An Assistive Computerized System for Children with Moderate Intellectual and Learning Disabilities

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Abstract— We aim in this project to develop a system for children with intellectual and learning disabilities that supports collaboration, data exploration, communication and creativity. The system offers specific tutorials on basic concepts. It can enhance the communications and learning capabilities of the children. The tutorial contents contains multimedia elements that help the children understand effectively the topics. An assessment component is being developed to evaluate the children understanding. Parents can also be involved in the learning process by adding some contents suitable to their children.

Keywords-component; Educational software, Tutorials design, Learning Disability, Assistive learning Tools.

INTRODUCTION

Conducting research and develop software and tools for people with disability is a challenging task. Few individual research projects are carried out in the Arab world and the obtained results are moderate [1]. Many special needs instructors have individually developed Arabic tutorials for children with special needs. However, these educative tutorials are very primitive with low attractiveness. They are developed mainly in Microsoft Power Point software with low quality images. In addition, most of the Arabic software engineering companies do not develop educational software for special users because they do not see great financial benefits from this market. But 10% of the population around of the world are with some kind of disability. One study estimates that 3.73% of Saudis have intellectual disabilities [1]. No accurate statistics are given. Some of the important projects for people with special needs are: “AmiVita” [3] launched at the University of Granada (2007) which creates devices for elderly and disabled people. Archimedes [8] which promises accessible technology for the disabled. Chelin et al. [4] proposed a system that uses natural language to assist visually handicapped people in writing compositions. Alper and Raharinirina [2] reviewed literature on assistive technology for people with disabilities and offer guidelines for future researchers in this area. First, each student should be given an individual assessment before the assistive technology is given to him. The student’s needs and features must be taken into account as people with disability are different in terms of understanding, intelligence and limitations. Second, family involvement in the learning process is critical if the student is to gain maximum benefit from the technological assistive system. Third, studies should build in a period of maintenance and generalization, particularly with the development of software for students with intellectual disabilities. Jemni and El ghoul [5] presented an untested web based tool called WebSign that translates text to sign language. ALFakheer from King Saud University has announced recently the development of an educative web-based tool entitled FAHEEM for children with Autism. However, this tool is still in the testing phase and we don’t know yet its effectiveness. Mechling [7] has conducted an extensive literature survey on research (1990–2005) on assistive technology as a self-management tool for prompting students with intellectual disability to initiate and complete daily tasks. She mentioned that, “although Kimball, Kinney, Taylor and Stromer (2003;2004) outline instructions on how to create computer-based activity schedules with photographs and video models using MS-Power Point, to date no research base exists to support this new and creative use of high tech systems in providing students with visual, auditory, and animated cues for following and transitioning between activities or use in other forms of self-management”. Based on this conclusion, we propose to develop a system that use multimedia elements to assist the children with disability to understand concepts of living, and strengthen their self-reliance.

People with learning disability can have different problems with many everyday learning activities. They can be helped in different ways to learn if they are given suitable support, different learning materials, or even just some encouragement. Their difficulties can cover all aspects of life and learning and affect their performance in almost everything they do. Others will have very specific difficulties, for example, someone with dyslexia may have a problem with writing and reading or even with just one aspect of spelling. This type of difficulty may just affect their performance in spelling alone, or may have caused other problems by delaying their development of writing skills. Experience, skill and care are needed to help to identify the core problem and to understand when this has given rise to further difficulties.

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PROJECT OBJECTIVES

Our focus in this research project is to develop an Arabic-based tutorials system to enhance the communication capabilities of children with moderate intellectual and learning disabilities who are resident in the Shafallah center for children with special needs in Doha, Qatar.

The main objectives of our project can be summarized as follows:

To develop Arabic-based tutorials system for children with moderate intellectual disability (MID) and those with moderate learning disability (MLD). We can then unveil the hidden potential within these children and improve their skills. They can be reintegrated in normal schools and compete with their peers. The tutorials give short and simple Arabic sentences with clips, images and sounds. Some features will be added like words prediction and abbreviation expansion based on the work done in [6]. Whenever the children begin to type a word, the system displays a list of frequently used words that begin with those letters. The children can select the appropriate word (or picture) from the display. We can then improve the writing skills of these children.

To enhance the thinking and memorization skills of children with MID-MLD. We propose puzzles and games of different levels associated with the tutorials. Children can try to solve the puzzles and improve their thinking and memorization skills. Intelligent algorithms are used to guide the children in their selection of the moves and to converge always towards the solution. In addition, encouraging messages are heard at each move that the children performs.

