Design of a Web System of Learning Evaluation of Students with Visual Disability by Voice Recognition

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Abstract. In the actuality, exists a variety of applications of the information and communication technologies for the educational ambit. Nevertheless, is required to attend students with special educative necessities. The objective is to present the design, development and implementation of a web system as an inclusive tool for people with visual disability to support the learning evaluation in courses of high education, achieving a digital transformation of the educative processes and services for in the education 4.0. The methodology utilized was the inclusive design centered in the user and the implementation uses PHP, MySQL, JavaScript, voice libraries. The tests of functionality and usability were realized in a focal group of students with visual disability.

Keywords: Inclusive education · Accessibility · Evaluation · Interfaces

1 Introduction

The education in Mexico requires attending the students with different capabilities, which entails to generate inclusive educative systems. The current programs must be inclusive guaranteeing that the students can have access to the obligated and superior education. The inclusive education should incorporate the students with different disabilities in the ordinary classrooms, which implies a permanent effort and the development of digital abilities in the use of new tools of the trend of the learning 4.0.

According to the results of the Census of Population and Housing realized by the National Institute of Statistic and Geography [1] Mexico has a population of 129,9 millions of people, of which 35.2 million are registered as students in basic schooled education, which represents 73.4% of the enrollment of educative system. In middle high education, is offered an educative service to 4.4 millions of young, and in high education are 3.3 millions of students, which means 29.2% of coverage, distributed in seven thousand schools in the whole country [1]. In agreement to the statistics published, the students in age to enter to middle high education, who obtain a place is 15% and for people with disability is reduced even more in 2%. Since despite the technological advances and the opening to the education continues existing the lack of

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inclusion to the people with disability without having the materials, technologies or instillations to support the admission exam to obtain a place in the schools.

According to UNESCO [2], in Mexico, the students with disability its access to the education is limited for diverse factors: the educative services are not relevant, due to its environment, which does not make easier the access, like is the transport or by factors of discrimination.

Since 2008, the inclusive education has formed part of the World Declaration of "Education for Everyone", as an alternative to transform the educative systems. In agreement with inclusive UNESCO [3], the inclusive education can be understand as: *The inclusive education can be conceived as a process that allows approaching and respond to the diversity of the necessities of all the learners through greater participation in the learning, the cultural and community activities and reduce the exclusion within and out of the educative system.*

In the 2014, the National Program for the Development and the Inclusion of the People with Disability 2014–2018 [4] one of its objective is to attend the necessity of "Strengthen the participation of the people with disability in the inclusive and especial education"*, and search to "Impulse inclusive educative politics to favor the access, permanence and egress of the people with disability in all the type, modalities and educative levels".*

For the students with disabilities, the use of digital technologies means principally two advantages: a major possibility of access to the information and the use of didactic resources to be able to support their learning [5]. Which implies, be able to generate materials, platforms, learning resources, strategies, educative process that can improve their academic life of the students.

The voice recognition is a technology that refers to the capacity to listen (input audio), is being incorporated like the ideal interface for the communication between people and the computer due to the naturalness of the communication that present the current systems of voice recognition. This voice recognition includes the steps: voice recordings, detection of word limit, extraction characteristics and recognition of knowledge models, like the acoustic model, language models, interpreter model, that help the recognition system and currently can support to people with some visual disability low or total and combine different technologies as are screen readers, platforms and browsers to ease the interaction and access to the information.

The purpose of this work is to present the design of a prototype to support the learning evaluation for students with visual disability using natural interfaces of voice recognition and the processing of natural language to ease the evaluation. The software EV@-INCLU allows to the user to interact through the voice commands in every section of the evaluation, realizing exercises and simulating diverse proves of evaluation, the system stores the results of the evaluation and generates an file of results in pdf format, which can be consulted later by the user and evaluator.

This paper is organized in the following form: in the Sect. 2 is presented the revision of work related to our research work. In the Sect. 3 is defined the methodology, the analysis and design of the prototype. In the Sect. 4 are showed the results of the pilot prove and the evaluation for the students with disabilities in the focal group through a qualitative methodological approach and the inspection and exploration technic. Finally, the results of the research, conclusions and future work are presented.

2 State of the Art

In this section, are presented the revision of some works that are found related with voice processing and natural interfaces of voice used to support people with disability in their daily life.

