Original Research Paper

A Learning Mechanism to Improve Skills Acquisition for Autistic Children in Mauritania

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Abstract: The learning of autistic children is an issue for care and treatment centers for children with autism spectrum disorder, however many studies seek to find learning mechanisms and models in order to facilitate their social integration. The aim of this study is to propose a learning mechanism based on the analysis and annotation of a corpus video filmed during the learning and training sessions of autistic children in Mauritania. We have analyzed these videos with the objective of identifying a classical and software annotation and then producing a coding schema while importing it into ANVIL software. In this respect, we are interested in the XML files generated by ANVIL presenting details of the appearance of attributes in the annotated videos. The match between the two annotations illustrates that the data in the files converge in showing that the children who had an improvement in skill acquisition in the treatment sessions due to the fact that the specialist educators in the videos emphasized attributes that promote collaboration more than others to get the children's attention. Indeed, we wish to obtain a learning mechanism that is as complete as possible for the schooling of autistic children in Mauritania and that can later be implemented as a pedagogical conversational agent.

Keywords: Autism, Learning Mechanism, Annotation, ANVIL, Coding Schema, Pedagogical Conversational Agent

Introduction

Autism is a neurodevelopmental disorder (Jamain *et al*., 2003), this phenomenon according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-V), is a group of alterations that appear between 12 and 14 months (Esposito and Venuti, 2009). The prevalence of autism is four times higher in boys than in girls (Bédard-Bruyère *et al*., 2022; Wang *et al*., 2023); In addition, according to WHO statistics, 1 child in 160 (0.625%) worldwide suffers from ASD (Lagos *et al*., 2021). Which affects the development of children either in their behaviors, their interests, their specific activities, or their social integration abilities (Bédard-Bruyère *et al*., 2022; Jamain *et al*., 2003).

In recent years, Mauritania has attached great importance to this phenomenon, which is considered to be a cause for concern given the number of children affected by this disease. In this context, several public centers have been set up attracting each year dozens of children categorized according to their condition such as simple, medium, and severe. The evaluations carried out regularly by these centers, show that the rate of progress for the primary and middle levels has not yet reached 50% (for example, last year it was respectively 37% and 48%, according to the TSA center in Nouakchott Mauritania). These results show a need to support these centers by adopting a new learning strategy to improve the treatment of children.

In the literature, many studies (Esposito and Venuti, 2009) have been carried out in this framework, some of them investigating the causes of the symptom which is still unknown, and others seeking to find treatment methods (Hochmann, 2009) in order to facilitate social integration and learning of children affected by ASD. Other studies (Grindle *et al*., 2009) on the development of people with autism have shown that without specialized intervention, many will continue to have severe deficits in communication and social skills throughout their lives (Schuh and Eigsti, 2012; Jamain *et al*., 2003).

According to Hinojosa *et al*. (2021), items from a parent report measure of ASD symptoms were matched to

DSM-5 criteria and used to assess the sensitivity and specificity of DSM-5 criteria and current DSM-IV criteria to clinical diagnoses.

This requires solutions with technological facilitators (Purnama *et al.*, 2021) that build on children's strengths and work on their weaknesses with a focus on removing barriers to help them improve their vocabulary and communication skills (Putnam and Chong, 2008; Hourcade *et al.*, 2013). Other studies have also shown that children with ASD often analyze and receive visual information more effectively than auditory information (Fteiha, 2017), and prefer interventions that involve interaction with technology, as these cause them less anxiety than face-to-face or group work (Cassidy *et al.*, 2016).

Mauritania, having limited means, has implemented these centers with several gaps in both resources and learning standards, manifested by the lack of specialized interventions and leading to the use of almost traditional learning methods. It is within this framework that we propose a pedagogical model appropriate to the Mauritanian context that would allow us to fill this gap.

This brief introduction is followed by a section that presents a state of the art and secondly, the approach mechanism by explaining the methodology, and the results obtained at the end we discuss it, and conclude.