To involve parents in the learning process in addition to teachers. The system allows parents and teachers to add and update contents according to specific rules. Involving parents in the learning process contributes positively in improving the skills of children with MID-MLD and help them acquire academic skills more easily so that they can take pride in themselves as shown in [2]. In fact, the school day is limited and if the children can use the software at home, there is a greater possibility of use.

To assist the children with MID-MLD improve their understanding of electronic text (and dialogue). We propose some computing techniques to extract keywords from electronic text (i.e., web sites) using concepts analysis. We associate then these keywords with images, sounds and clips that would be displayed to the children to enhance their understanding.

PROJECT TASKS

Task 1 (Design the Graphical User Interface): Any successful computerized system should have an easy to use graphical user interface that facilitates its use. Thus the system should possess an attractive GUI that is suitable to the potential users. The interface will be tested by its users and updated whenever necessary. A touch screen can be used to allow the quick selection of images.

Task 2 (Contents Development): To develop the contents which are suitable to the children with MID-MLD. The contents should be attractive by using multimedia (i.e., Flash, Dreamwaver). The advantages of a multimedia content are: It is an audiovisual and interactive medium and help creativity; The treatment or situation can be reproduced; It can be adjusted to the individual needs; It has an effect on more than one sense, and can be more effective.

Task 3 (Design of simple questions/answers tools, Puzzles and Games): These tools will help the children improving their thinking and memorization skills. A scoring system will be implemented to check the correctness of the proposed sentences. After learning the daily morning concepts, the children will then be asked to solve specific puzzles for instance how to initiate and complete the brushing activity.

The images will be presented randomly on the screen and the children will be asked to arrange them. If the child selects the toothbrush image it will go automatically to the first position. The child will see it moving slowly to the right position (drag-and-drop, select-and-move) and will be encouraged to complete the activity.

The teacher can also activate the audio option so the children with hearing and verbal understanding abilities can take benefit from this option.

Once the complete solution is reached the children will receive some animated encouragement.

SYSTEM ARCHITECTURE

Our system is composed of four different modules which are the followings: (1) the teacher Module; (2) the student module; (3) The server module; (4) the manager module.
The teacher module: This module is used by teachers to present lessons to students and to control the students’ computers during class time in order to keep students focus on the lesson. This module allows the teacher to: (a) Share his computer screen with each student so they can get a front row seat for the lesson; (b) Lock student’s computer keyboard and mouse for more attention; (c) Broad cast multimedia materials to each student PC; (d) Monitor all students’ screens and watch their activities; (e) Access individual student’s computer to help him during class; (f) Restart, logoff students’ computers remotely.

The student module: This module is installed on students’ computers. It performs the following tasks: (a) Allows student to navigate subjects and lessons, interact with contents, and solve exams during free mode; (b) Communicate with teacher computer by sending students response and interaction during control mode; (c) Displays and plays back multimedia materials sent from teacher’s computer; (d) Allows student to show off his good work to other classmates.

The server module: this module is installed on a server machine and performs the following tasks: (a) Control all communication between teacher and student module; (b) Manage database and system configuration; (c) Provide remote access to parents through the Internet; (d) Archive all transactions which include: students results and activities and teachers activities; (e) Present reports about students, teachers, and lessons in the system.

The manager module: This module is installed on a server, and provides the following functionalities: (a) Manage subjects and lessons; (b) Assign lessons to plan and to group of students; (c) Manage students, teachers, supervisors, and parents; (d) Control the access of all users type to the system.

CURRICULUM CONTENT

The topics cover different subjects based on the Shafallah curriculum and will be delivered through well-design interactive multimedia tutorials that reflects the children cultures and customs. The curriculum includes the following topics: Mathematics: Numbers, Simple arithmetic (addition, subtraction, etc.), Dealing with Money, Date and Time, Measurements Calculation; Reading and Listening: Simple texts and answer the questions about, Listening and Comprehension, Arrangement stories events using pictures, Recognizing environmental animals and plants, Foods, Clothes, Safety and Personal Care, differentiation between objects, Social Activities (Cinema, Entertainment, TV, Club, etc.), Transportation Means, Community Services, Using Communication Devices, Cleaning and Properties, Simple Religious Concepts, First things first, Using the computer machine, Dealing with MS-Word and MS-Power Point, Email, Chatting and Internet, Using Tools for Special activities, etc . The software will support the instructors to deliver educational materials more effectively.