A system text-to-speech converts the language of normal text in speech; other systems recreate the linguistic symbolic representations as phonetic transcriptions in speech. The synthesis of text-to-speech (TTS) is the automatic conversion of a text to a native language. The TTS is a technology that allows use an algorithm that analyses, processes and synthesizes the text, generating sound data in an audio format as output. The quality of a voice synthesizer is judged by its similarity with the human voice and by its capacity of being understandable. An intelligible program of text to voice allows people with visual or reading disability to listen documents and be able to interact.

There are several available platforms that work in the voice recognition like Google, Facebook, Microsoft, being the tool HTK the most managed and effective to implement systems of voice recognition, based on the technic of hide models of Markov, developed in the University of Cambridge, UK [6] achieving the conversion of speech to text. Being this tool used in platforms UNIX, LINUX and Windows.

In [7] the investigation was focused in determine the effectiveness of the software to covert "speech-text". With the objective of realize the diagnosis and determine if the cognitive load for its training would decrease for the participants that were classified in three categorical disabilities that affect the reading and written expressions areas. For which was analyzed writing samples of the students with and without support of the software, verifying that the participants improve in relation to the ones who used the software. The software that was used were applications in platforms of iOS and Windows.

In [8] the presented work is focused to the use of TTS software to improve the reading abilities for students with difficulties of academic performance. The TTS software used for this studio was the Kurzweil 3000, which was designed as a countervailing tool for people with disabilities, included learning disabilities (LD), attention-deficit/hyperactivity (ADHD), reading difficulties and some physical disabilities, like the tetraplegia. The TTS software provides a synchronized visual and auditory presentation of text. Reproduce text through spoken words of electronic documents. Finally, the results demonstrated that the participants that used the TTS software had improved in the reading, the vocabulary and comprehension.

In the realized investigation in [9], designed a software for the conversion of text to voice for people with visual disabilities. The development of the synthesizer of text to voice in form of a simple application, converts the joined text in synthesized voice and later is read to the user, which can be kept as a mp3 file. Achieving to obtain a motor for the English idiom and later for the Nigerian.

Regarding the Natural User Interfaces (NUI), the researchers focuses in the creation and evaluation of gestures and natural actions realized for a multitouch interaction. In [9] affirm that the NUI, are considered new methods for the Human Computer Interaction (HCI) and the design of informative applications based on interfaces with which the interactions are realized from the natural actions of the human beings, that is to say,

that allow reconsider the existent abilities of the user. Whereby, are considered quite adaptable and accessible for the people with some disability. On the other hand, affirm that the characteristics of the NUI are centered in the user (necessities, wishes and limitations), multichannel (sensorial and motor abilities), extended, of great bandwidth, and of interaction based on voice (voice and communication processing), based on image (integrate images for the communication of the user), based on behavior (recognition of the human behavior and of the expressions) achieving to support the users in their necessities.

The Automatic Speech Recognition (ASR) [10] is the process of converting a signal of voice to a sequence of words by an algorithm, implemented as a computer program. The voice interfaces are mechanisms designed to allow the control of device or application by the verbal interaction. The voice recognition must comply these three tasks:

1. Processing: Convert the input of voice into a form that the recognizer can process, that is to say, convert the analog signal into a digital one.
2. Recognition: Identify what was said, realizing the translation.
3. Communication: Sends the recognition to the software of application.

Traditionally, the three main areas of work in the voice-processing field since the processing of the signals are codification, synthesis and recognition.

Which in [11] and [12] show that the synthesis of text to voice is computational technology of fast increase and perform a roll every time more important in the form that the users interact with the system and the interfaces achieve to integrate to a variety of platforms and adapt to the user necessities. The interactions of voice are a trend in the natural interfaces as are considered apt to improve the lives of the peoples with disabilities achieving to join text to documents, reading of books and realize activities of self-study [13].

3 Methodology

The methodology that was used was a qualitative approach, using the Centered Design in the Inclusive User (DCUI) and the model of prototypes, which is described in the analysis and design of the system.

3.1 Analysis and Design of the Prototype

The DCU inclusive use the usability criteria of heuristics [14] and in the lines of the Accessibility guide to the content in the Web. For which was applied the criteria of use of color, independence of the device, the navigation by voice and keyboard commands. In the same way, was realized a series of interviews and surveys with the focal group, achieving to identify the interaction necessities [15]. For the analysis and the design of the system were determined the cases of use and of sequence, such as is showed in Fig. 1. The system allows identifying two users for the access and manipulation of the system:

– Teacher User: Can realize general consults of the evaluation of the theme, generate exercises for the evaluation and review the exam.

