Artificial Intelligence in Education of Children with Learning Disabilities

As computer science and technology make gigantic technological advancements in the past decades. As well as educational institutions are taking advantage of this available technology and incorporating individualized programs and software into student’s learning activities. This paper provides a summary of what had been accomplished by A.I researchers in educational sector.

1. Introduction

A.I. research and study empowers and enables many areas where machine have an obvious advantage. Education is one of those areas, where traditional teaching of students is not always effective. In some cases, individualized applications and programs outperform traditional class room learning experience in its effectiveness in student's progress.

Due to high rises of the number of kids affected by autism spectrum disorder (ASD), the purpose of this research is to find out what are researches had been done in this area to help these kids with learning process. As well as how Al techniques involved in tool development for kids with learning disabilities.

2. Identifying Learning Disabilities (LD)

Before perusing research on how AI and machine learning can enrich and fulfill the needs of individuals with learning disabilities (LD), lets look at what had been done to improve diagnosis process of such individuals.
where the delays in therapies and educational plan adjustments would be undesirable.

First of all, identifying individual's weaknesses in different areas as well as establishing correct diagnosis and educational plan had been always a difficult[9] area as some disabilities are more settled and with possibly some other disabilities and disorders overpowering and interfering capabilities of individual that may appear to have certain learning disabilities. For instance, attention deficit disorder (ADD) without hyperactivity component is the major overcoming factor for an individual to appear to be suffering learning disabilities. However, in most cases this disorder is easily corrected with the right combination and dosage of medication.

Up to this date, diagnosing various learning disabilities relies heavily on ones understanding of scholar research and actual findings from individual interactions with patient. Not only this process is costly in terms of manpower, but also can be highly delayed due to the fact that not all individuals exhibiting certain learning disabilities are capable of demonstrating early signs of it to their educators. As well as not always educators capable of seeing those early signs.

Even though the problem of early diagnosis of LD present in US,[9] concentrates mainly on this outstanding issue in Taiwan as diagnosis of LD appear to be more underestimated in contrast with US.

A lots of expert systems were developed and used. Their performance considered to identify LD of an individual as well as by human expert in the field. However, thus systems didn't show any impact on the number of diagnosed kids with LDs.

Artificial neural network (ANN) and support vector machine (SVM) classification techniques gained a lots of attention within AI world, but never appeared to be used for diagnosis of kids with LDs. Several experimental runs demonstrated that SVN results were consistent independently of the size of the training data set. ANN by itself wasn't giving high accuracy in general. Hybrid techniques yield better results, but still were lacking some accuracy in diagnosing kids with LDs[9]. Thus more research is needed to be done in this area to increase accuracy.

Another expert system was designed to help with diagnosis of children with various developmental disorders[10], as well as provide families with early intervention at the luxury of their home. It is a web based solution uses agent based neural nets to diagnose child with ASD. The detailed report mailed out to the child's parents and medical staff for future evaluation. Future evaluation by medical staff is necessary as common characteristics of ASD can be also associated with other types of disorders.

This knowledge based system uses learned knowledge and heuristics to evaluate child in its process using gaming strategies. Once deficiencies determined by the system, the child can start using the system to improve autistic child's vocabulary and interaction with family and peers. The learning/tutoring portion of the system is also web based solution that is also supports various language options. As an overall, the main purpose of this system is to help diagnosis of children with ASD and provide families with early intervention.
3. Tutoring Software for Children with Learning Disabilities

Highly important factor in learning is the motivation to learn. How can the software know if the student is motivated to learn? How can it keep its interest? Because of the challenges of this type of identification, a cognitive science studies emerged in this area [11]. Cognitive approach recognizes human strengths and weaknesses and uses this knowledge to emphasize on a thinking process/ability rather than on learning by example traditional teaching method. Such systems require external sensors to monitor learner’s posture, expressions, heart rate, breathing, etc.

In [11] organizing framework analyzed as a base for cognitive learning. Framework contains three main roles: tool, tutor, and tutee. According to [11] computers are still mostly used in the tool role. With the lesser frequency they are used as tutor or tutee, of which K. Vimala is hoping to change in the near future.

