

“NET4VOICE - NEW TECHNOLOGIES FOR VOICE-CONVERTING IN BARRIER-FREE LEARNING ENVIRONMENTS”: DEVELOPMENT OF INNOVATIVE LEARNING METHODOLOGIES, EXPERIMENT AND RESULTS

E. Luppi, R. Primiani, C. Raffaelli, D. Tibaldi, A.M. Violi ¹

Alma Mater Studiorum Università di Bologna
Bologna/Italy

*elena.luppi@unibo.it, raffaella.primiani@unibo.it, carla.raffaelli@unibo.it, daniela.tibaldi@unibo.it,
anna.violi@unibo.it*

Abstract

This contribution is aimed to present the general aims and structure of the 'Net4Voice' European project, involving three Universities (Alma Mater Studiorum, Università di Bologna, Italy; University of Southampton, Great Britain; Universität Ulm, Germany) and two high schools (Istituto Professionale di Stato per i Servizi Sociali "Iris Versari", Italy; Totton College, Great Britain). The final aim of this project is to increase the quality of learning opportunities promoting the adoption of barrier-free learning environments and the development of innovative learning methodologies which utilise speech recognition technologies. Speech-recognition technology can automatically transform a lecturer's speech into digital text in real-time, by generating an electronic transcription of the lesson, or conference material, to be printed or delivered through different devices and channels.

Students with different kinds of auditory or motor disabilities can particularly benefit from the use of speech recognition technologies, which can give access to synchronized speech-recognised text, allowing disabled students to follow lessons in an accessible learning environment without additional intermediary support and without losing lesson content. Also, second language learners, and all students in general, can take advantage of these technologies which enable them to exploit the available multimedia transcriptions a second time, after the lesson, by reading and listening to the lesson content again. This happens because, after the lesson, the software saves the speech recognition generated transcript, audio, and PowerPoint slides as streaming media file. This allows students to select lecture information that suits their individual learning preferences

In particular, Net4Voice aims at defining a clear scheme to assess the impact of speech recognition technologies in education, by experimenting it in at least three different learning contexts: university, school and adult education classrooms. Secondly, it evaluates the impact on key actors involved, such as students and teachers, by particularly focusing on learning settings addressed to people with particular needs.

Net4Voice recognises that education in traditional classrooms is still the most pervasive way to support learning. Nevertheless, there are needs related to accessibility and effectiveness of learning that are not properly satisfied in the traditional classroom.

The experimentation aims to evaluate: software accuracy in speech recognition in relation to the environment and the trial duration, the student's viewpoint, the usability of aside products like transcription of the speech, open points.

At the same time, describing and comparing the six different learning situations, the teachers and lecturers involved are stimulated to develop a learning methodology like a guideline supported by Pedagogical assumption. This Learning Methodology should offer a pedagogical support system in order to use technology at its best, exploiting all its potential, adapting it to students' conditions and needs and combining software with personal teaching experience and methods.

Information and Communication Technology can be an effective means to improve the quality of educational processes in terms of accessibility and effectiveness. The adoption of a universally accessible learning methodology will help to promote a better quality of education for the whole community.

Keywords

Learning methodology, education, innovation, technology, speech recognition, accessibility

¹ Part 1 authors: R. Primiani, D. Tibaldi; part 2 authors: R. Primiani, D. Tibaldi; part 3 author: Elena Luppi; part 4 author C. Raffaelli, part. 5 author A. M. Violi.

1. INTRODUCTION

Speech-recognition technology can automatically convert speech, such as a school lecture or a talk, into a digital text in real time. It generates an electronic transcription of the speech which can then be printed or transferred to the user by means of specific devices. This technology will especially benefit students with different kinds of auditory or motor disabilities, who can thus have access to synchronized speech-recognised texts that allow them to follow the lecture in an accessible learning environment without additional intermediary support and without losing anything of what is being said. In addition to that, second language learners, and all students in general, can take advantage of these technologies which provide multimedia transcriptions and recordings that are still available after the lesson. In this way, the lecture can be read or listened to once again to make sure that the content has been fully understood. This is possible because once the lecture is over, the software saves the speech-recognition-generated transcript, audio, and PowerPoint slides as a streaming media file. This allows students to select the information from the lecture that best suits their individual needs or preferences.

