

Applying a Methodology for Educating Students with Special Needs: A Case Study

J. L. Fuertes¹, Á. L. González¹, G. Mariscal², C. Ruiz²

¹ Facultad de Informática, Universidad Politécnica de Madrid

Campus de Montegancedo. 28660 - Boadilla del Monte, Madrid – Spain

² SETIAM – CETTICO, Campus de Montegancedo. 28660 - Boadilla del Monte, Madrid – Spain

¹{jfuertes,agonzalez}@fi.upm.es

²{gmariscal, cruz}@cettico.fi.upm.es

Abstract- The introduction of innovative educational technologies opens up new ways of interacting with students. We propose to exploit this potential to help in the education of children with special needs. We analyze the state of the art of tools supporting the teaching process, focusing on the omissions of existing research. We propose a new framework to help throughout the whole teaching process and describe its application to *Proyecto Aprender (Learn Project)*, an educational resource targeting children with learning difficulties. Finally, we outline some conclusions and current/future research lines.

I. INTRODUCTION

Teaching pupils with SEN (Special Educational Needs) is a complex task. It involves implementing a teaching process and providing access to materials suited to pupils' skills. This depends on each individual's educational needs. For each pupil, this entails establishing a special-purpose and individualized programme of competencies selected from the standard curriculum. This is called curriculum modification. Additionally, pupils need to be given tools and materials that satisfy their needs.

Curriculum modification does not focus exclusively on learning objectives and contents. It also sets out all the access alterations required for curriculum development, like the environmental, material and personal conditions that improve the teaching process. We refer to such alterations (environment accessibility, materials, methodology, assessment, etc.) as "accessibility measures", and they also need to be considered as part of the teaching/learning process to be amended. Additionally, remember that this modified curriculum is sometimes far removed from the standard curriculum. It is a statement of the minimum abilities and skills that a pupil should/can acquire, with the necessary assistance, to be able to lead an autonomous life.

Curriculum modification, and consequently the education of people with SEN, clearly involves many elements from the physical and social context. The integration of this context information would give educators of SEN pupils a reference for designing curriculum modifications and provide intelligent systems with a source of reasoning, explanation and decision making for curriculum design. These ideas have led to partial solutions in this field like [1, 2].

Digital media are a very useful tool for teachers to exploit in the classroom to educate SEN pupils. They offer multiple representations and manners of interacting with the content. However, there are few tools today that take into account all the factors involved in curriculum modification. Therefore, many educators have elected to amend their own materials, whereas others have even carried on teaching without accessible materials. This is an outmoded and costly situation in which educational communities grow based on individual knowledge rather than collective and collaborative experience [3].

We believe that the best way of tackling and overcoming the numerous weaknesses present in SEN pupils' educational process is to take into account all the factors involved in the education of these pupils and the interrelations between all the elements.

In this scenario, there are, from our experience-based viewpoint [1, 2, 4, 5, 6], two major problems:

- *Provide educators with tools* for (1) guiding them through curriculum modification, (2) selecting which materials to use, (3) choosing which assistive technologies (hardware and software) to employ and (4) deciding how to go about teaching depending on the pupil's characteristics and the skills and the knowledge to be learnt.
- *Provide software developers with a methodology* to develop materials, tools and multimedia applications to improve the skills and knowledge of the SEN community.

The first point targets educators and will consist of a knowledge-based system that will provide recommendations and guidance for successfully undertaking the learning process with the pupil. The second point obliges us to formulate a special-purpose methodology to achieve, through the use of ICT, an overall and comprehensive improvement of the entire educational process for pupils with SEN. This methodology will cover all the necessary steps from curriculum modification to the generation of ICT tools to support curriculum development in the classroom.

In this article, we will give an overview of the elements that are relevant for curriculum modification. This way, we will be able to develop modified resources that have a good chance of being successful. In conclusion, we will explain the results of applying our development philosophy and how to use the acquired knowledge to build an expert system designed to make recommendations for educators.

