Sophisticated Learning Technologies: Leveling Education for Autism Spectrum Students

K. A. Comfort
Department of Psychology, Fielding Graduate University, Santa Barbara, CA, United States

Abstract - *Neuro-Education technologies that teach empathy are powerful evidenced-based interventions targeted for autism spectrum conditions (ASC). Effective technologies improve social competence in students with ASC, and ultimately, their quality of life. Clinical studies show these technologies meet two criteria. First, best-in-class educational and therapeutic interventions are inspired by neuroscience research to address this empathy disability, and at the same time exploit the student's hypersystemizing strengths. Second, best-in-class interventions create learning environments that integrate all three Narrative Game-based Learning Objects (NGBLOs). Specifically, these technologies are steeped in learning, gaming and narrative theories. The first two combine traditional pedagogic methods with state of the art gaming approaches, while the power of story transports students to the world of emotions. The Neuro-Education Empathy-Enhancing Technologies (NEETs) concept is introduced to describe sophisticated interventions. The author calls for further research into NEETs that teach the art and science of empathy.*

Keywords: Autism, empathy, Neuro-Education, imitation, social learning

1 Introduction

Educational visionaries have long predicted the powerful role neuroscience and technology would play to promote social learning at the neural level [1-5]. These scholars called for research into applications that could engage children in collaborative, constructive and interactive learning environments [2, 3]. They envisioned computer-based technologies and behavioral interventions that would effectively address the most pressing learning needs of today's students and tomorrow's workers [5-8]. All students, and particularly those with an empathy disability, must be equipped for group collaboration, interactive engagement, frequent feedback, and real-world, meaningful connections through imitative learning [2-9].

Media psychologists envisioned new learning cultures and outlined several cultural competencies that are required attire for this new participatory culture [2, 3]. The new collaborative learning cultures is where youth are "messing around," "geeking-out," and "hanging-out" in highly participatory spaces- a collective where people belong in order to play along and learn [4]. In order to develop social competence, students must be outfitted with emotion recognition skills, [5, 6, 7]. Today's collaborative workplace demands competencies in the skills of play, performance, simulation, collective intelligence, judgment, transmedia navigation, and negotiation [2, 3].Concurrently, the U.S. Secretary of Education, Arne Duncan, declared the state of education a national public health crisis [4]. At the same time, autism emerged as a major public health concern in the United States and began to tax the educational, medical and social services systems [4]. The state of California funded $34 million for a new research and treatment center for autism called the Medical Investigation of Neurodevelopment Disorders (MIND) Institute [4]. However, these challenges are of great concern to over 80 nations across the globe [10].

In response, the International Mind, Brain, and Education Society has launched several initiatives [4]. So begins the story of the birth of a new research discipline called Neuro-Education. This interdisciplinary approach to learning models the very collaboration required to integrate the collective fields of education, psychology, neuroscience, and cognitive science. The aim is to better understand how we learn and how we can construct better teaching methods, policies and curricula [4].

2 Neuro-Education and Empathy-Enhancing Technologies (NEETs)

This paper will highlight research from the above Neuro-Education disciplines and introduce the concept of Neuro-Education and Empathy-Enhancing Technologies (NEETs). These educational and clinical interventions are specially designed to teach empathy skills to children known to be neurologically impaired in social competence, namely those diagnosed with autism spectrum conditions (ASC) [7-10]. The author argues that scientifically sophisticated interventions meet the NEETs best-in-class criteria when they are inspired by Neuro-Education research, and when the technology's design incorporates all three of the Narrative Game-based Learning Objects recently introduced in the Technology-Enhanced Learning field [4-6]. Specifically, NEET interventions are steeped in gaming, learning and narrative theories [7-11].

Although there is no shortage of nifty applications for individuals with ASC, there is a paucity of theoretically sound, empirically tested and purpose written solutions marketed specifically for empathy education in populations with ASC [12]. Neuro-Education interventions are designed with a solid foundation in all three of the NGLOBs [11]. Specifically, the NGLOBs map to the three effective approaches that teach social skills to youth with ASC.

The three domains are first, storytelling, or the use of stories as instruments for suspenseful knowledge transfer. The second domain is the use of game theory and gaming, or providing a playful learning environment where interaction and exploration are dominant. The third critical domain is learning, here knowledge transfer is reinforced with pedagogical assessments of learning success, and include reward systems and intrinsic motivational systems to engage players [11]. At the end of the yellow-brick lesson plan, NEETs provide evidence-based learning outcomes with improved emotion recognition and social competence [7-10].

