TOWARDS AN INTELLIGENT TUTORING SYSTEM TO DOWN SYNDROME

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ABSTRACT

With the rapid and the fast development of artificial intelligence technology, intelligent tutoring Systems (ITSs) are becoming one of the most important area of research and development. Intelligent tutoring Systems have very good impact for making computer-based instruction more adaptive and interactive. Intelligent tutoring Systems are becoming important aspect of educational systems that makes use of adaptive technologies to bring in aspects of a human-teacher delivering personalized and customized tutoring to a student, into online computer-based learning environments.

Early Intervention Program (EIP) is very important to improve and enhance the overall development of children with Tiresome 21 (Down syndrome). Up till now, there is no ITS for Early Intervention for Down syndrome children. In order to help a child and parents in the implementation of Early Intervention Program, a proposed ITS framework has been developed. This ITS can help his/her parents assess and evaluate children's' skills in order to provide effective early intervention services to handicaps children according to their mental age and to evaluate their progress and learn.

This paper explore the construction requirements to build ITS for Down syndrome children, and the points that differ the ITS for Down syndrome from the traditional ITSs.

KEYWORDS

Intelligent tutoring Systems, Early Intervention Program, Down Syndrome.

1. INTRODUCTION

With the fast progress of computer technology, researchers have assayed to use artificial intelligence and computer networks to improve computer-aided instruction systems. Meanwhile, researchers have also attempted to develop more efficient and impressive programs to enhance the learning performance of students. However, customary systems for testing merely give students a score, and don't give them the occasion or a chance to learn how to improve and develop their learning performance. If the test results could be analyzed and advice could be advanced to students, they would benefit more. That's why the development of intelligent tutoring systems has become an important issue in both computer science and education [1].

Accommodating learning enables the learning process to take place at the time, place and pace which suits the learner's circumstances and needs. Learning with computers also helps students to be freer in their actions so that they do not feel the pressure to do well. They feel free to try stupid

actions, from which they can learn in a trial and error manner. A computer based system can help to learn student and test knowledge without being controlled by a teacher[2].

An intelligent tutoring system can be defined as educational software containing an artificial intelligence component. The software follow students' work path, customize feedback and hints along the way. The software can make conjecture about strengths and weaknesses of the student, and can suggest additional work by collecting information on a particular student's performance, [3].

Some studies over a long period have proved that ITS can be very effective for educational purposes if they are well designed. For example, the students using the LISP tutor completed programming exercises in 30% less time and scored 43% higher in the final exam than those who received traditional instruction in classrooms. Students spending 20 hours using an Air Force electronic troubleshooting tutoring system gained a proficiency-level equivalent to 48 months of training experience on the job. CAPIT has been quite successful in teaching school children of 10-11 years old the capitalization and punctuation rules of English grammar by providing selectively appropriate levels (brief to detail) of feedback when they make mistakes, based on their individual performance [2].

People with disabilities – mental, physical and social - often either cannot attend classes or would prefer not to be involved in human interaction, but are still motivated to learn[4]. Several studies in ITSs with disabled people have focused on dealing with physical disabilities (Visual, Hearing, etc). A number of ITSs have been developed with the intention of being used by people with hearing disabilities; they are oriented to train people by developing the necessary skills to overcome their disabilities [5].

In an early attempt, a model for early intervention's framework for disabled infants was introduced [6].

This paper will explore an ITS framework architecture for Down syndrome children providing them with early intervention services in order to enhance their mentality and increase their learning performance.

This paper is structured as follows: Section 2 is an overview of ITSs, section 3 is classification of ITSs, section 4 is about Down syndrome and early intervention, section 5 about the previous work of ITS to down syndrome, and finally section 6 about our proposed frame work for ITS to Down syndrome.

2. INTELLIGENT TUTORING SYSTEM OVERVIEW

In the early 1970s, there a new and ambitious goal for computer-based instruction has been defined. They picked the human tutor as their educational model and sought to apply artificial intelligence techniques to comprehend this model in intelligent computer- based instruction. The goal of intelligent tutoring systems (ITSs) would be to employ and occupy the students in accepted reasoning activity and to collaborate with the student based on a deep understanding of the student's behaviour. If these systems realize even half the impact of human tutors, the payoff for society guarantee to be influential [7].

ITSs are computer-based learning systems which struggle to adapt to the needs of learners and are therefore the only such systems which attempt to be concerned with learners in that sense [8]. Intelligent Tutoring Systems are the result of the specialization of AI-based educational software into individual interactive components [4].

