) and the evaluation values are assigned as shown in Table 3.

The question is primarily devised to test the learner's knowledge of area A - Letter recognition and alphabetical order and to a lesser extent knowledge of area D - Reading.

The following values are assigned to the correct answer options (2, 3 and 6):

- **Section A:** 1.0 – because the answer is correct and the question is relevant to this area.
- **Section D:** 1.0 – because the answer is correct and the question is relevant to this area.
- **Sections B, C and E:** -1 because the question is not relevant to these areas.

Table 2. Evaluation values

Answer Code	Answer Options	Correct/ Incorrect	Evaluation Values				
			A	B	C	D	E
1	open	Incorrect	0	-1	-1	0	-1
2	NO ENTRY	Correct	1.0	-1	-1	1.0	-1
3	closed	Incorrect	0	-1	-1	0	-1
4	Staff Only	Incorrect	0.3	-1	-1	0.3	-1

Table 3. Evaluation values

Answer Code	Answer Options	Correct/Incorrect	Evaluation Values				
			A	B	C	D	E
1	v	Incorrect	0	-1	-1	0	-1
2	G	Correct	1.0	-1	-1	1.0	-1
3	C	Correct	1.0	-1	-1	1.0	-1
4	p	Incorrect	0	-1	-1	0	-1
5	h	Incorrect	0	-1	-1	0	-1
6	B	Correct	1.0	-1	-1	1.0	-1

If we assume the learner selects options 1, 2 and 3 but the correct answer is option 2, 3 and 6. The following string is sent to AFELS:

[4,0,0,1,0][0,1,1,0, 0,1][1,1,1,0,0,0][0,-1,-1,0,-1][1,-1,-1,1,-1][1,-1,-1,1,-1[0,-1,-1,0,-1][0,-1,-1,0,-1][1,-1,-1,1,-1]

where the first set of values within square brackets is the question's relevance (blue), the second set of values is the correct answer (green), the third set of values is the learner's answer (red) and the following six sets of values are the six answer options' evaluation values (black).

Purpose and Transmission of Training Data

It is considered by pedagogical experts that a learner who selects one combination of answers could show more or less understanding than a learner who selects another. Training data values are assigned to specific combinations of answer options.

Training data values are assigned in advance and passed to the AFELS system manager to be input directly onto the expert system before training begins.

Assignment of Training Data

Evaluation values and training data values are the same for single select questions as there is only one correct answer option. However, in multi select questions evaluation values and training data values may differ. In multi select questions more than one answer is required in order to be completely correct. The learner may still demonstrate partial understanding by selecting say two out of three correct answers.

In this example, "Which three adjectives can you use to describe a car?" the training data values are assigned to five answer option combinations. A, B, C, D and E refer to the learning areas while OS is an overall skill value and represents the pedagogical expert's view of the learners overall language skills based on the combination of answers selected (see Table 4).

Even though combinations 2, 3, and 4 are not completely correct, the pedagogical expert considered that they demonstrated an understanding of the question and assigned positive values to them. If the learner selects any other combination, data values of 0 are assigned for areas that are relevant to the question and -1 for areas that are not. 0 is assigned as an overall skill value.

Table 4. Which three adjectives can you use to describe a car?

Answer Option Combination Code	Answer Option Combination	A	B	C	D	E	OS
1	New (correct) Smart (correct) Small (correct)	-1	1	1	1	-1	1
2	New (correct) Young (incorrect) Smart (correct)	-1	0.6	0.6	0.6	-1	0.6
3	New (correct) Smart (correct) Happy (incorrect)	-1	0.6	0.6	0.6	-1	0.6
4	New (correct) Young (incorrect) Small (correct)	-1	0.6	0.6	0.6	-1	0.6
5	All others combinations	0	-1	-1	0	-1	0

CONCLUSION

The implementation of an intelligent system for the evaluation of deaf students is in the immediate future work plans, in the framework of this project.

The final system uses modern techniques of neural networks and fuzzy logic. This system classifies the student in knowledge levels, which also determines the final structure of the educational material. More analytically, it is a system of measurement of the level of acquisition of knowledge and skills of the student for the duration of the training process.

The official approach becomes with the use of a short test in each unit. However, it is known that the process of learning is figured with various students behaviors that depend on the experience, the background, and the particularities of the student. The approach that will be developed is the classification of various behaviors through unclear (fuzzy) proposals and their connection through fuzzy rules, which will be used by an experienced system. The experienced system will choose the most suitable strategy for each student. All the processes will become through the follow-up of a hypertext environment through which we can represent the behavior of the student and which constitutes the condition in order to have the possibility of fuzzy inference.

The main limitations of the study are divided into linguistic, educational and technical limitations. Most of the limitations are typical in video streaming projects, and were expected before the beginning of the project. From a linguistic and educational point of view, the major issues that need to be addressed are the following:

In some areas of the language there are no standardized signs, so there may be some theoretical objections as to the use of particular entries. However, a platform such as the one described in this article allows multiple translations but also has some limitations as to the size of the files since these files have to be published in the form of streaming video through the Web. A second problem is the ability to make changes in the database of video files.

The data available in GSL, for example when compared with data in Greek, are dauntingly scarce. Error correction mechanisms were sought after, in order to assure reliability of results. Such back-up mechanisms are the use of approved dictionaries, the consulting of the Pedagogical

Institute and the feedback from the deaf community along with the continuing data from GSL linguistic research.

Lastly, all schools in Greece have access to the Internet, deaf settings included. In practice however, there are many more accessibility barriers for a considerable number of deaf students who have additional special needs. Relevant provisions have been made according to general accessibility principles for these students (as to text size, keyboard settings etc) but the pilot implementation of the project after six months has indicated more points for development.

Technical problems include the following:

A qualitative videoconference sign language communication is highly expensive in terms of bandwidth. Especially in the case of multipoint continuous presence communication the demand of bandwidth is multiplied according to the number of the conferring signers. Under these circumstances, DSL links of at least 384Kbps are considered as the minimal requirement for a Sign Language Virtual Classroom.

Given that the platform under discussion consists of an original research object, successful completion of its development has opened the way to a complete support system for the education of the deaf community members in Greece.

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