2.1 Testosterone trouble

Many psychiatric conditions are identified more frequently in males that females. These include attention deficit hyperactivity disorder (ADHD), early onset persistent anti-social behavior, specific language impairment, dyslexia, and autism [14]. More boys than girls have pervasive developmental disorders that land along the autism spectrum disorders. Anorexia, depression and anxiety disorders don't share a male bias, causing researchers to explore sex-limiting factors behind sexually dimorphic aspects of cognition and behavior [14]. Specifically, the "extreme male brain" (EMB) theory of autism proposes an etiology of specific sexually dimorphic traits fueling a stronger drive to systemize, rather than empathize [10]. It expands the empathizing-systemizing (E-S) theory originally described by Hans Asperger. The empathizing-systemizing (E-S) theory of autism, identifies typical psychological sex differences [10]. And hypothesizes that females on average have a greater tendency to empathize (or relate to other's feelings, and to respond empathically with a socially appropriate behavior) in contrast to a stronger male drive to systemize (analyze or create rule-based systems, abstract or literal). Scientists do not have conclusive evidence about whether it is environmental, hormonal or genetic factors are behind the higher male incidence of ASC. However, recent research supports evidence arguing that prenatal exposure to testosterone might be related to later development of autistic, or "extreme male brain" traits [9,10,14].

2.2 The problem of empathy

The autism spectrum conditions (ASC) are neurodevelopmental disorders recognized by severe social communication problems, "obsessions" or an extremely narrow range of interests, along with the need for sameness, and repetitious behaviors [6-10]. As a neurological condition identifiable in infants, autism symptoms vary tremendously along a wide spectrum of clinical severity. What stands out behaviorally are the socio-emotional and communication deficits, with a particularly palpable absence of empathy [8-10]. Hence, the ASC fall under the umbrella of "empathy disabilities" [6,9,10].

Since the macro ability to empathize is underpinned by micro skills such as emotion recognition, individuals with ASC are also recognized by severely impaired social communication and emotional abilities. All along the empathy bell curve, this empathy disability presents itself every where a toddler turns [6-10]. These kids struggle in three domains: social, communication, play and imagination. Cognitively, they tend to have rigid and narrow interests or "obsessions." For the higher functioning individuals with ASC, such as with Asperger's Syndrome, this is typically in the very lawful or highly systemized academic domains like math, all the sciences, physics and technology [13].

3 Sophisticated technologies

What is meant by "sophisticated technologies?" NEETs are psychologically and neuroscience sophisticated technologies designed for students with ASC. They are not merely cool gadgets and nifty applications. These are carefully designed products grounded robust theory and years of research that meet the NEETs criteria outlined in this paper. Designers will have operated from the Narrative Game-Based Learning Objects (NGBLOs) approach.

The NEETs are Neuro- Education inspired and gaming, learning and narrative theory steeped. The game theory helps engage the student with things they like best, and motivates them to improve their level of expertise. The power of narrative transports students to a world of emotion. They will author stories or act them out, or have their robotic pet act them out, or they will read them or view them- via any media that can captivate the learner story. Specifically, the intervention's story line transports ASC students to the emotional world of faces, friends and feelings [7-10,14].

In addition, sophisticated NEETs, will teach students about the causes and consequences of feelings [9]. Finally, effective solutions propose clear learning objectives that are targeted specifically for an ASC population. In other words, these are educational and clinical interventions that teach empathy and improve an individual's mind reading, emotion recognition skills and emotional intelligence, or Empathy Quotient (EQ) [7-10,14].

The manufacturer should clearly identify which of the 412 emotions are taught. For example in *The Transporters DVD*, 15 specific basic and "intermediate" complex emotions are taught. If schools, hospitals, pre-schools and day care centers have screened it and use it as a therapeutic intervention, or the solution has won reputable awards, these are additional indicators of an effective and evidence-based intervention. For example the animated series The Transporters was nominated for a BAFTA in the Children's Awards Category in November of 2007 [14].

3.1 PETS

Researchers from the Advanced Computer Studies at the University of Maryland partner with children as their fellow researchers and have published fascinating results. They used a methodology called cooperative inquiry alongside of their authoring application (story telling environment) called PETS [15]. They use an interactive robotic pet as a story-telling platform to teach emotion recognition and appropriate expression. PETS stands for a Personal Electronic Teller of Stories, and is a robotic story telling environment designed for elementary school age children.

Each PETS kit holds a box of fuzzy stuffed-animal parts and the My Pets software, a variety of methodologies for story construction [15]. The application includes a robotic companion, a library of story starters, and all the parts needed to build a robotic animal or pet. PETS1 was the first intergenerational design team to partner with children who assisted in the design of the robot. PETS is an innovative educational technology designed for typically developing elementary aged children. It seeks to inspire collaborative learning and narrative skills. This authoring application is best described with a compelling example of the story written by a seven year old child [15]. The title is *Michelle*:

"There once was a robot named Michelle. She was new in the neighborhood. She was HAPPY when she first came, thinking she would make friends. But it was the opposite. Other robots threw rocks and stick. She was SAD. Now no one liked her. One day she was walking down a street, a huge busy one, when another robot named Rob came up and asked if she wanted to have a friend. She was SCARED at first but then realized that she was HAPPY. The other robots were ANGRY but knew that they had learned their lesson. Michelle and Rob lived HAPPILY ever after. No one noticed the dents from rocks that stayed on Michelle." [15].