Assistive Technologies Laboratory (ATL) team proposed a model for the effective tool development process, as a result of which they had successfully developed and deployed 25 tools in three Ecuador’s centers for special education. Their proposed model combines the knowledge from school staff (which includes involvement of teachers and other students without disabilities) with experience of special education professionals [2].

The involvement of students at universities gives them an opportunity to help children with disabilities by interacting with developed tools and providing feedback on improvements, development, and even implementation. These students, as well as teachers, would have a base knowledge and understanding the needs about specific disability the tool is made for by interacting with special education experts and psychologists through out the process. The main goal of the entire model is to create a tool where children with disabilities would be motivated to learn [2]. Since the Ecuador’s highest toll on disabilities in kids in intellectual, physical, and visual/hearing areas, ATL team concentrates mainly on this top three disabilities.

On the other hand, learning experience with software applications had shown large benefits for kids on autistic spectrum disorder (ASD) [12]. Kids with ASD typically strive better in stable, predicable environment that computers are good at providing it to them. On the other hand, human instructors have a lot of inconsistencies that imposes undesired impacts on the learning progress of individuals with ASD.

Each individual child on ASD is very different, each one of them have its own set of disabilities /abilities, visual/auditory preferences, and different preferred learning techniques. Thus the learning software have to be highly flexible and capable of using different /combined techniques and approaches. With that in mind, Smart Tutoring model was proposed by Centre for Development of Advanced Computing [12]. Centre for Development of Advanced Computing developed Smart Tutor expert system that was composed from two main sessions available to its end-user: assessment and e-Learning sessions. At the beginning of each e-Learning session, expert system
performs assessment session to determine mood levels, interests, and concentration levels of the child. Then expert system proceeds into e-Learning session by working on two main levels: conscious and sub-conscious levels. On the conscious levels expert system actively interacts with the child and captures information on child's responses in order to adjust its session accordingly. On the sub-conscious level, system updating child's profile and builds its own domain expertise.

As a result Smart Tutor expert system provided children with highly adjustable interface as well enabled capabilities of evaluating learning progress over time.

4. Use of Robots and Humanoids

FMRI study [3] had shown that both autistic kids and normal kids tend to be drown to the autonomous agents. However, normally developed child relates better with humanoid type of agents and perceives them as its peer. In fact, during interaction with the artificial agent that resembles a human (humanoid), the same regions of the brain were activated in a normally developed child that respond to human faces.

In order to determine if there is a preference of autistic kids to artificial agents vs. human agents, correlation needed to be performed on which areas of the brain activated during interaction with human agents vs. artificial agents in typical kids and how these regions compare with regions activated in autistic kids. The results of preformed experiment had demonstrated that ASD kids don't tend to see the difference between artificial agents and human agents. Also the study suggests [3] that ASD kids use same resources with human agents as they used in interaction with artificial agents, while typical kids had demonstrated noticeable difference between the two.

However, since artificial agents tend to be more emotionally stable and predictable, another study [5] suggest use of robotic toys with ASD kids as an intervention tool is highly effective that engages them better in learning social interactions.

A successful design of an interactive robot, Keepon, that prompts kids and adults to the group play and interactions was demonstrated in [6] (See Figure 1). The goal of this robot to involve child with ASD in playful interaction. Simple appearance and predictable built in interactions provided children with a relaxed mood, which yield better results in engaging child in a group play.

Keepon provides two operation modes: automatic and manual modes. In automatic mode, software provides face detection location, toy of predetermined color, and/or movement. These three factors provide a likelihood of the child in play. In manual mode, human operator fully controls robot.
To oppose usage of non-human like robots as well as pictures and DVDs as a primarily technique in teaching social interactions and interpreting facial expressions, Italian team of researchers [8] created humanoid robot FACE (Facial Automaton for Conveying Emotions) (See Figure 2). Their argument is that most other robots concentrate on promoting interaction skills which are also highly critical for kinds with ASD. Picture and DVD therapies provide effective preparedness of the ASD person to certain life scenarios, but very limited to these situations. While FACE is more advanced learning tool for ASD kids and adults.