II. RELATED WORK

Some solutions, ranging from curriculum modification to accessible hardware and software tools selection, have been developed to support the teaching process. Up to now though, all of these approaches are partial solutions. None of them connect the whole process or share knowledge from one step to the next. They deal with one or more (but not all) steps of the teaching process. All of these tools work independently. This is the main problem facing education for people with SEN.

A. Curriculum Modification

Curriculum modification is a key requirement for people with SEN to be able to access education. For instance, changes in how the higher education curriculum is designed in the United Kingdom are discussed in [7]. Several research institutions and groups have worked on the "Teachability project", a guide for academics specifying what aspects should be amended to get an accessible curriculum for students with disabilities that meets their learning needs.

B. Educator Support Tools

Proaci [8] and ALBOR [1] are prominent software tools related to this subject matter. Proaci is a computer program aimed at helping teachers to design individual curriculum modifications and generate the necessary documentation (recording an argued proposal by the pupil's tutor, proceedings of the meeting to decide whether or not a curriculum modification should be devised, the pupil's level of curriculum competency, amended attainment targets, amended assessment criteria, sequencing of amended contents and proposed activities).

ALBOR (Barrier-Free Computer Access) is an intelligent system that searches for assistive technology solutions to give disabled people access to computers. Not only can it be used to evaluate how a SEN pupil's physical, hearing, visual and cognitive abilities can affect computer use, but it also weighs up and suggests which of the many assistive technologies are the best option taking into account the pupil's computer access abilities.

III. ICT-BASED FRAMEWORK APPROACH FOR IMPROVING THE EDUCATION OF PUPILS WITH SEN

Ordinary curricula, materials and methods are evidently not directly applicable for teaching pupils with SEN. To be able to teach SEN pupils, educators will need a curriculum modification, an amendment of the methodology to be applied and an alteration of the materials to be used for teaching. Teachers need help to decide on all the questions related to this process and assure that the pupil's educational process is all-inclusive.

To achieve this goal, we think that educators should have the support of a toolkit. The input for these tools would be a curriculum, a SEN taxonomy, a qualified assistive technologies database, and expert knowledge about teaching

SEN pupils and expert knowledge about adapting ICT to jobs. As a result, the educators will be supplied with a better teaching methodology, complementary classroom activities and so on (see Fig.1).

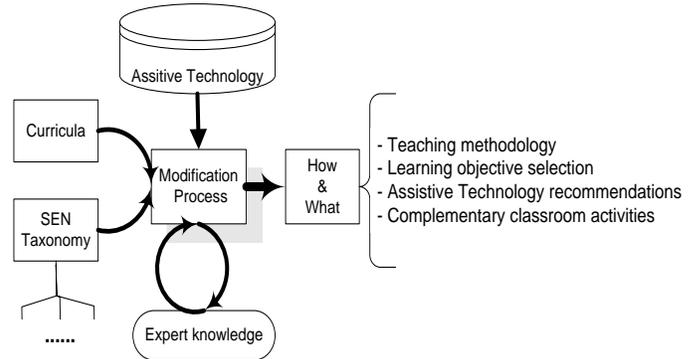


Fig. 1. Adapting the teaching process

To begin with we have to identify all the elements that are involved in the process (see Fig. 2). The conjunction of all these elements defines a philosophy and/or methodology for devising and modifying individual teaching for pupils with SEN. In the following, we outline the teaching process based on these elements.

First of all, we have to modify the curriculum. This is when the learning objectives and methodology best suited for achieving the stated objectives need to be selected. If the selected methodology uses ICT for development, it will also be necessary to select the application or applications enabling the pupil to use ICT. This modification of the teaching/learning process should be carried out for each pupil individually and for all the process situations (specific activities, educational levels, etc.). Remember that the cornerstone of our approach is the actual pupil and the skills to be developed.

To be able to establish the criteria for selecting and combining each element involved in teaching, it is necessary to establish a taxonomy to classify and correlate the different types of educational needs. In the following sections, we describe each module in detail and then propose a taxonomy of SEN types.