This narrative illustrates the immense power of story to teach and transport students to the world of emotion where sometimes feelings and change make the world a huge scary place full of uncomfortable feelings.

3.2 The Transporters

The Transporters is a multi-media animated broadcast series was specially created for children with ASC who have trouble reading faces, feelings and making friends [9]. It was supported with funding from the UK government and designed by a team of clinical psychologists, film and technology experts. Professor Simon Baron-Cohen, the Director of the Autism Research Centre at the University of Cambridge, is one of the experts who was involved in establishing the educational goals of *The Transporters* intervention [9]. These include: to familiarize children with the human face and increase the amount of time that they spend observing faces; to introduce children to emotional concepts; to teach that emotions have causes and consequences; and to illustrate diversity in the way characters react differently to the same situation. In terms of the NGBLOs, and NEET criteria, *The Transporters* has traditional pedagogical assessment tools, including quizzes after each episode and a detailed guide and discussion book parents can use to reinforce learning. Gaming rewards are built into the program when a child answers a question correctly. If the question is answered incorrectly, the narrator asks the question again until the correct answer is given. There are also gaming levels built in for an easy or hard quiz. The DVD utilizes storytelling to teach learning objectives design to help the children identify the causes of certain feelings [9].

In one study, s group of children with ASC watched the DVD for one month, for at least 15 minutes a day. During that short time, the researchers found evidence that the children made significant progress in expanding their emotion recognition skills. This same group also "caught-up" with typically developing children. Also, there is evidence this intervention teaches emotion recognition in such a way that children do generalize the learning to other faces in their real world, besides just the faces of the trams and trains.

ASC kids are enthralled with vehicles, because they move predictably. They don't move unexpectedly off schedule, and for no apparent reason, particularly trams and trains. The opposite of faces and feelings and friends. The strategy was to engage children with ASC and help them learn about emotions, as one of the fundamental precursors to developing the ability to empathize.

For kids who do not naturally prefer to look at faces (they move unpredictably), *The Transporters* creates a learning environment where real faces are "grafted" on to cool vehicles. Suddenly, real faces become interesting through 8 friendly characters. The primary aim of the designers is to help children (even those without autism) to learn to recognize the causes and consequences of emotional expressions. Although scientists have identified 412 complex emotions we grown-ups are supposed to know, *The Transporters* limits the selection by focusing on teaching the main 15. These include: (alright pop quiz, quick, close your eyes and name at least ten to win fabulous prizes): afraid, angry, ashamed, happy, sad, excited, disgusted, jealous, joking, kind, proud, sorry, surprised, tired, and unfriendly.

Infants and toddlers who grow-up with the neurodevelopmental challenges of ASC, are believed to be about 1% of the population in the UK [14]. They begin life with severe social difficulties that are disabling, and we know that social competence level predicts the eventual quality of life for individuals with ASC. As early as pre-school they lose friends in the sandbox, they get kicked off the bus in middle school and by high school they are expelled from the conventional classroom. Hence, an early detection and public health education approach to ASC is the only one that really makes sense.

The important conclusion is that emotion recognition difficulties found in ASC are not insurmountable, particularly when there are NEET interventions available like those discussed in this paper. Until the United States government

funds such interventions for families with toddlers, academic and health care institutions may want to consider placing these tools in the waiting rooms and hands of mental health professionals, teachers, parents, pediatricians, residential treatment centers and psychiatric hospitals. While Americans quibble about the prevalence rates of ASC here in the states, should we not consider even a temporary borrowing of these evidence-based tools in the interim and capitalize on interventions like *The Transporters*?

The research indicates these are powerful empathy teaching tools designed to help vulnerable children and families get transported safely to our big, busy world of emotions. Charlie, Sally, Jennie, Barney, William, Oliver, Dan and Nigel are waiting [9, 10]. These friendly faces truly make learning feelings fun. Seriously.

3.3 Mind Reading

Teaching empathy, and its prerequisite skill-emotion recognition, certainly is not an exact science. However, scientists have done their homework. They have developed taxonomy of 412 complex emotions and identified 24 groups or families of emotions that are universal across the world [8,16]. Their mission was to scientifically explore the best approaches to teach emotion recognition to individuals with ASC.