In particular, Net4Voice aims at defining a clear scheme to assess the impact of speech-recognition technologies in education by experimenting it in at least three different learning contexts: university, school and adult education. Secondly, it also evaluates the impact on the key actors involved, students and teachers, by especially focusing on learning settings created for people with specific needs. Net4Voice assumes that education in traditional classrooms is still the most pervasive way to support learning, although it does not always properly satisfy certain needs related to accessibility and effectiveness of learning. The experiment is therefore aimed at evaluating: software accuracy in speech recognition in relation to the environment and the duration; the student's viewpoint; the usability of side-products such as transcriptions of the speech; open issues. At the same time, describing and comparing the six different learning situations, the teachers and lecturers involved are stimulated to develop a learning methodology such as a guideline supported by pedagogical assumptions. This Learning Methodology should offer a pedagogical support system in order to use technology at its best, exploiting all its potential, adapting it to students' conditions and needs, and combining software with personal teaching experience and methods.

Information and Communication Technology can be an effective means to improve the quality of educational processes in terms of accessibility and effectiveness. The adoption of a universally accessible learning methodology will help to promote a better quality of education for the whole community.

The paper is organized as follows: in section 2 the project is described in detail, along with its main software characteristics and requirements; in section 3 the learning methodology is presented and discussed; in section 4 some experiments are described; finally, in section 5 a numerical evaluation of some experiments is given.

2. DESCRIPTION OF THE PROJECT: AIMS AND REQUIREMENTS

Summary of the project

Three European Universities and two high schools are partners in the 'Net4Voice' project, which consists of testing voice recognition techniques and methods within a variety of learning contexts. Speech-recognition technology can automatically transform a lecturer's speech into digital text in real-time, by generating an electronic transcription of the lesson, or conference material, to be printed or delivered through different devices and channels. The need to support the learning process with non-traditional technologies derives from the fact that teaching material is not easily accessible to users with disabilities in different learning contexts. The exploitation of interactive technologies helps students to learn by doing, receiving feedback, and continually refining their understanding. This facilitates participation in lifelong learning by people with various needs.

Objectives

The project main goal is to create empirically based, optimal models enabling barrier-free access to information for people with disabilities in a variety of real world educational environments. The project

will build centres of excellence for the development and delivery of innovative learning and teaching process and methods within the European Community. The project strengthens the worldwide competitiveness of the European Community by incorporating principles of universal design and inclusive education.

The project will test various speech-recognition techniques and methods within various traditional and non-traditional learning contexts. Utilizing a collaborative action research framework, researchers will investigate how the impact of speech-recognition technologies differs across categories of disability, languages, and across educational contexts. The final aim of the project is to increase the quality of learning opportunities for the whole of society, promoting the adoption of barrier-free learning environments and the development of innovative learning methodologies which utilise speech-recognition technologies.

In particular, Net4Voice aims at defining a clear scheme to assess the impact of speech-recognition technologies in education, by experimenting with speech-recognition in at least three different learning contexts: university, school and adult education classrooms. Secondly, it evaluates the impact on the key actors involved, such as students and teachers, by particularly focusing on learning settings addressed to people with particular needs.

Concrete aims of the projects are:

- to develop a new learning methodology that experiments and evaluates the impact of speech-recognition technologies in at least three educational settings: School, Higher and Adult Education;

- to focus on different target user needs: people with disabilities, second languages learners, ...

- to evaluate the scalability of the speech-recognition based learning methodology and to define a strategy for transferring to other EU countries;

- to raise awareness and further in-depth knowledge about the impact of speech-recognition technologies in different educational settings.

Short-term expected outcomes are:

- To experience speech-recognition technology in a wide range of subjects, testing all the opportunities offered by this technology and the adoption of multi-channel learning methodologies;

- to produce a tested and validated learning methodology that can be shared with other educational Institutions in order to create a stable and broader network.