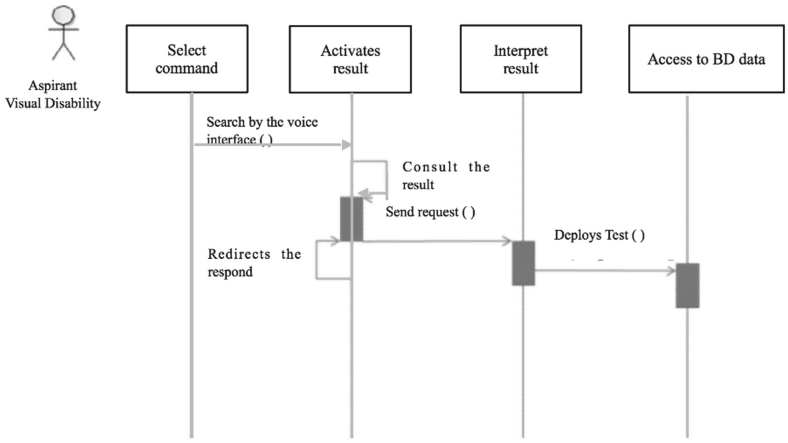

Fig. 1. Diagram of user interaction user with the software.

– Student User with low vision/blindness: choose time of evaluation for knowledge area and can realize series of exercises of a guide before applicate evaluation and finally it shows the summary of evaluation.

3.2 Architecture and Development of Prototype

The voice recognition, for prototype, is handled an extractor of characteristics and classifiers. When is received the signal of voice for the microphone, pass through a recognizer that gives as a result the word. After a processing of natural language, is realized a semantic representation and finally one action, been the process as is shown in the Fig. 2.

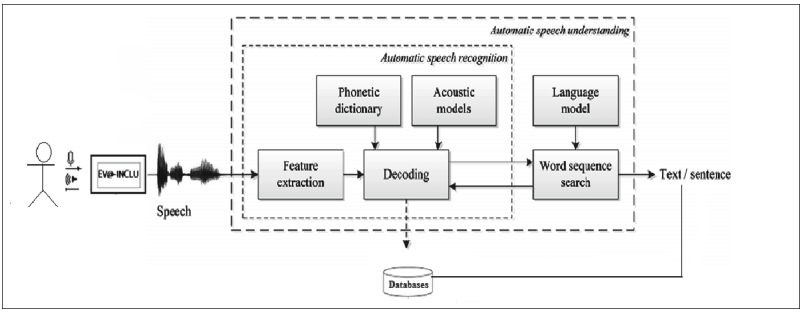

Fig. 2. Design speech recognition of system.

The interface through the device is in charge to send the user voice (the input) and later is in charge to process the voice and execute the corresponding function (voice processing) by one lambda function to interpret the voice commands of the user and convert them in actions that the API through the JavaScript libraries Artyom.js and

Annyang.js, both ease the use in HTML5 for the voice recognition, allowing that the user control and navigate in the web application through the instruction by voice in JavaScript.

The integration of speech technology into web system pages a client-server based architecture is applied. This allows implementing into web page with libraries of JavaScript that provides the speech services such as speech recognition, speaker verification and speech synthesis. Using these services voice control and speech output can be easily incorporated into existing web pages, the requirement on the client side is a JavaScript enabled browser and Java-Plugin, view in Fig. 3.

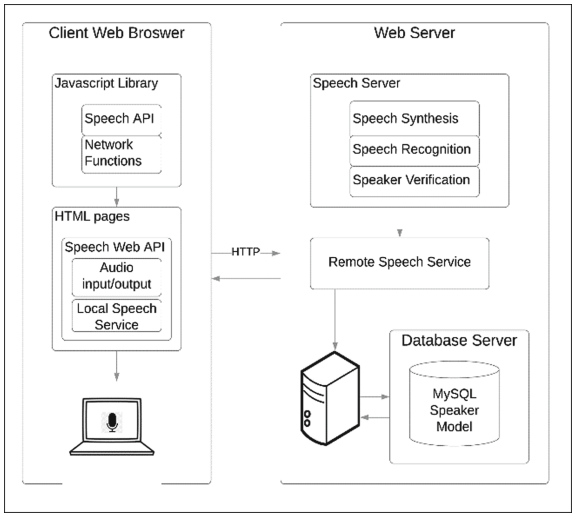

Fig. 3. Architecture of system.

The libraries implemented in the JavaScript language for the recognition and synthesis of voice Artyom.js and Annyang.js that is based in the "web-kit-speech-recognition". The first library has English and Spanish support and the other in various languages so that the voice recognition and use of the platform can realize in both languages.