State of the Art

Presentation of the Work Environment

As part of its strategy to improve living conditions and access to educational programs for people with disabilities, especially autistic children, Mauritania has set up care centers to alleviate the suffering and improve the learning of this category of society. For example, the autism spectrum disorder center in Nouakchott includes 66 children including 8 girls, divided into two levels, beginner and intermediate, supervised by 15 specialist educators and one expert.

As a result, the children at the center follow a series of lessons to acquire basic skills, where the skills belong to areas such as presence, attention, self-care, language, expression, pre-academic and academic, the sessions are divided into two components, beginning and intermediate, and are evaluated weekly, monthly, quarterly and annually to determine the extent to which children are benefiting.

The center's program is based on the Applied Behavior Analysis (ABA) method, which aims to promote the autonomy and social integration of children by reinforcing appropriate behavior and reducing inappropriate ones.

Learning Model Dedicated to Autism

In the care of autistic children, it is necessary to follow a well-organized and well-structured learning process provided by specialist educators in order to develop their delays in communication, behavior, social interaction, imitation …etc. Indeed, several methods such as PECS (Ostryn *et al.*, 2008), ABA (Ingersoll *et al.*, 2020), TEACCH (Siu *et al.*, 2019), and ESDM (Baril and Humphreys, 2017) have shown their relevance to apply and implement a program adapted to learning in a structured setting:

- **PECS:** Picture Exchange Communication System is a system of communication by exchange of images developed in the United States by Dr. Andy BONDY and Lori FROST in 1985. It is based on the Pyramid method, which is used to quickly teach communication skills to people with reduced or absent oral communication skills. It takes into account the needs of the person and evolves into an augmentative alternative communication system. The aim is to teach people with autism how to initiate interaction spontaneously (Howlin *et al.*, 2007; Sulzer-Azaroff *et al.*, 2009). PECS comprises six phases. The first phase consists of teaching the individual to deliver a simple image of a desired object or activity to a "communicative receiver". The receiver immediately motivates the exchange as a request. In the second phase, the sender and receiver are further apart, and they persist in exchanging the image. The third phase adds image discrimination, learning to select favorite images. Phase four structures the sentence by learning to construct simple sentences on a large sentence strip. Finally, phases five and six use requests to answer more complex questions (Pereira *et al.*, 2020)

- **ABA:** Applied Behavior Analysis based on the adaptation of an autistic child's behavior to social contexts. It is addressed to specialized educators and parents and is based on the cognitive and developmental disorders associated with autism. An adapted educational intervention program is then put in place (Güleç-Aslan, 2011; Donaldson and Stahmer, 2014). This plan employs techniques aimed at behavior modification and social skills development. The aim is also to teach children new behaviors such as sharing, taking turns, and asking to play, as well as more complex social behaviors such as asking a classmate to go to the school dance (Sarcia, 2021). There are two forms of learning that provide the opportunity to work with a student with autism at school, at home, or in the various social settings

Structured teaching is based on learning each step of an action.

Incidental teaching teaches children to discover the world around them.

- **TEACCH:** Siu *et al.* (2019); Ardianingsih *et al.* (2023) refer to a comprehensive intervention program based on the initial observation of the person's skills, using their natural interests and motivations to develop their communication, social interaction, and environmental skills. It is characterized by the involvement of parents or a relative where possible, the use of emerging skills as the primary teaching objective of the person's individualized program, and a structured learning environment. According to (Muslim and Irvan, 2023) the TEACCH method is designed to optimize the strengths and overcome the weaknesses of children with ASD

Denvers or ESDM or the Denver Method

Holehan and Thomas Zane (2019) or Early Start Denver Model (ESDM), is a method of stimulating the developmental abilities of children with autism spectrum disorders. It is particularly aimed at young children aged 1 to 5 years. This method seeks to reproduce the stages of typical development, starting from the child's motivations. Play is at the center of the learning provided. The work consists of reducing the social, motor, and communicative difficulties associated with autism. Teaching with the Denver program is based mainly on the organization of play activities (role-playing, use of musical instruments, toys, etc.,). These moments give the opportunity to establish social interactions with young children. These activities help to stimulate their communication and imitation skills, and can also be implemented by parents to maximize learning opportunities in daily activities and to bridge service gaps (Abouzeid *et al.*, 2020).