ITSs are computer programs that can be individualize instruction based on inferences about student's knowledge [9].

The traditional ITS model contains four components (Figure 1): the domain Module, the student Module, the teaching Module, and a learning environment or user interface [3, 10-14].

Student Module contains a description of the state of the student with regard to his/her educationally significant attributes [4] Attributes can be as specific as short term knowledge and misunderstandings relative to a given topic, or can be more general descriptions of skills (strengths and weaknesses) as well as including an estimation of the general level of mastery of a given knowledge domain. Student Module keep track of the student's activity and learning progress, discern and correct his/her errors and misconceptions, and possibly redirect the session accordingly [15].

Expert Module's main role is to make decisions that are used by Tutor Module for generating teaching plans and adaptive presentation of the teaching material. In many traditional ITS systems these roles are in the charge of the tutor Module, and other ITS's decided to separate them in two distinct Modules in order to increase the flexibility of the system [16].

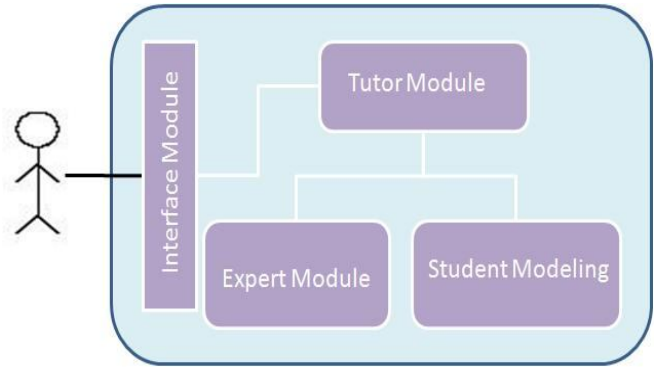

Fig. 1 Traditional Intelligent Tutoring Systems [10-11]

Expert Module analyses student's response with the expert's solution. Based on the correctness of the student's answer create the appropriate feedback [17]. It contains the knowledge that the student is trying to acquire and able to solve the same problems the student is trying to solve [18].

Tutor Module grants the infrastructure knowledge necessary to tailor the presentation of the teaching material as stated in the student Module [19]. Tutor Module consists of teaching strategies and the essential instructions [13]. These strategies must be adapted by tutor module to suit the student's needs, without the intervention of a human teacher.

Tutor Module generates an instructional plan as a sequence of instructional plan items (e.g. concepts and lessons) appropriate for the student's knowledge of the domain [16].

The interface module is the communication between the student and the aspects of the system. It is required for intelligently controlling the dialogue, the screen layouts, and other interactions with the learner [20]. Interface module manages the flow of communication between the student and the ITS [21].

3. A CLASSIFICATION OF ITS SYSTEMS

Majority of intelligent techniques applied in ITS can be roughly classified into three groups of technologies: curriculum sequencing, interactive problem solving support, and intelligent analysis of student solutions[22]. All these technologies are direct towards supporting the "intelligent" responsibilities of the human teacher which can't be supported by non-intelligent tutoring systems. Intelligent analysis of student and curriculum sequencing solutions are the best-studied technologies in the field of ITS. Most of ITS that had been developed during the first 10 years of ITS history belong to these groups of technology. The technology of interactive problem solving support is a newer one, but it is more intelligent and supportive, as it helps the student in the most difficult part of the learning process and provides the most useful support for the teacher in the classroom. It is expecting that it became a dominating technology during the last 15 years.

The following are some examples of existing ITSs with different methodologies:

1- OOPS[23]: is a problem-solving ITS in which students can resolve Object Oriented Programming exercises. OOPS identify students' level of knowledge and also generates feedback and important notes to help students to understand and overcome their misconceptions and to invigorate correctly learning the concepts.
2- BITS[24-26]: is a web-based intelligent tutoring system for computer programming. The decision making process conducted in BITS intelligent system is guided by a Bayesian network. BITS can help the student in navigation through the materials online, and also can suggest learning target and purpose and generate suitable learning sequences. As an example, a student may want to learn (adding operation) without having to learn every concept discussed in the previous materials. BITS can determine the minimum prerequisite knowledge needed in order to understand (adding operation) and display the links for these concepts in the correct learning sequence.
3- COMET[27]: Collaborative Intelligent tutoring system for medical problem-based learning, which can accept a wide variety of plausible solutions without placing an extensive burden on knowledge acquisition.
4- Acharya[28]: is an ITS currently targeted at teaching SQL. Its primary components are: Traditional course material on SQL organized to selfishly make use of ITS technology and an intelligent problem solving environment where a student receives a concept based recognition of his/her solution to the problem raised by the system. Acharya go along with the constructive model for delivering the instruction.
5- AIDS [13]: The Animated Data Structure Intelligent Tutoring System is an intelligent tutoring system developed as a teaching guide for a data structures course to enhance students' understanding, for example linked-lists, stacks, queues, trees and graphs.