In the medium/long term, the project aims at supporting the development and dissemination of innovative and well-balanced ICT educational tools and the design of new standardised pedagogical documentation for the lifelong learning in a European educational setting.

Main activities

During the first year, the project has aimed at developing a new joint speech-recognition technology based learning methodology in order to increase the accessibility and effectiveness of learning at all of its stages.

Once the new learning methodology was defined and shared among partners, professors of the educational settings identified by partners were trained on the developed methodology.

During the second year of the project, testing the speech-recognition technology based methodology within the educational settings identified by partners will be the main activity.

Other important activities which will be carried on during all the project are:

- sharing and validation of the results of the experimentation;

- evaluation of the scalability of the testing results and planning of dissemination and exploitation activities

- dissemination of project results.

Beneficiaries

Certain individuals are clearly disadvantaged in traditional and non-traditional learning environments. Many individuals who are deaf or hearing-impaired cannot access spoken content without intermediary support. Some people with physical disabilities cannot take their own notes and some with various learning disabilities struggle with auditory, visual and haptic challenges. People without disabilities can also experience difficulties in accessing information under certain conditions (i.e. different language environments). Speech-recognition technology can potentially resolve or significantly affect a number of these educational accessibility challenges.

Students with different kinds of auditory or motor disabilities can particularly benefit from the use of speech-recognition technologies which can give access to synchronized speech-recognised text, allowing disabled students to follow lessons in an accessible learning environment without additional intermediary support and without losing lesson content.

Also, second language learners, and all students in general, can take advantage of these technologies which enable them to exploit the available multimedia transcriptions a second time, after the lesson, by reading and listening to the lesson content again – anywhere and whenever they wish. This happens because, after the lesson, the software saves the speech recognition generated transcript, audio, and PowerPoint slides as streaming media file. This allows students to select lecture information that suits their individual learning preferences. In addition to text transcripts, the software creates a series of files (SMIL, XML, WAV, RT, RTF) that can easily be published on the web, creating a rich set of teaching resources for all the students.

Moreover, Net4Voice supports teachers, professors and academic staff in taking a proactive, rather than a reactive, approach to teaching students with different learning styles. It provides educators with a practical means of making their teaching accessible, and improves the quality of teaching in the process.

ICT, accessibility and learning methodology

Net4Voice recognises that education in traditional classrooms is still the most pervasive way to support learning. Nevertheless, there are needs related to accessibility and effectiveness of learning that are not properly satisfied in the traditional classroom. In this regard, while extremely important and unique, traditional face to face (F2F) education presents constraints due to physical, temporal and cultural barriers that could hinder access to - and the effectiveness of - learning.

ICT can be an effective means to improve the quality of educational processes in term of accessibility and effectiveness. The adoption of a universally accessible learning methodology will help to promote a better quality of education for the whole community.

3. LEARNING METHODOLOGY

Defining a new learning methodology

At the end of the project, the partners involved are expected to have defined a common Learning Methodology that can be adopted within different educational levels and settings with various needs and constraints when using SR technology. The Learning Methodology is carried out, step by step, as a shared document, developed through contributions coming from all the partners.

The Learning Methodology activity is aimed at making the five professors able to share and transfer all the information about their own methodological choices or tools to other local institution professors. In order to lead the five partners toward the definition of a common and effective Learning Methodology, the following stages and goals have been planned:

- Analysing and comparing learning contexts of speech-recognition technology application;
- Describing each educational setting where the speech-recognition technology is/will be used;
- Describing the speech-recognition technology experimentation in the different educational activities;
- Analysing each learning approach to speech-recognition technology;
- Testing the speech-recognition technology based methodology;
- Sharing and validating the results of the experimentation;

Developing a joint speech-recognition technology based learning methodology, to increase the accessibility and the effectiveness of learning at all of its stages.

This list of actions corresponds to the expected activities of the project for defining the final Learning Methodology.

Describing and comparing six different learning situations (methods and tools)

The first activity of the Learning Methodology Work Package has focused on the comparative analysis of the educational settings features. This is fundamental in order to achieve a common knowledge of the similarities and differences that characterize the five partners, and makes the further exchanges significant and effective.