Learning Methodology

This research aims to help and facilitate the scholarship of autistic children through a series of computerized sources in the form of a set of games.

Following the analysis of the corpus of videos containing training scenarios and aiming to produce real cases of learning for children with autism, we have chosen to describe some videos according to the following learning categories.

Calculation Training

The first video (filmed at the Zaid Center for autistic children in Nouakchott) describes a repetitive session of learning to calculate. It is 3 m and 46 s long and is conducted by a specialist educator for two autistic children. As part of a process of social integration of such children. The game has certain means, namely: (Number coins, game coins, gifts). (1) First, the teacher takes a number coin and asks one of the children to say the number. (2) The child answers 'verbally', and the teacher encourages

him/her if he/she answers correctly; if not, the teacher insists that the child answers correctly. (3) Secondly, the teacher asks the child to count the game pieces related to the number, the child starts to count if he/she succeeds, the teacher proceeds to encourage him/her either by verbal motivation or applause and offers him/her a gift. If not, the teacher encourages the learner to pass the test and makes sure that each child participates and that the work is done individually.

The second video describes a repetitive learning session in the form of a game, of 51 sec filmed at the Sheikh Zaid center. The game teaches an autistic child the days of the week and trains him to order and pronounce them correctly. This video has a table on which the days of the week are written: The days of the week are written separately on sheets; an indicator sheet, which mentions the word "today" and an arrow inclined towards the day sheet).

The game begins with the child placing the indicator sheet next to a day and saying the day indicated by the specialist educator and then asking the child to say the day that follows and precedes it. After the child responds positively, the specialist educator encourages the child.

Learning the Alphabet

The third video describes a 1 min 45 sec repetitive session for learning the alphabet facilitated by an specialist educator. The learning is dedicated to an autistic child at the Sheikh Zaid Centre for autistic children in Nouakchott. The means used are simple (sheets of paper on which the letters of the alphabet are written). The learning activities take place around a series of exchanges between the teacher and the child, such as: (1) The child sits down in front of the teacher. (2) The teacher takes a sheet of paper and shows it to the child, asking him or her to pronounce the letter. (3) The child gives an answer and, if the answer is wrong, the teacher encourages the child to find out the correct answer. (4) The specialist educator asks a question or restores confidence after destabilization. (5) The specialist educator encourages the Child).

Imitative Learning

Fifth video the video describes the evolution of imitation in 7 years old autistic child, who has benefited from imitation sessions since he was 5 years old at the emotion center of the pitié-salpêtrière hospital-France,

During the first few learning sessions, the child did not respond to the suggestions of his specialist educator despite numerous attempts to imitate these postures. The specialist educator had to change his strategy in order to attract the child's attention by imitating the child's posture. This leads the child to change these postures in order to be imitated.

After 2 years of training, the child's social skills and imagination develop remarkably, he chooses what to

imitate. He takes the initiative to change roles and imitators. As a result, he becomes a model.

He takes the action of his specialist educator and transforms it in a creative way. He understood the alternation between imitating and being imitated which was the objective of the experiment.

Annotation

Annotation is both a technique (more or less automated) and a method (predominantly empirical), at the point of convergence of the human sciences (investigation, fieldwork) and computer science (Bergounioux *et al*., 2017). In this research work, we have opted for the use of two modes of annotation, one classical based on observation and the other through software (ANVIL).

Classic Annotation

The videos that are the subject of this study are annotated individually/separately by specialist researchers in order to observe the children's behavior during the processing sessions. The goal is to extract all the words used and/or actions produced by the child in order to describe them in the form of attributes, which were used to produce a coding scheme.

Annotation by Software

Among the existing video annotation tools, we have chosen to use ANVIL because it is a free tool and it offers

a multi-layer annotation based on a user-defined coding scheme (this is the scheme presented in the previous section), it also offers the possibility to export/generate XML sheets detailing the appearance of the scheme's attributes in the video sigma.