4. DOWN SYNDROME AND EARLY INTERVENTION

The incidence of Tiresome 21 in the world is 1 in every 770 live births. This means there are 40000 babies are born every year in this world are Down syndrome [29]. Often Down syndrome is associated with some impairment of cognitive ability, and physical growth. Although some of the physical genetic limitations of Down syndrome cannot be overcome, but correct education and helpful care will improve a lot of their quality of life. This requires an early intervention program, a positive learning attitude, an appropriate medical care.Results of research show that children with Down syndrome who were engaged and participate in an EIP, had significantly higher scores for the measures of intellectual and adaptive functioning than children of comparable ages with Down syndrome who did not involve in an EIP [30-32].

The effectiveness of early intervention services for children with special needs has been extraordinary. People with disabilities and the members of their families provide a detailed statement that early intervention services improve their quality of life[33]. The quality of life to the children with special needs will be improved and increased when providing them with early intervention services[33-34]. In addition, Net Industries research results has presented that when children with special needs receive early intervention services, they tend to live more profitable lives, score higher on standardised assessments, and contribute more to society[34].

However, the early intervention program is not widely applied yet. And that is because of the lack of measurement instrument, shortage of individual curriculum, insufficient information, and human resources limitation [31].

5. ITS FOR DOWN SYNDROME: PREVIOUS WORKS

Researches in ITSs with mental disabled people are relatively rare. Earlier studies have explained how the ITS help people in increment their autonomy both in social, labor and daily life activities [35]. It allows the user to receive assistance when facing complicated situations during work or daily tasks, filling the gap between the skills requested for the tasks and the user capabilities [36].

There is a study that research in teaching mathematics to children with Down syndrome[37]. The research is based on designing an ITS for teaching elementary mathematics concept such as addition operation as a learning tool for children with Down syndrome (Figure 2).

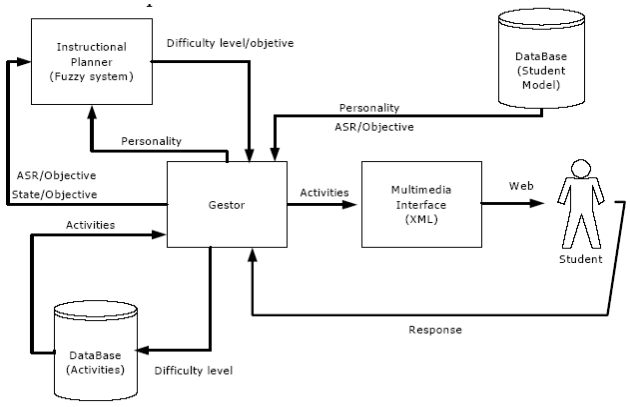

Fig. 2 ITS architecture for teaching mathematics to Down syndrome children [37].

In order to achieve the main objective of addition operation concepts learning we have set up 4 phases (Figure 3). These phases must cover sequential tasks with corresponding progress or return to a previous phase depending upon the results of the learner's accomplishment. Regression (return to a previous state) is the main learning characteristic of Down's syndrome.

There is also an assistive tool was developed in order to support workers with Down syndrome in their working environment. The tool worked in a mobile platform and it helped the users to execute in an easier way the tasks entrusted to them. The system was designed to be easy to manage for non-technical staff. The product was very well received by the workers' managers as the performance of the workers improved conspicuously [38]. This Intelligent Tutoring Systems has been adapt into mobile platforms to achieve proper solutions to one of the problems of people with disabilities, and to engage them into social and working environments16. These devices are designed for user adaptation in order to compensate the personal disabilities and to increase

individual autonomy, work capability, and personal security [38]. Due to the fact that exist many different cases among people with disabilities, an intelligent structure has been formed to achieve an appropriate tutor system configuration for each case. This implies a personal study made by the researchers, the tutors of the users and their assistive staff.