The professors involved have been guided through an analysis of their educational setting features. The model for comparison that has been proposed takes into account some of the main variables occurring in educational processes in order to make each description easier and more sharable.

The first variable taken into account is the Educational Context: School Education, Higher Education or Adult Education. Each partner has been asked to describe the main characteristics of his own situation. The second very important variable is the Learning Setting: we had to distinguish between three possible situations: distance learning, presence learning or a blended learning perspective. It was also fundamental to be clear about the characteristics of students and teachers, are they disabled or not? Are they foreign or not? This is something that can have a certain impact on the teaching and learning methodology when using SR technology. Furthermore, teachers and lecturers were asked to reflect on their own educational approach in order to distinguish and compare it to that of the others. We have proposed three kinds of educational perspective for comparison, and asked which, if any, they feel closer to.

Educational approach:

Reproduction learning perspective, based on comprehension, memorisation, focused on elementary learning objectives and using traditional teaching methods;

Construction learning perspective, based on construction-conceptualization, focused on intermediate learning objectives and using teaching methods based on problem solving, research methods, the use of tools, group work;

Creativity learning perspective, found on Learning processes based on discovery and learner autonomy, focused on higher learning objectives and preferring creative learning activities.

Each partner was asked to fill in a questionnaire with both closed and open questions, and to give a qualitative description of his/her own educational setting. The quantitative and qualitative data collected made it possible to describe the different learning contexts involved in the project.

The following table presents a summary of this first comparative analysis, highlighting the main characteristics of each learning situation. It was also used as a training tool in the first meeting of the project, to introduce the partners to the characteristics of each learning context and to reflect on the differences or common aspects as elements for comparison and starting points for sharing activities.

	Educational context School Education (SE) Higher Education (HI) Adult Education (AE)	Learning setting Distance learning (DL) Presence learning (PL) Blended perspective (BP)	Students' characteristics Disabled (D) Not disabled (ND) Foreign (F) Not foreign (NF)	Teachers' characteristics Disabled (D) Not disabled (ND)	Educational approach Reproduction perspective (REP) Construction perspective (CON) Creativity perspective (CRE)
learning situation no. 1	SE	PL	D – ND – F- NF	ND	REP - CON
learning situation	HI	BP	D – ND – F- NF	ND	CON - CRE

no. 2					
learning situation no. 3	AE	BP	D – ND – F- NF	?	REP – CON - CRE
.....					

(Table 1. Comparative analysis tool)

Other data was collected in order to have a clear view of the sample features: the course subject, the number of hours, the setting (classroom, laboratory,..), the social learning organization (individual or group learning), the use of tools (blackboard, slides, PowerPoint, etc...), the assessment methods/ tools, etc.

Sample general features

According to the data collected from each partner, we can give a description of the main features of the learning contexts where the SR technology is tested. The three school, university and adult education learning situations are represented in the sample. The classes where the SR technology is tested are, for all partners, mixed classes with both disabled and not-disabled students as well as foreign and not-foreign students. All the teachers and lecturers involved tend to use the three educational approaches hypothesised (reproduction, construction, creativity) according to the educational goals and the different teaching and learning stages. They all tend to use a blended educational perspective and many teaching methods based on face-to-face teaching, as well as interaction, communication and cooperation. Several tools are used in the experimental classes: PowerPoint slides, videos, blackboard, internet.

Considering the differences between the net4voice partners, we have to underline firstly the students' age: the learner sample goes from adolescence to adulthood. This means a group of people with very different characteristics and learning needs. This data is very important to avoid superficial comparison or the simple transfer of methods and tools from one class to another without considering the age variable. Another difference between the learning situations is course duration: it varies from 10 to 60 hours or more. This means very different timetables and time management for each one when organising teaching methods and tools, and needs to be taken into account when defining the common learning methodology. The last significant difference between the partners' learning situations is represented by assessment strategies, tools and methods. This differs greatly from one context to another, and needs to be analysed and compared very carefully. The comparative analysis should distinguish many aspects of the evaluation process: the assessment indicators, the assessment tools, the measurement process, the assessment scale, the evaluation. We also need to compare some important evaluation moments and aims: initial, formative and summative. This analytical approach to evaluation goals, moments, strategies and tools make the comparison between very different learning contexts feasible.