For the implementation was used HTML5, CSS and JavaScript, acceding directly to the API of voice recognition with the libraries Artyom.js and Annayang.js. In the same way, is used the recognition of keyboard commands, so that the user can use some combinations of keys to access to the platform.

3.3 Design of the Database

The Fig. 4 shows the design of the database implemented in MYSQL to stock the information regarding the web system for the tracking of the evaluation, is of rational type and accomplish with the rules of normalization. The DBMS stocks the disability level and register the results of the evaluation of every proof that is applied, as well as the relation that has with every topic and block that allows giving an academic tracking to the student.

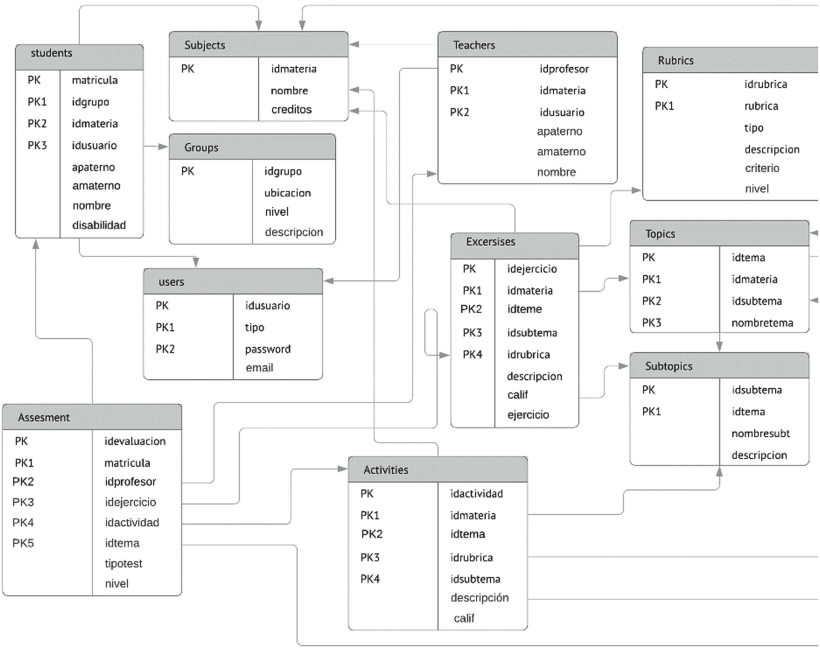

Fig. 4. Design of the database of system.

After the screen of login, the user has the possibility to navigate by the platform, either between sections for the evaluation exercises and application of test. The system realize by a screen reader, the tracking of the instructions in order that the student can interact with the evaluations and answer the questions with voice or keyboard selecting the correct answer as is observed in the Fig. 5.

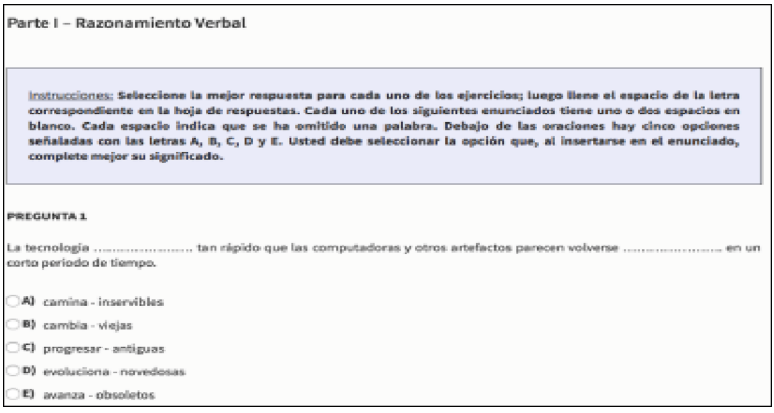

Fig. 5. Interaction with screen reader and user voice.

So too, for the tracking of the learning, is proportionated the results, are stocked and is generated a file in the pdf format, that afterwards the student or evaluator can consult, see Fig. 6.

Fig. 6. Results send to a pdf file.

4 Results

The web system of evaluation of the learning to support the students with visual disability, was realized a pilot test that was made with a focal group conformed by two students with visual disability, and one blind student, which have worked with screen readers, realized the exercises and the evaluation of verbal and mathematical reasoning learnings.

The size of the selected sample is small because the admission processes and conditions of the institution for students with visual impairment are very limited and exclusive. For this purpose, the technique of inspection and exploration was applied under three possible stages that are described below:

- Situation 1: To the user was given a brief explanation of the use of the system and was accompanied in the system in the navigation and execution of the evaluation.
- Situation 2: To the user was explained the use of the system and only was accompanied in the beginning of the evaluation.
- Situation 3: To the user was explained the use of the system and was not accompanied either the navigation or execution of activities.