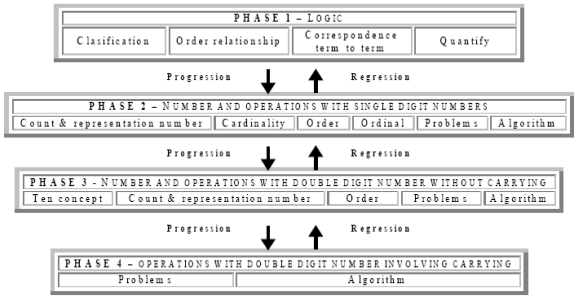

Fig. 3 Phases in the addition operation [37]

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The University of the Basque Country has a comprehensive history in the research on adapted and assistive technology. An assistive tool was developed in order to support workers with Down syndrome in their working environment, but we are extending our works in order to cover many other characteristics of persons with intellectual disabilities. In addition, the works are being extended to other daily life, social, and leisure tasks in order to suit the needs and preferences of these users instead of the demands of the working environment [38].

According to all these researches, we didn't find an ITS for mental disabilities to provide early intervention services that serve Down syndrome children in the mental age from birth to five years. This work introduces architecture for ITS framework to serve Down syndrome children by providing them with early intervention services in order to enhance their mentality and increase their learning performance.

The integration into social and work environments of people with disabilities is a fact nowadays. Tutoring systems are intended for helping this community in their life. These tools are very helpful; although at the moment don't completely meet their needs.

6. A PROPOSED ITS FRAMEWORK FOR EARLY INTERVENTION TO DOWN SYNDROME

Children with Down syndrome have a verities and different learning styles. Your child’s education thereby may need to try more than one method of illustrating material before finding the one that works best for your child. If material is presented in a way that is not like- minded with a child’s learning style, that child may appear board and fidgety.

The level of the material may also be a problem. If a child is presented with concepts that are too difficult for his cognitive level, he might "tune out" and appear inattentive. A child who is bored with overly easy material may also attend poorly and act out.

So the traditional ITS (Figure 1) can't fit the needs of Down syndrome children. In order to build ITS for Down syndrome (Figure 4), some points have to be taken into consideration:

1- Repetition: We have to repeat the information to Down syndrome children more than one time in order to learn it.
2- Way of learning: Each child of the Down syndrome has way of learn, we can find a child who learn my graphics and animation and can't learn by text. Also we can find one who learns by sound and music, and so on.
3- History: We have to keep history about each child, his preferences, the information and lessons he learn and the grade of each lesson, and so on.
4- ILOs: The ILOs that belong to Down syndrome children are very special to them.
5- Assessment: It is not important how much a Down syndrome child is learned and how much time he takes, but it is very important that he understand the information very well.

There are some modules will be added to the traditional ITS (Figure 1)in order to fit the needs of Down syndrome children.

Down syndrome learning methodologies: this component contains a Down syndrome learning methods DB in order to choose the best learning method by the tutor model that fit that child.

Down syndrome Knowledge base: this component contains Down syndrome preferences DB to be able to know every preference of that child, and also contains Knowledge base that saves the child's Knowledge to help the student Knowledge base to give the tutor module the recommended concept that the child should learn.

Down syndrome learning guides: this component contains the ILOs that fit the Down syndrome children, and also the learning object repository DB to help the expert module to know the suitable learning concepts that fit every Down syndrome child.

Assessment process: this component is very important, because it measures if the child was learned well the material he/she took or it has to be repeated to the child.

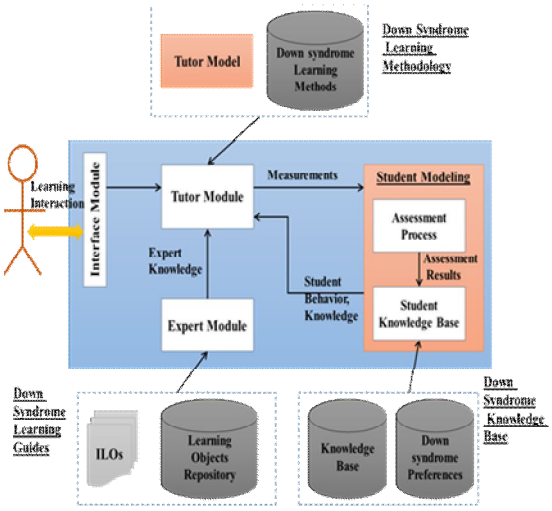

Fig. 4 ITS framework for Down syndrome

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