Possible problems or risks in the educational setting

The general data collected from each partner gives us a description of the main educational features of our sample. Analysing this information in relation to previous SR experimentations and to the scientific literature on this subject, we can try to make some hypotheses about the possible common problems or risks that can occur in the different educational settings. In the methodological approach that has been proposed to the partners, these problems are not considered as constraints but rather as challenges for our educational strategies. This view tries to improve the Learning Methodology through problem solving. Teachers and lecturers need to be aware of the possible risks of SR technology in order to try also to identify some solutions.

The hypothetical difficulties that have been highlighted can be divided in four groups: technological performance problems, environmental factors, problems related to students' characteristics, and interaction or communication problems.

Technological performance problems

The first, and maybe most restricting, problem in the use of SR technology in a classroom is the

lack of accuracy that, of course, interferes with digitized lectures and produces errors that have been seen to be very distracting elements during speech.

Environmental factors issues

We know from previous studies (Kalyuga S. 2000) carried out into SR technology that the use of it provokes a redundancy of information: the same information is, in fact, given in an oral and in a written form at the same time. This means that students are required to manage more than one cognitive process at the same time. The possible consequences of this, in particular when students are not used to attending lessons with SR technology, are an overload of short-term or working memory, as an individual problem, and distraction in the classroom as a group difficulty.

Problems related to students' characteristics

When using a very particular tool such as SR in a classroom, we need to be aware that it cannot always be compatible with individual learning styles. Each student is different from the others when learning, and it has been shown in testing this technology that not all students might benefit from digitized lectures (Leitch D., MacMillan T. 2002).

Interaction and communication problems

Analysing the setting characteristics of a SR classroom, we cannot ignore the fact that the use of this tool, very much centred on teacher speech, risks the limitation of dialogue in the classroom. In fact, it is very difficult for the SR technology to involve any interaction between teacher and students.

This list of possible problems or risks has been presented to the partners as a starting point for discussing what can be done for getting through, and to start working on the better educational strategies for SR technology.

Pedagogical assumptions and support system

The problem analysis in the use of SR technology highlights the necessity to give an educational intentionality to this particular tool. Students with disabilities in particular and also students in general need to be accompanied through a learning process using SR technology. This is why we believe it is important to create and implement a pedagogical support system, or teaching and learning methodology. This is fundamental in order to use technology at its best, exploiting all its potential. According to SR technology characteristics and to the learning contexts where it can be applied we have tried to define some educational assumptions starting through which a common learning methodology can be defined.

Beyond the traditional metaphor of Communication

The first important educational point to take into account when using SR technology in a classroom is the idea of communication behind. Traditionally, communication is considered as a channel which links the transmitter to the receiver. This idea considers the receiver as passive and doesn't attribute students with an active role in learning. On the contrary, we know that learning is significant when the students don't simply receive the message but elaborate, manipulate and gain it. We cannot consider educational communication as a one-way channel but rather as an action of giving-delivering and receiving-taking. Teacher and students are both active subjects in communication (Baldacci M. 2004).

Individualisation – personalisation

It is very important to plan and organize teaching and learning activities in order to find a good balance between the students' needs for individualisation and personalisation. We need to enable each student to achieve the necessary skills that guarantee his/her right to equal treatment as well as his/her right to meet and develop his/her personal needs and attitudes. When we focus on individualisation or personalisation, we make very different educational choices in terms of goals, methods, learning strategies and evaluation tools. It is very important to be very clear on this when planning educational activities, in order to give to students both the opportunity, for every topic, to reach the fundamentals and to deepen personal interests and views thereabout.

Improve students' empowerment and participation

When introducing new technologies and methodologies in a classroom, we often risk encountering resistance from students. This is why it is very important to improve students' participation in the educational processes and choices and to work on student empowerment as

a strategy for making students more and more active in learning activities. We need to stimulate both self and social empowerment in order to involve students and to make them as aware and active as possible when using SR technology.