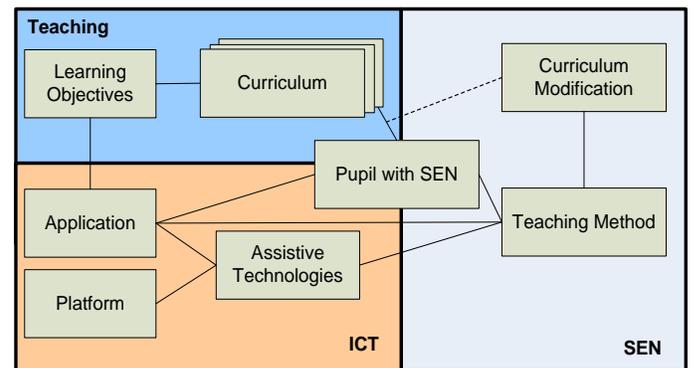


Fig. 2. Elements involved in the teaching process of SEN pupils using ICT

A. Pupils with Special Educational Needs

Pupils with SEN are defined as pupils that require, during a period of or throughout their entire schooling and particularly as regards assessment, some specific educational support and assistance because they have physical, mental or sensory disabilities or severe personality or behavioural disorders. The education system will provide the resources required for pupils with temporary or permanent special educational needs to attain the targets established generally for all pupils.

A method is a set of logically coordinated times and techniques that target pupil learning towards certain objectives. The method is what unites all the teaching and learning steps, essentially as regards the presentation and the preparation of the subject matter. Methods and techniques aim to make learning management more efficient. Thanks to them, pupils can more easily build upon knowledge, acquire the skills and internalize the ideals and attitudes that schools aim to transmit to their pupils.

The methods for pupils with SEN and learning using ICT are delimited, specifically defined and substantially conditioned in both directions.

B. Teaching

After selecting the characteristics of a specific SEN community, we must modify the curriculum and learning objectives. We must also determine what learning objectives can or cannot be aimed at depending on each pupil's (dis)abilities. To do this, it is important to establish relations between specific needs and modifications to these needs by defining a SEN taxonomy. The proposed SEN taxonomy is described later.

Curriculum: A curriculum is a structured programme of subject contents. It is an ordered series of learning objectives that are to be attained. The curriculum prescribes (or at least anticipates) the outcome of instruction. We will need to define different ways of structuring a curriculum in order to ease selection and later modification depending on the pupil's characteristics. The most important point is to determine what can be taught, what cannot be taught and what can be taught with curriculum modifications depending on the characteristics of each individual pupil. This decision will be founded on the SEN taxonomy and expert knowledge.

Learning objectives: Learning objectives are separate, self-contained, reusable parts of content for instructional purposes. These blocks are fitted together to build an adequate teaching process.

C. ICT (Information and Communications Technologies)

ICT are what will implement and instrument the teaching method defined for the learning objectives required to achieve the selected targets in the programme of study. The incorporation of ICT will provide a set of applications that will serve as tools to support learning. The pupil will require assistive technologies (AT) to be able to use these applications properly. The application-assistive technologies mix will only be available on a particular set of platforms. Therefore, a

process needs to be set up for selecting the best assistive technologies for each particular situation.

Assistive technologies: To be able to use ICT as a teaching aid, pupil-system interaction will need to be altered. This modification will depend on the pupil's abilities, the platform's possibilities and the defined teaching methodology. Assistive technology refers to all those technological elements that aim to improve the abilities of people whose performance is, for any reason whatsoever, below average for the population of the same age and sex as a whole. Within the framework of ICT use by pupils with SEN, these assistive technologies are defined as tools that enable and/or improve the use of ICT by pupils for the purpose of learning. They can be hardware or software technologies and be just as wide-ranging and diverse as applications and pupils' needs and levels are. The selection of the best technology calls for a thorough and complex decision-making process to assure proper and effective use by each pupil.

