How robots could improve education of children with Autism Spectrum Disorders

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**Abstract.** The abstract should summarize the contents of the paper in short terms, i.e. 150-250 words.

**Keywords:** Social Robotics, Neurofeedback, Autism, Education.

1. New technologies for education in Autism Spectrum Disorder

**Autism Spectrum Disorders (ASD)** are among the most disabling neurodevelopmental disorders in the children. They are characterized by impairments in social interaction, communication and restricted and repetitive behaviour (American Psychiatric Association, 2013). There are frequent (1,5%) and the prevalence seems increasing (Lyall et al., 2017). These disease are chronic and can still be impairing for adults. There is not drugs efficient for these disorders. The management of these disorders consist of psychotherapeutic approaches (Exchange and Developpement Therapy, Applied Behavior Analysis, Early Start Denver Model, cognitive remediation focusing on social skills) (American Psychiatric Association, 2013). Education is a big challenge in this population. A lot of adjustments of the classroom are necessary. When it is possible, it is often more feasible in smaller class and with specially trained professionals, sometimes with a specific auxiliary teacher in charge of the child.

At school, **new technologies** offer the possibility to support the role of the teacher. They seems accepted by these children since they are more predictable, rewarding and simple than classic human interaction. Electronic tablets are already developed to help communication the children with application. Let Me Talk allows children to connect images with spoken words to support their communication skills[[1]](#footnote-1). Social Handy aims to improve and test the knowledge of the children about the basic autonomy of everyday life[[2]](#footnote-2). These application are easily applied in school settings and very well accepted by the children. However, it could be difficult to use the tablets in a social context and they hardly improve engagement in social and education activities.

It seems that the use of the robots is a good strategy to improve these skills since such technologies are socially more simple and predictable. Predictability is moreover very important in experimental setups to improve reproducibility. Embodiment could make the transfer of trained social skills to humans more easily. A robot can do better graduation of difficulty and can repeat more precisely and without a special target behavior than a human.

Some project of robots are developed but they hardly target the school skills directly.

* **Quee ball robot** is a rolling spherical robot that produces sounds and lights. It allows to evaluate motricity, pointing, imitations and turn taking skills and ability to answer from a request for help (Salter et al, 2014).
* **Milo robot** is able to imitate the facial expressions of the child in a turn taking. The child learns to produce and imitate the facial expression of the robot in a ludic way[[3]](#footnote-3).
* **Nao robot** (in the cowriter project) aims to the child to learn to write to a robot. The robot imitates clumsily the writing of the child and the child has the responsibility to teach it how to write in a ludic and pedagogical turn taking. He learns to write by teaching to the robot how to write. The child thanks to the protégé effect invests the writing progress of the robot. He is less anxious and can be more progressive than in front of an adult. These tools could help to support attention among these patients. (Hood, 2015)

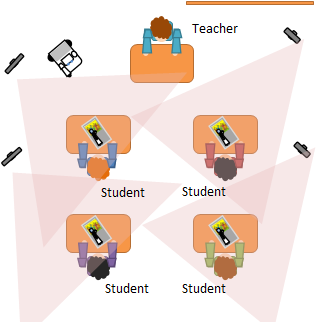
These scenarios are very precise and stereotypical. Unfortunately, they don’t allow the possibility to make a classical school training.

1. Nao Attention trainer Robot

Without attention no education is possible. Attention disorders are often comorbid among this population. It is more difficult for children with autism to focus on an educational task. Attention style among children with autism is different. They have a specific interest toward objects and less interest toward other humans. Theories suggest that the social load is too much important and the humans are too much unpredictable. In this framework, it is legitimate to make the assumption that children with ASD are more motivated to interact with robots than with humans.

We suggest that we could improve implementation of robots at school by:

1. Precisely measure the behaviour and attention cues given by the teacher at school with a Microsoft Kinect directly installed at school;
2. Brainstorm different scenarios to improve attention and engagement of children with autism at school:
   1. Detect the shortage of attention of patients with an EEG device detecting the anomaly of beta/theta ratio (Arns, 2014), the motor hyperactivity (by accelerometer) and the shortage of visual contact (a webcam connected with face detection software (Xing, 2013) with the school task. We plan to label behaviors in school and to train machine learning algorithms to give a feedback of the attention level of the child
   2. Call the child and show him the task (joint attention (Dawson, 2004) to help him to refocus on the task when his attention is lost
   3. Be more predictable by measuring the different period of work and reward to give more gradual training to the child. This could support the inhibition processes impaired among these children with attention disorder who are not able to delay a reinforcement (Wilson, 2011). Children with delay discounting impairment are not able to delay gratification (reinforcement) and prefer a small gratification soon than a larger gratification later.
   4. Support the request for help from the child to the teacher when he is struggling. For instance, model the behavior of raising its hand when the child needs help (Huskens, 2013).
   5. At the end, robots could be interesting to give specific social gratification. We could use interest of children with dinosaurs or songs to display images, imitates songs. In this set up, a turn taking could be very interesting to increase interest the child with simple positive social interactions.
3. A Wizard of Oz approach would probably be necessary at the beginning of the development of the robot to evaluate the relevance of the scenario.
4. Implement these scenarios to increase autonomy of the child and the robots and decrease input from the technician and the teacher
5. Evaluate and disseminate these scenarios.



**Fig. 1.** The use of a robot in a classroom. The robot acts as active partner of the teacher and the pupils; RGB-D sensors are conveniently placed to capture the behaviours of pupils.

An interdisciplinary interaction between roboticists, teachers and healthcare professional will be necessary to select relevant scenarios. This approach is for instance promoted by the Human Robot Interaction Summer School[[4]](#footnote-4) which holds every year.

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2. https://auticiel.com/ [↑](#footnote-ref-2)
3. https://robots4autism.com/ [↑](#footnote-ref-3)
4. https://hrisummerschool.org/ [↑](#footnote-ref-4)