FACE facial expression recognition system is built on a neural approach, which is more efficient than a human therapist, as it captures and processes all of the data. The preliminary experiment was run successfully on the high functioning child with autism, who typically learn social skills well through a therapy. However, the system was not tested with less functional autistic kids, so the results seems to be very inconclusive. Still the benefits of processing facial responses to the displayed facial expressions are highly beneficial data for further research in this area.

However, the cost of such robots runs generally high, so authors of [5] had proposed a piloting the use of robotics as an affordable aid for home use.

In [5], a prototype of a cartoonish looking penguin robot was developed and named PABI (Penguin for Autism Behavioral Intervention) (See Figure 3). Besides the ability to demonstrate human-like emotions, robot was built with high tolerance to all possible abuse

![Figure 1. Keepon movement examples(left) and pictures of interaction with the child(right) [6].](image1.png)

![Figure 2. FACE humanoid developed and built by Italian researchers (images used from the team’s website of the project that can be found at http://www.faceteam.it).](image2.png)

FACE built to generate six basic facial expressions and is controlled by either algorithm or an operator. All of the observed responses are analyzed and recorded for future studies.
on it as a stuffed animal would withhold from a child.

With the purpose of extended therapy of ASD child at home, PABI has two main modes. One of which is to interact with the child independently, and another one is to interact with the child with guidance of the therapist remotely controlling robot and observing child's behavior and interactions. Facial recognition algorithms are used to observe child's behavior.

5. Use of Virtual Characters

As demonstrated in Section 4, artificial agents that closely resemble human facial features benefit the learning of social skills and interpretation of facial expressions in ASD kids. In this section a closed look will be taken on a virtual characters used with the same purpose.

Portuguese team of developers, researchers, and experts developed LIFEisGAME [1] interactive game for ASD kids teaching kids to recognize facial expression by a playing this game with a virtual character (See Figure 4).

Currently, LIFEisGAME has four main activities: recognize facial expression, build facial expression, play with avatar (avatar on the screen mimics child's facial expressions), and identify appropriate facial expression for presented real life story/situation. Although the modes presented to the player in a sequential matter, but in the future mode selection will be available. A small camera allows monitoring and analyzing child's expressions during the game.

Incorporated game techniques into this learning product (LIFEisGAME) created higher interest of the child with ASD to participate. That by itself makes this application to stand out from many other applications that are used to teach kids with ASD about facial expression recognition.

However, LIFEisGAME still needs work on individualizing learning process for each of its user, as well as allow more customizations on avatar features, colors, and sounds. An additional interest was shown by experimental run on several kids with ASD about using different types of avatars in addition to human faces.
6. Other Educational Applications and Computer Aided Instruction

With involvement of technology in educational areas, more and more application had been developed to aid and improve educational process, as well as provide better and more effective learning experience for distance learners.

Process of learning algebra requires student's continues and constant training. Many solution had been developed in this area. However, most of them have a basic instructional guide with practice exercises. None of the looked solutions by [4] have had any tracking systems of individual student to measure their progress and dynamically adjust the system to it. Thus Research Center for Information Technology and Systems Autonomous University of Hidalgo State had developed a tutoring system to aid algebra education that is dynamically adjusts itself to the student's progress and have a tracking system [4].

Its knowledge based system was developed with the knowledge provided by professors teaching experience. As a result of this coordinated work, the system is capable of adaptation to the student's progress, as well as teachers have a capability monitoring the progress as well as direct/assign certain topic to the students. The successful use by private and public schools in Mexico had demonstrated great results.

A more generalized research was done on application of AI to computer aided instruction by H. Li from Lonyan University [7]. With rigorous details, Li' researched successful applications and techniques used in educational systems using AI techniques.

7. Conclusion

With the number of autistic kids on the rise and proven benefits of stable and predictable computer behavior on autistic kids, more applications and systems are built to aid and improve autistic deficiencies caused by the disorder.

Several robots and humanoids were discussed here that education of social interaction and facial recognition for individuals with ASD.

In addition, other systems were discussed that help with general stream education.

As an overall, this research had highlighted the work had been done to improve and increase efficiency of educational process for kids and individuals with ASD as well as without.
References