Application: An application or system will be devised for use as a tool to improve or ease the learning of one or more attainment targets associated with a curriculum [2]. These applications should have been developed in compliance with recognized accessibility and ergonomics standards [9]. This way, assistive technologies can be customized for an individual pupil.

Platform: The platform model describes all the computer systems that can run a user interface. The platform model contains information about the capabilities, constraints and limitations of the target platform [10]. When developing applications for disabled people, not only must the application be ISO/TS 16071 compliant [9], but it should also provide special-purpose interaction techniques in order to be better able to meet the needs of a specific group of people. For instance, children with cognitive problems or autism perform better using a conceptual keyboard. In this case, keyboard combinations need to be provided for every element of the user interface.

D. SEN (Special Educational Needs)

The curriculum will specify what to teach and what cannot be taught depending on the pupil's characteristics. It will also establish the prerequisites for embarking on certain learning objectives.

Curriculum modification: To be able to use a curriculum properly, it is necessary to establish "how" the "whats" defined in the curriculum are to be attained. This process is what is referred to as curriculum modification, and its goal is to define the best teaching method for a SEN pupil's innate characteristics.

Teaching method: It is not the aim of this paper to define the applicable teaching methods. Teaching methods are the different techniques that make up the resources required to conduct the teaching process in an ordered, methodical and adequate manner. These methods should be used to make learning more efficient. Therefore, their inclusion in the curriculum modification is a must.

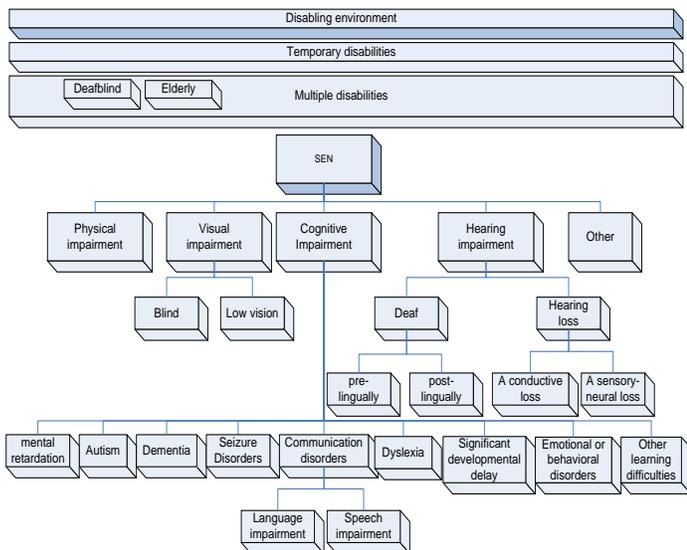


Fig. 3. Proposed SEN taxonomy

E. Taxonomy of SEN types

A number of authors [9, 11, 12] have classified the SEN that can influence a pupil's teaching and learning. We propose our own taxonomy (Fig. 3) based on the classifications put forward by the above authors and on our experience in developing tutoring software systems targeting people with SEN. Our aim is to cover all users with some disability and to neither over-generalize nor over-specialize by assuring that group members are similar enough as regards the curriculum modification that users require. The specific types of disabilities identified as relevant for building a curriculum modification are suspended from the SEN box. All user groups that have a combination of two or more disabilities (*multiple disabilities*) or do not have any specified disability (*temporary disabilities* and *disabling environment*) have been placed apart at the top of the figure.

IV. CASE STUDY

Based on the philosophy described in this paper, we have developed the *Proyecto Aprender* (Learn Project) [2, 13], an educational resource targeting children with learning difficulties. This case study was developed bearing in mind pupils' needs with a view to customizing the resource (see Fig. 4). Also, a methodology for creating multimedia resources was defined and applied to the project. This project was developed for the Spanish Ministry of Education. It involved developing an accessible online resource targeting children with special educational needs. It includes an alternative curriculum modified to meet learners' needs.

The overall objective is to build up and develop the physical, emotional, cognitive and communicational skills of learners with SEN, using new information and communications technologies to promote their personal autonomy and social integration to the greatest possible extent.