Materials and Methods

The methodology adopted in this study is composed of two types of annotations of the video corpora, The first consists in making a manual analysis and annotation to identify the attributes of the coding scheme and the second consists in annotating the video corpora via the ANVIL v6.0 software, by importing the previous coding scheme, however, the automatic annotation by ANVIL made it possible to generate XML files demonstrating the attributes of the schema which help more in the acquisition of skills in autistic children.

Results

The Table 1 presents the coding scheme obtained after analysis and observation of the video corpus. It is made up of a set of attributes distributed over the areas of competence most used by specialist educators during learning sessions dedicated to children with autism.

This allowed us to obtain accurate attributes, categorise and order them for a more complete coding scheme.

Table 1: Coding schema

Attribute	Sub-category	Category
Ask To Do (ATD)	Animate	Intent
Enroll The Learner (ETL)		
Ask For A Response (AFAR)		
Building Trust After Destabilization (BTAD)		
Note A Question (NAQ)	Evaluate	
Note the Answer With Repetition (NAWR)		
Reminder With Indication (RWI)	Inform	
Inform With Indication (IWI)		
Pass The Play Pieces To the Child (PTPPTC)	Others ressours	Moyens
Position The Indicator Paper (PTIP)		
Show a paper to the child (SAPTC)		
Enrolling papers (EP)		
Produce an Action (PAA)		
Ask a Question (AAQ)	Linguistic resources	
Encourage		
Affectif Parmettre		
Affectif		
Parmettre		
Encourage: Verbal motivation VM, Motivation by applause MA or Motivation by offering a reward MOR		
Attract The Child's Attention (ATCA)		
Encourage to Take The Test (ETTT)	Strategy	Strategy
Order The Child To Start (OTCTS)		
Encourage To Respond (ETR)		
Repeat Tasks (RT)		
Imitate An Action (IAA)		
Imitate A Sequence Of Movements (IASOM)		

Fig. 1: Learning session for autistic children

Fig. 2: Video annotated by ANVIL

Fig. 3: XML file generated by ANVIL

Discussion

We proceeded to analyze the video corpus (Fig. 1) and the coding scheme (Table 1) using software annotation. To do this, we introduced the coding scheme and imported the video in question into the ANVIL software (Fig. 2). We then annotated the attributes and their values by progressively following the video. This process allowed us to generate an XML file (Fig. 3) showing the appearance of the coding scheme attributes and their categories according to a well-defined duration. The figure shows an extract of an XML file for one of the videos analyzed.

The data obtained from the XML files resulting from the analysis of all the videos were presented in the form of graphs in order to evaluate the impact of the use of attributes that influence each other on the improvement of autistic children. Indeed, we present hereafter two graphs which show the appearance of the attributes respectively according to the duration and the category.

This first graph (Fig. 4) presents the attributes of the schema according to the duration of their appearance in the annotated videos where each attribute is characterized by the following values: Start, end, duration, and the category it belongs to.

This second graph (Fig. 5) shows the number of appearances of the attributes of the coding schema according to their categories.

The results obtained show that some attributes of the coding schema appear more than others because they attract more autistic children to interact following the pedagogical scenario proposed by the specialist educator. Statistics show that certain attributes of the coding scheme appear more than others due to their positive effect on the improvement of the child's level. According to specialist educators, the use of these attributes attracts more attention and curiosity of the child to understand the actions and tasks required. For example, attributes like ATD, MOR, ETR and ETTT have 55.4% of allocated time compared to other attributes. These attributes favoring the interaction and curiosity of children, certainly have a favorable impact on understanding and consequently on the success and social integration of children.

Following these results, we proposed to autism centers in Mauritania to encourage specialist educators to migrate to a socio-constructivism pedagogical model based essentially on these attributes in order to increase the progress and treatment of autism in Mauritania.