The users should comply certain tasks to check the system functionality:

- Task 1: Access to the system registering the key and password, selecting the voice control and commands through the keyboard.
- Task 2: In the navigation menu, select the exercise or test options made up of the reading, writing, mathematics and English sections.
- Task 3: Travel the systems through the selected interaction of voice, commands and use of keys.
- Task 4: Consult the results of exercises and tests to generate the evaluation in a pdf file.

The obtained results of the inspection prove are presented in the Table 1. Which reflects that the users with a brief explication of the Situation 1 their development was of an 87.5% of the accomplishment of the tasks meanwhile that the users of the Situation 2 was 82.5% and for the Situation 3 achieved the tasks only in an 80.75%.

Table 1. Inspection tests of the development of users

Task	Situatión No. 1	Situatión No. 2	Situatión No. 3
Task 1	90%	85%	80%
Task 2	90%	80%	85%
Task 3	85%	85%	80%
Task 4	85%	80%	78%
Average	87.5%	82.5%	80.75%

This implies that the inclusive software supports the exercise for the preparation and simulation of evaluations as was the admission exam in a way that the voice interfaces ease the interaction with the software to the people with visual disability.

Wherefore, can be affirmed that the applicability of technology device is measured by its actual usage, ease in accessibility by its users and in their satisfaction in interaction with their environment. The users must participate directly in the design and development having present the following.

1. According to the necessities of the user and environment, achieving be helpful in different situations.
2. Accessible and easy to obtain cost-benefit to support students with visual disability.
3. Integrate the technologies to support a transformative education to generate the digital abilities in the students achieving an inclusive education.

Finally, was applied a survey of satisfaction, to value the software [16], which evaluates seven criteria: Navigation, Interactivity, Immersion, Usability, Creativity, Effectiveness and Quality, with a scale of 1 to 5.

Whose obtained average was of 4.6 (92%), what indicates that the satisfaction of the student was high to be able to develop their competences and a significant learning, due to the use of interfaces with voice as is showed in the following Fig. 7.

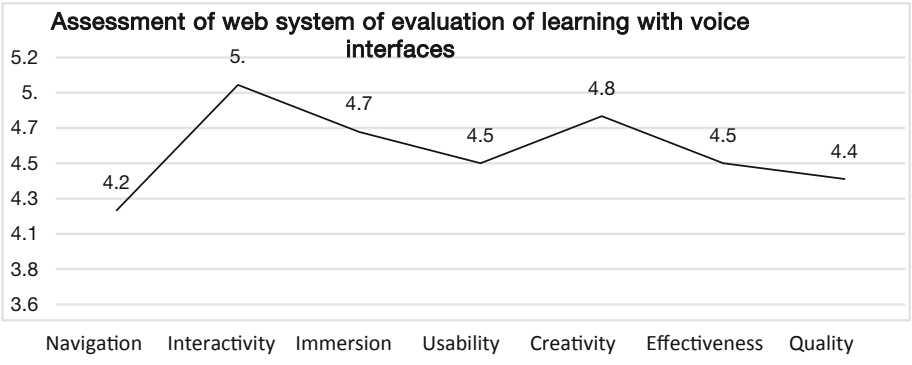

Fig. 7. Results of assessment of satisfaction of the software

This implies that the use of the voice interfaces should be considered for the design of the software for people with visual disabilities and to support the inclusive education and offer major accessibility to the people that have special necessities. The evaluation process of learning requires support of informative tools that achieve easily an evaluation according to the student and teacher profile can recommend actions and strategies to improve the level of performance of the student achieving an inclusive education.

5 Conclusion and Future Work

One of the principle contributions is the input of a software to support the preparation and realization of evaluations to students with visual disabilities achieving to integrate the technologies of voice processing and natural language processing to support the interaction with the student and the academic environment.

This research work, whose objective was to offer a tool to support the assessment of learning to motivate the students with visual disability to continue their studies and promote an evaluation according profile and disabilities of to the student.

Giving guideline to a new panorama in the inclusive education supported by the technologies of voice recognition, which offer assistance and interaction with the people with disability and allow reducing the digital gap.

As perspective of this work, is generate more reactives for the database that support to distinct evaluations for the middle high and high education. In such a way that can be constructed as an alternative to support the periodic and admission evaluations in the middle high and high education.

As well, as apply the usability tests and be able to extend the sample to other academic units and institutions.

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