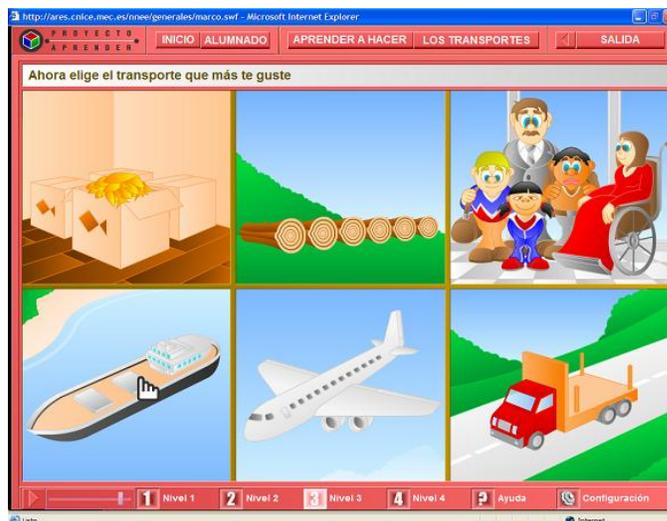


Fig. 4. Proyecto Aprender screenshot

To achieve the main objective, it is necessary to attain other general goals:

- 1) Introduce ICT at primary and secondary schools
- 2) Develop modified curriculums to meet pupils' needs
- 3) Create accessible web sites and software
- 4) Develop accessible contents
- 5) Develop materials to help teachers

Other specific objectives related to pupils' skills are:

- 1) To establish multimedia activities related to personal autonomy, everyday problem solving and decision making.
- 2) For pupils to learn to live in society through knowledge of the rules of cooperation and participation.
- 3) To develop understanding, knowledge, linguistic skills, memory, logical reasoning and everyday problem-solving.

A. Organization of Learning Objectives

The learning objectives are presented as metaphors (worlds, scenarios, characters, or objects) to make the contents more appealing.

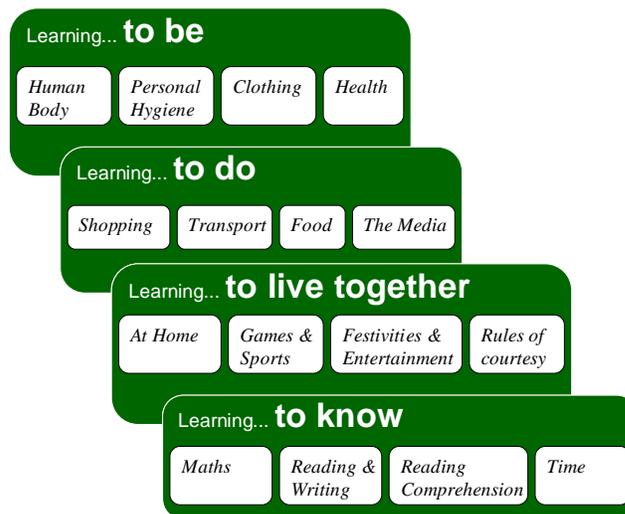


Fig. 5. Course Organization

Fig. 5 gives an outline of the contents. At the top, learning objectives are divided into four modules called learning worlds (Learning to be, Learning to do, Learning to live together and Learning to know). Each world is divided into four scenarios. Each scenario is a learning unit.

Learning worlds have the following contents:

1) *Learning to be*: This module develops personal skills, such as dealing with feelings and tension [14]. Scenarios are presented as different interesting places visited in daily life. The scenarios and skills developed in this module are: the Human Body (Evolutionary changes, Self-esteem), Personal Hygiene (Routines, see Fig. 2), Clothing (Tidiness, Proper use), and Health (Illness, Healthy habits).

2) *Learning to do*: This module develops practical skills in which pupils apply their knowledge to interact with the environment and acquire new competencies [14]. The scenarios and skills developed in this module are: Shopping and Money (Handling money), Transport, Food (Healthy diet, Preparing simple meals), and The media (Press, Television, Computers).