The TSA center of Nouakchott which started to apply this mechanism on a sample of children, showed itself satisfied with the proposed approach. The evaluations carried out show an increased progression in the level of social integration and understanding of the children because the success rate has increased for secondary school from 48% (last year) to 62% (the current year) and for primary from 48% (last year) to 56% (current year).
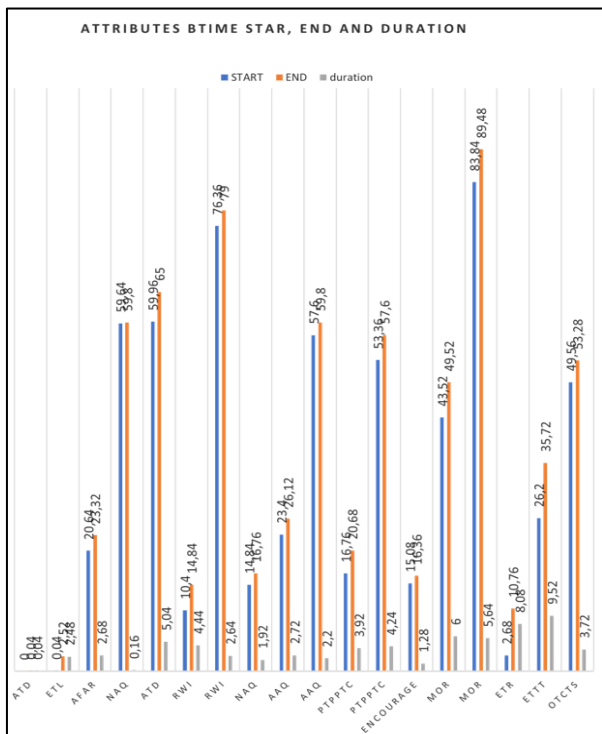
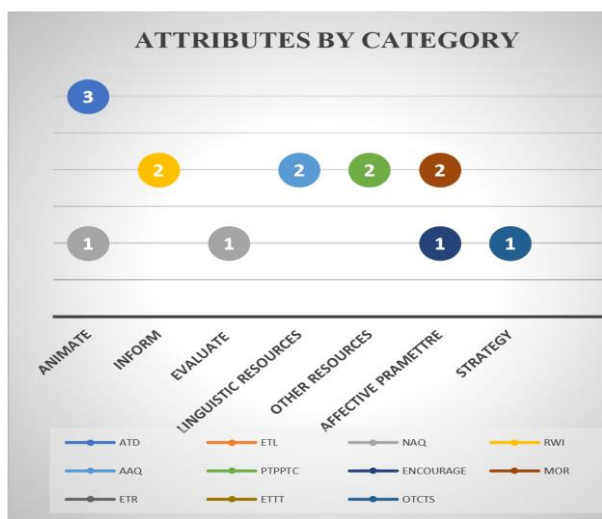**Fig. 4:** Attributes presented based on time

Fig. 5: Attributes classified by category

Conclusion

This article proposes a pedagogical model dedicated to specialist educators in learning centers for autistic children in Mauritania in order to improve the achievements of children affected by this disease and accelerate their integration into social life.

We began this study with the analysis and manual annotation of the videos shot in the centers in order to produce a coding scheme. This allowed us to identify and choose the videos where the children had progressed and acquired more skills.

Then we moved on to software annotation using the ANVIL tool. Then we did a comparison study between the two, which allowed us to deduce that the acquisition of skills is largely based on specialist educator. The latter must turn to a pedagogical model that has a favorable impact on the improvement of autistic children.

This model is based on the attributes that attract children's attention and promote their collaborations with their specialist educator. According to the study, the application of these attributes by specialist educator has favorable effects vis-à-vis the increase in success rates in these centers.

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Author's Contributions

Cheikhne Mohamed Mahmoud Seyidi: Organized and wrote the manuscript, and meet with specialists in dedicated centers in order to collect more concrete data about autism. Collected data Analysed and annotated videos, interpreted and proposed.

Cheikhane Seyed: Assist with annotation and interpretation; revised and corrected the version of the submitted manuscript.

Mohamed El Moustapha El Arby: Collected data, Analysed and annotated video interpreted and proposed; assist in the analysis and interpretation of source data which are video collected and proposed mechanisms such as supporting the treatment centers.

Mohamed Lamine Diakité: Supervised and guided the work in the semantic research axis.

Mohamedade Farouk NANNE: Supervised and oriented the work.

Ethics

The article complies with all ethical principles.

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