Disabled students as differently able learners

SR technology is first of all a barrier-free technology focused on the needs of disabled students. In this view, it is not enough to simply apply the technology, it is fundamental to work towards the integration of disabled students. It is possible to involve the group as a tutorial tool, promoting mutual support and preferring cooperative learning strategies.

This list of assumptions is not definitive, but needs to be discussed and implemented by each partner throughout the experimentation in order to build a common pedagogical framework as a basis for the learning methodology.

Educational strategies proposal

According to the pedagogical assumptions listed above, the final Learning Methodology should provide each partner with practical strategies and tools for using SR technology at their best, solving problems and exploiting all the educational potentials. We know, for instance, that introducing SR technology in a classroom, students might initially be intimidated, sceptical or unwilling to use the technology itself. Our educational experience and assumptions can help us to avoid this risk, for example by trying to promote student empowerment, involving them in the project by making aims and steps clear and shared.

Concerning planning, it is important to underline that the use of SR technology requires that teachers do it very much in detail, focusing on how they are communicating. It is also a very good opportunity to reflect on their own teaching style and self-assess it. At the same time it is also very important, even when we follow an accurate programme, to be open to “unexpected” events. This is called serendipity: the ability to find what we wasn't looking for.

Setting is another very important point to be careful about in order to find the best strategies to overcome SR difficulties. We can imagine, for example, that due to the fact that not all students may benefit from digitized lectures, the classroom setting should be adjusted so that the screen can be placed more or less centrally for different learners, according to their needs and preferences.

Considering communication, it is clear that students' interaction risks being constrained by SR technology. It is not always possible to repeat every student's intervention, nor is it always effective. In order to solve this problem, teaching methods can be organized with the planning of specific activities for interaction, mediated by written texts that can be read by the teacher (e.g. discussion in small groups, each of which will produce a final written report or written brainstorming).

In the choice of teaching tools, it could be useful to use pictures rather than written texts while speaking, as a possible way of reducing the risk of making information redundant. Furthermore, this would involve different cognitive channels.

Concerning assessment, it is very important to apply both formative and final assessment in order to evaluate learning processes and products in order to adjust teaching strategies to students' characteristics. Many tools and assessment methods can be used to assess the effectiveness of SR technology (observation -check lists, interviews, satisfaction questionnaires, tests, etc.)

When thinking about SR technology from the educational point of view, we can try to consider its utility in learning processes; for example digitized lectures should be transformed in educational tools and be used as:

- recovery tools of previous lectures or classes,

- reading comprehension exercises (compensating for information that has been missed, giving the text to students and asking them to correct it);

- note-taking exercises: comparing students' notes with the text of the whole lecture, improving notes, learning note-taking strategies;

- material for producing conceptual maps or reorganising the lecture.

The educational strategies that have been presented represent some possibilities for exploiting SR technology, and make it as effective as possible for every learning context. Many other solutions, and techniques can be found, and it is very important for teachers to look continuously for them. When using technology for educational purposes, we need to consider technology itself as an educational tool, an active approach to SR technology is needed in order to adapt it to students' conditions and needs and combine it with personal teaching experience and methods.

4. EXPERIMENT DESCRIPTION

The experiment consists of a cycle with three main phases:

- Registration during lectures based on power point slides
- Off -line correction of transcription and generation of the updated voice profile
- Upload of the new profile

The equipment used during lectures consists of a lap top PC and a wireless microphone; it can be set up at the beginning of each lecture module with very little interference with the lecture itself.

The projection of the transcription is not shown to students during this software learning period because it contains words which are often out of context.

Aims of the experiment

The experiment is aimed to evaluate:

- software accuracy in speech recognition in relation to the environment and the trial duration
- student's viewpoint
- usability of by-products like transcription of the speech
- open points

At this time the software is not used as a real time text display.

Accuracy results

Speech transcription was edited after each lecture to update the speech profile of the speaker. The accuracy was shown to be strongly dependent on the kind of speaker. It was noticed how slow speaking and well-articulated words can significantly influence the quality of the results. In any case, we think that, especially in the presence of disable or foreign students, the teacher should pay attention to this issue.