3) *Learning to live together*: This module develops interpersonal skills, pointing out students' ability to interact and work in groups. These lessons also develop empathy, courtesy, friendship, cooperation and teamwork. The scenarios and skills developed in this module are: At home (Housework), Games and sports (Leisure), Festivities and entertainment (Leisure), and Rules of courtesy.

4) *Learning to know*: This module develops cognitive skills, such as decision making and problem solving [14]. The contents built into these scenarios are: Maths, Reading/Writing, Reading Comprehension, and Time.

B. Curriculum Competency Levels

Learning objects are grouped into modified levels of curriculum competency. Four levels of learning have been established:

1) *Level 1 (Stimulation)*. Stimulation mainly focuses on people with severe mental disorders. The activities will involve animation-clicking on some element-answer of the animation. The task will be to recognize or identify a visual and sound stimulus, simply press the mouse or switch button and watch how the exercise is completed automatically...

2) *Level 2 (Lexicon or vocabulary acquisition)*. The pupil will be required to perform a simple activity to acquire vocabulary.

3) *Level 3 (Broad contents)*. Pupils will be required to perform an activity.

4) *Level 4 (Higher level activities)*. This level focuses on the development of reading and writing skills or the completion of an activity where the pupil must demonstrate that he or she has acquired the skills practised in earlier activities.

C. Accessibility and Tailoring

The project was implemented as a website and a multimedia application that complies with conformance level Double A of the Web Content Accessibility Guidelines (WCAG 1.0) [15],

as well as the accessibility for human-computer interfaces standard (ISO/TS 16071:2002) [9].

The pupils section includes a multimedia application embedded in a web page, where pupils access different multimedia activities organized by learning objects: skills, levels of difficulty and real-life situations.

The specific accessibility-related components developed for this project are described below:

1) *Captioning bar* (for deaf students with learning difficulties). This is a text area located in the upper part of the user interface, just above the activity area. It provides the subtitles for the audio, and several captioning features can be configured.

2) *Manual and automatic scanning* (for students with motor problems). The system moves across objects, and users use a keyboard, mouse, switch or other device to select one object. There are two scanning operating modes: automatic (works to a user-configured time) and manual (using a mouse or a switch with a button to scan and another to select objects).

3) *An audio system* (for blind students with learning difficulties). This system is used to reproduce audio describing the scene, audio explaining the activity and the background sounds in a scene.

4) *Alternative descriptive texts* (for blind people). It consists of introducing alternative descriptive texts associated with objects and activities. This will encourage the use of tools like screen readers.

5) *Contextual help* gives a clue to help complete the current activity.

6) *Configuration of accessibility options* makes it possible to configure the application to meet the pupils' needs, taking into account the abilities and disabilities of a particular pupil.

Finally, special care is taken over the presentation of the content. We have adhered to pedagogical guidelines, apart from the above-mentioned accessibility standards. With regard to text format, for example, capital letters were used at early learning levels and language was adapted for each level. With respect to illustrations, contrasting colour, style guidelines and contrasting lines were used.

V. CONCLUSIONS

Educating people with SEN is a complex task even for experts and educators. Each pupil's education should be individualized depending on his or her characteristics and abilities. This would enable a more effective use of platforms and software tools built for educating people with SEN. Unfortunately, none of the earlier proposals connect the whole teaching process or share knowledge from one step to the next.

In this article we have identified the elements and relations that denote the educational needs of SEN pupils. The philosophy and ideas described here are based on previous research [1, 4] and have been applied to develop several projects aimed at educating people with SEN, *Proyecto Aprender* [2, 13] and its continuation *Internet in the Classroom* [16, 17]. As part of these projects we are creating a

formal methodology for developing accessible applications that materialize the ideas defined in this paper. A model like this would give research institutions and groups a common framework covering all the elements and relations between them that are part of the context information for educating people with SEN.