KNOWLEDGE EXTRACTION FROM TEXT AND DIALOGUE

Formal concepts have been introduced by WILLE [9] and were applied in different areas of science like psychology, sociology, anthropology, medicine, biology, linguistics and computer sciences. A strong feature of Formal Concept is its capability of producing graphical visualizations of the inherent structures among data. We have developed many tools in some supervised senior projects to summarize English and Arabic text without using semantic rules. In fact, we build concept lattices based on concept analysis and Galois connection to extract the meaningful knowledge from a text (called also best concepts). The following graphic is a snapshot of one of our systems that we have developed recently. It can automatically extract the main concepts from an Arabic text using formal concept analysis. We propose to use this solution in our project in order to summarize information (text and dialogue) to present them in different views and formats which can be used by the children MID and MLD.

SYSTEM EVALUATION

We intend to evaluate the tutorials through a developmental study which consists of conducting a series of surveys taken at different points in time and compared together. This includes the following:

Trend Study: All the children participating in learning through the designed and developed tutorials are surveyed. We will than analyze the data and study the trend of improvement in general.

Cohort Study: The students’ performance will be followed over the project duration and sampled every 3-4 weeks to be analyzed in order to give us an indication of the progress and feedback on the redesign process of the tutorial.

Panel Study: Two identical groups of students will be followed up throughout the life time of this project. One group will be studying according to our proposed tutorial and the other group without the proposed multimedia tutorial. We will then evaluate the progress of both group in an objective way.

We will use the “Evaluation Matrix” presented in the following table which will help us study the effectiveness and worth of the developed tutorials.

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<th>Some Evaluation Questions</th>
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<td>a. What knowledge was learned by participants?</td>
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<td>c. What attitudes were formed by learners?</td>
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<td>d. What were learner reactions to the multimedia interface?</td>
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<td>e. What were instructor reactions to the multimedia interface?</td>
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We will be also doing human computer interaction usability studies as below:

At the design stage (Storyboarding and UML Diagram): Traditionally, storyboarding was used in the film industry, particularly in animation, to illustrate the flow of a story in picture form. However, this technique can be used to illustrate navigation in an application by drawing a series of screens.
This is also useful for highlighting the needed interaction elements.

At the early prototyping stage (User Interface Heuristic Evaluation and Data Mapping / Object Model): Each screen (and the navigation from screen to screen) is evaluated against a list of heuristics and any problems noted. This is repeated and the problems recorded.

At the End/delivery stage (Observation in the Workplace): The best way to find out about a system, its users, and how they interact, is to observe the system in context, i.e. in the workplace. Observations such as these should deliver accurate, natural data for evaluating prototypes or delivered systems. We intend to use video taped sittings and evaluate them.

Usability: Is the system providing a coherent and flexible user interface that can be used easily with all users? Has the system an obvious component which allows the user to navigate easily? Are the tutorials easy to use by teachers, parents and children? Is the system adaptive to user needs? Is the tracking component working properly and produce the expected results?

Supportability: Can the system be easily modified or extended easily? Can teachers and parents add materials easily?

Contents and Design: Are the design and contents of the tutorials and puzzles satisfactory to children, teachers and parents? What are their feedbacks? Do the tutorials cover well the topics? Are they useful and meet their goals? Quality of texts, images, sounds, and clips? We will compare the progress of students.

Performance: Are the performance requirement concerned with quantifiable attributes of the system, such as response time, throughput availability and accuracy?

Flexibility: Is the system flexible, since it will be used regularly with a new set of initial data and can accommodate changes in database such as modifying the contents?

Security: Is the system preventing unauthorized users to access the system?

The quality of special education depends on the quality of assessment information and its timely application in the classroom, school and community to prescribe practices and monitor programs and services. We know that the indicators of intelligence are mainly based on the ability to think logically, to use stored knowledge to solve problems, to reason by analogy, and to extend or extrapolate knowledge to new situations. So the system provides us with assessment module based on logic, language, spatial representation, use of the body, social competence. The main strengths of the system is features and functions:

(1) Easy to use and self-administration, (2) Software control of item presentation, (3) Response evaluation based on conceptual models or algorithms, (4) Decision making based on rules and criteria, (5) Assess and evaluate the progress of individual children, (6) Test of Nonverbal Intelligence for children with communication challenges which requires no reading, writing, or speaking, (7) Some tests require that the child have adequate verbal abilities to answer the questions it includes verbal, arithmetic, picture completion and object assembly, (8) Students entering their responses by simply touching a computer screen.