Influence of the environment

One of the main external factors which is expected to influence the accuracy of the process is represented by the situation offered by the room where the lesson takes place. In practice, the room can change from lesson to lesson and the environmental background noise is expected to play a role in the speech recognition process. An experiment was set up to assess the influence of background noise, by obtaining some registrations in a small room without people with minimal environmental noise. The preliminary results show that the improvement in speech recognition by the software can be quite significantly improved.

Student's viewpoints

Students are not really users during this trial. In any case, the reaction was however extremely positive, and they showed interest also in the possibility to use the speech transcription as lecture notes. In fact, the transcriptions contain both the recognized speech and the image of the slide to which the speech refers. This product can be useful also in the case, such as this, in which speech recognition is around 80%. It can help as a quite complete complement to student's notes.

Open points

This trial has outlined the ease of the methodology and its potential in supporting real-time text display of the speech. At the same time, it has been very useful for highlighting some open points to improve the effectiveness of the applied software.

First of all, the achievable accuracy greatly depends on the speaker. Should the speaker change, the lecture cannot be given with the same methodology.

In relation to low accuracy, words are proposed out of the lecture context. It could be useful if the original set of words could be changed in order to avoid words that the speaker does not use in the lecture context.

The maximum accuracy of recognition seems to be only slightly affected by the environment, if the microphone is correctly used.

The software must be trained for a long period before a good level of accuracy is reached, in order to assure the projection of subtitles during lessons.

The software training consists of the correction of transcription mistakes, and this activity requires a lot of time (an average of 8 hours for 1 hour's registration), especially at the beginning of the training when the accuracy is still very low.

Finally, it is necessary to improve the accessibility of files created after the lesson by the speech recognition technology in order to make them useful also for students who use particular instruments while surfing the web.

5. RESULTS

Analysis of quantitative results obtained from the first experimentation carried out with two teachers

Number of recorded lessons	6
Number of recorded lesson hours	11.92
Number of corrected hours	3.35
% corrected hours over the total	28%
Initial accuracy (% correct words)	40.91%
Final accuracy (% correct words)	80.05%
Improvement of accuracy	95.67%

(Table 2. Teacher 1 experiment results)

Number of recorded lessons	2
Number of recorded lesson hours	2.2
Number of corrected hours	0.81
% corrected hours over the total	37%
Initial accuracy (% correct words)	26.13%
Final accuracy (% correct words)	34.99%
Improvement of accuracy	33.91%

(Table 3. Teacher 2 experiment results)

References

- [1] Baldacci M. *I modelli della didattica*, Carocci, Rome, 2004.
- [2] Calvani A. *Elementi di didattica*, Carocci, Rome, 2000.
- [3] Guerra L. Elaborazione didattica di Learning Objects, *Ricerche di Pedagogia e Didattica (RPD) rivista dell'Alma Mater Studiorum-Università di Bologna* no.1, 2006.
- [4] Genovese L., *Insegnare e apprendere. Temi e problemi della didattica*, Rome, Monolite, 2006.
- [5] Hede A.. "Student reaction to speech recognition technology in lectures" in S. McNamara and E. Stacey (Eds), *Untangling the Web: Establishing Learning Links*. Proceedings ASET Conference. Melbourne, July 2002.
- [6] Kalyuga S. When using sound with a text or picture is not beneficial for learning *Australian Journal of Educational Technology*, 2000, 16(2), 161-172.
- [7] Leitch D., MacMillan T., Year III Final Research Report on the Liberated Learning Project "How Students With Disabilities Respond to Speech Recognition Technology in the University Classroom", July 2002 [PDF].

- [8] Leitch D., MacMillan T., Year IV Research Report on the Liberated Learning Initiative, "Innovative Technology and Inclusion: Current Issues and Future Directions for Liberated Learning Research", 2003 [PDF].
- [9] Wald M., "Creating Accessible Educational Multimedia through Editing Automatic Speech Recognition Captioning in Real Time". *International Journal of Interactive Technology and Smart Education: Smarter Use of Technology in Education* 3(2) pp. 131-142, 2006.