REFERENCES

- [1] F. Alonso, S. Frutos, J. L. Fuertes, Á. L. Martínez, and C. Montes, "ALBOR. An internet-based advisory KBS with a multi-agent architecture". International Conference on Advances in Infrastructure for Electronic Business, Science, and Education on the Internet, 2001, pp. 1-6
- [2] P. Cantón, A. L. González, G. Mariscal, and C. Ruiz, "Developing pedagogical multimedia resources targeting children with special educational needs". 10th International Conference on Computers Helping People with Special Needs (ICCHP 2006). Springer-Verlag, LNCS 4061, pp. 536-543
- [3] S. Stahl, "A discussion of accessible curriculum materials". Wakefield, MA: National Center on Accessing the General Curriculum. Retrieved September 2007 from http://www.cast.org/publications/ncac/ncac_policy.html
- [4] F. Alonso, A. de Antonio, J. L. Fuertes, and C. Montes, "MEHIDA: An Intelligent Multimedia Tutoring System for the Hearing-Impaired". Proceedings of the SPIE Multimedia Computing and Networking, volume: 2417, 1995, pp. 24-34
- [5] S. Frutos, Á. L. González, A. Santos, and J. I. Varela, "Sistema de Acceso al Lenguaje Escrito (ALES)". Congreso Iberoamericano Iberdiscap, 2000, pp. 25-28
- [6] J. L. Fuertes, Á. L. González, G. Mariscal, and C. Ruiz. "Herramientas de Apoyo a la Educación de Personas Sordas en la Universidad Española". Jornadas de Enseñanza Universitaria de la Informática 2005. Universidad Europea de Madrid, 2007
- [7] L. Stefani, "The difficulties of defining development: A case study". International Journal for Academic Development. Routledge, part of the Taylor & Francis Group. Volume 7, Number 1 / 2002. pp. 41-50
- [8] Proaci, "Programa para Adaptaciones Curriculares Individuales (PROACI). Iniciativa de los centros de Profesorado de la Provincia de Sevilla", Consejería de Educación y Ciencia. Retrieved December 2006 from <http://www.juntadeandalucia.es/averroes/cepsevilla/novedades/proaci.htm>
- [9] ISO (International Organization for Standardization), "ISO/TS 16071:2002(E) Ergonomics of human-system interaction — Guidance on accessibility for human-computer interfaces", 2002
- [10] G. Menkhaus, S. Fischmeister, "Dialog Model Clustering for User Interface Adaptation". 3rd International Conference on Web Engineering, Oviedo, Spain, 2003
- [11] R. Jackson, "Curriculum Access for Students with Low-Incidence Disabilities: The Promise of Universal Design for Learning". Wakefield, MA: National Center on Accessing the General Curriculum, 2005. Retrieved January 2007 from http://www.cast.org/publications/ncac/ncac_lowinc.html
- [12] Tiresias.org, "Guidelines for the Design of Accessible Information and Communication Technology, Systems", 2006. Retrieved January 2007 from <http://www.tiresias.org/guidelines/index.htm>
- [13] Ministerio de Educación y Ciencia. "Proyecto Aprender". Retrieved November 2007 from <http://ares.cnice.mec.es/nnee>
- [14] United Nations Educational, Scientific and Cultural Organization (UNESCO), "¿A qué 'destrezas' alude este enfoque?". Retrieved September 2007 from http://portal.unesco.org/education/es/ev.php-URL_ID=36637&URL_DO=DO_TOPIC&URL_SECTION=201.html
- [15] W3C. "Evaluating Web Sites for Accessibility: Overview", March, 2006. Retrieved November 2007 from <http://www.w3.org/WAI/eval/Overview.html>
- [16] M. Gértrudix, M. C. Gálvez, S. Álvarez, and A Galisteo, "Design and Development of Digital Educational Content Institutional proposals and actions", Computers and Education, Springer Netherlands, 2007, pp. 67-76
- [17] UPM. Internet in the Classroom. Beta Version. Retrieved November 2007 from <http://tellina.cettico.fi.upm.es/nee>