The assessment tools will contribute to eliminate the misplacement of student as a result of poor evaluation which can have bad results for both student and teacher, and misplaced students tend to lose interest. The system provides a more holistic evaluation of students in different contexts. The most widely used form of assessment is a direct observation of the student in a classroom setting. Direct observations, along with scores from both achievement and tests, are good evaluation methods, but very time consuming so a big waiting list for evaluation. This lag time is very discouraging to many classroom teachers, diagnosticians, and students and parents. Our computer-based assessment tool can speed up the entire process as computers store and compute test results. We can store and manage large data sets that can be easily accessed by school personnel, parents and practitioners. The system will allow a greater volume of information to be handled by fewer personnel, to better serve the needs of students, to comply with ever changes, and to manage and evaluate special education programs. We integrated in the system text, graphics, audio and video in order to give more comprehensive evaluations. So students with special needs will become more familiar and comfortable. Interactive methods of assessments will help students to learn according to their individual needs and skills. Teachers, administrators, students and parents will also benefit from the system concerning evaluation. This formulates a real-time picture of students in everyday life situations that allows a full view of students’ abilities, so skill deficits that occur during different tasks are more quickly and easily identified. The system is designed to monitor student progress. It provides teachers with a virtually real-time picture on which students need help, where they need it, and how the teachers can help best. The system can also monitor student performance throughout a portion of the curriculum which is a perfect way for teachers to catch and address gaps in a student’s knowledge or learning and provides them with the opportunity to teach more effectively. Teachers can use the assessment to gauge how well they’re teaching to student needs over time. If, for example, a first assessment reveals a particular student is at risk of failing in a particular subject, a teacher can reassess that student for a second time to see if changes have helped. If the student shows progress, the teacher can note what kind of approach to learning works best. If the student demonstrates little to no progress, the teacher knows it’s time to try something else.

The system is designed specifically for teachers and students; each component has a simple, intuitive interface that makes it easy to get started right away. The system also makes it easy for students to take more control over their own learning and get maximum benefit from the technology. The system assessment offers many facilities, such as numerical answers, symbolic answers, and negative mark for wrong answer. The assessment is a useful tool that enables teachers to conduct more frequent, detailed, consistent, and stable assessments of student. The system offers teachers an easy and effective way to discover how well each student understands lesson. It can also offer quizzes or planned tests enhanced with images and
multimedia content. By using the software, students can easily respond to questions and teachers can instantly see the results, which are automatically recorded in the student database. Finally, the teacher, parents, and administrators can log in through secure, password-protected access to view summary reports and analyses. These reports give them a "photo album" of student growth and which students needs extra help, ideas for why and how they can encourage students and to better serve their needs.

The system offer tools to teachers to access, view and manage all assessment data from one location. Teachers can design questions using six question types – true or false, yes or no, multiple choice, multiple answer, numeric response and short answer. They can also deliver interactive assessments that provide instant responses so they know when to review a concept or give students extra help. And, teachers can keep students focused on learning because they get a thumbnail view of each computer screen in the class. Different assessment strategies can be used to support positive behavior and monitor progress at the level of the student, the classroom, or the entire school.

The benefits of computerized forms of assessment “Quizzes” with automatic marking and feedback on progress are as follows: (1) Various question types, e.g. multiple choice. (2) Response options, e.g. multiple attempts. (3) Student feedback, e.g. give correct answer. (4) Staff feedback: detailed performance. (5) Test motivated them to understand the content. (6) Provide correct answers to quiz questions after first attempts. (7) Students are rewarded for choosing positive solutions.

We mention that the Software can be used in two modes:

**Control mode:** During a specific lesson, the instructor can control the software by activating only the required lesson in order to keep students focus on the current lesson only. The students will not be able to access other lessons or subjects.

**Free mode:** In this mode, the students can access different materials and lessons but only those included in the timely plan which are set by the instructors.

**CONCLUSION**

The project focuses on innovative practices directly related to children with MID-MLD. It addresses the teaching problem by interacting with active module throughout the course. The system will provide a direct link of interactions between the static content (text, images) and the dynamic content (animations and games) and in doing usability studies on the developed user interface of the system so that we do not develop just yet another tool. Note that, when designing a tutorial for children with MID-MLD, one can think to base it mainly on the ordinary curriculum that is taught in normal schools. We can then use the text and add some interactive animations. However, these children need specific treatment and deep care. In order to improve the understanding of children with MID-MLD, the tutorials should attract the maximum number of their senses. For instance, in addition to seeing, hearing and eventually reading, the children with MID-MLD should taste and touch whenever possible. If we want to teach a child with MID-MLD the concept of “coldness”, drinking cold water and touching ice would highly increase his understanding. We found that whenever the images used in the tutorials are from the children’s environment they can learn more quickly. When trying to decide how to use information communication technology to support someone with MID-MLD it is essential to work out what they are able to do and what they have difficulty with.

**REFERENCES**