These "emotion experts" have identified the "look" and "feel" of the "top 100" complex emotions, as well as the six basic emotions. They have integrated the long-term research from the field of Technology-enhanced Learning and incorporated the three critical domains required for any successful educational project. Namely, *Mind Reading* uses story-telling, gaming and learning theories to motivate and engage students with ASC [8,16]. For example, the Game Zone offers 5 interactive games for just plain fun. It includes a variety of "collectables" to earn as rewards and build a collection of various items. This capitalizes on the strong systemizing drive in the ASC brain, the typical "obsession" with a narrow and limited range of interests [8,10,14,16]. *Mind Reading*, is an interactive guide to emotions that contains brief film clips, photos and audio recordings of 412 distinct human emotions. [8,10,16].

This taxonomy of emotions bundles our extremely wide range of feelings into 24 "families of emotions," such as the Angry Group, the Sad Group, and the Happy Group, etc. In the game zone section of this software there are six different levels that distinguish each emotion according to when it is typically recognized whether in early childhood (Level 1), or developmentally in between (Levels 2, 3, and 4), or adulthood (Levels 5 and 6). Cambridge University researchers conducted follow-up studies with adults with Asperger's Syndrome (considered on the high-function end of the autism spectrum). The study participants who used the DVD for two hours a week for 10 weeks improved their emotion recognition skills, vocabulary and assessment scores [9,10,14].

This clinically tested digital education game (DEG) creates a learning environment specifically designed for teaching emotion recognition skills. *Mind Reading* has been studied by researchers to see if the learning could generalize to their real world settings with improved behaviors [8,10,14]. La Cava and colleagues evaluated the effects of this computer-based training on 4 boys with high-function ASC, aged 7 to 10 years. Like the adults, the boys used the computer program for 10 weeks, and they were also provided guidance by a tutor. These children showed improvements not only in their emotion recognition assessment scores, but also in their day-to- day interactions with peers. However in this line of research, the researchers need to conduct further studies to evaluate the unique contributions of the *Mind Reading* program and the interactions of the intervention in conjunction with tutor-aided training [8, 14].

3.4 Robota

Applying assistive technologies in behavioral studies has helped enhance the educational development of children with impaired communication and social cognition skills [10,17-19]. The Robota robots look like a human infant and have been used in studies to investigate their ability to assess children's imitation learning skills. Also, researchers are exploring the ability of Robota to teach low-functioning children with autism simple coordination behaviors that reinforce learning via the imitation play game.

The emphasis of Robota as both an educational and therapeutic medium has long-term clinical research that informs the design and use of robots for the rehabilitation of children with ASC. *Robota* has been included in longitudinal studies, conducted at the Hospital of La Salpetriere and the University Pierre et Marie Curie, that investigate the use of predictive interactive machines as a means to elicit imitative behaviors in children with autism [17,18].

Robota dolls are humanoid robots. They were developed as interactive media toys, learning environments and rehabilitation applications-all part of project AURORA (AUtonomous RObotic Platform as a Remedial tool for children with Autism). Robota and similar autonomous mobile robots are designed for remedial use to encourage children with autism to practice and increase the important pre-requisite skills to social behaviors [17,18,19]

For example, infants with autism exhibit less eye-contact, joint attention, approach and imitation games. Robots used in non-verbal children with autism showed delight and preference for interacting socially with robots in comparison to interacting with their peers and care givers [17,18,19]. The research indicates that use of robot-assisted therapies for children with ASC will stimulate the frequency and types of pro-social behaviors more so than other interventions. To date, these studies have revealed that children with autism, even those who are nonverbal and who have cognitive delays, are able to spontaneously imitate simple, as well as complex and novel sets of coordinated actions. Moreover, several of these children are capable of recognizing that they are being imitated and use this observation as a means of communicating with others, while the longitudinal studies

aim at exploiting these elementary skills to help a child learn the causal relationship of his/her actions on others' behavior [17,18,19]. Robot –assisted autism therapy has been encouraging as researchers have observed that children with autism exhibit some specific positive and social behaviors that they exhibit when interacting with robots, however not when they are engaging with peers, caregivers, and their therapists [17,18,19].

3.5 LEGO Therapy

One final intervention that meets the NEET criteria for showing a strong research base documenting its effectiveness is LEGO play therapy [20, 21]. ASC kids are very attracted to 100% lawful systems, including building materials such as LEGO [8, 10, 20, 21]. LEGO is a very predictable and highly structured toy that children with ASC really enjoy. Therefore, it consistently motivates and engages children with ASC to learn the LEGO club rules, level up, and learn their empathy education lessons.

Group and individual narratives are experienced with game-based reinforcers and specific learning objectives that clearly aim to improve their social competence. This is literal practice growing those neural circuits involved in joint attention, collaboration, impulse control and emotional regulation. Through imitative learning, they are likely growing their mirror neuron social learning circuits [6,7,10, 20, 21]. Long-term follow-up studies of LEGO play therapy document three fascinating findings [20, 21].

The first is that children with ASC do improve their social competence significantly compared to a no intervention group. Specifically, the scientists measure increases in the frequency with which they initiate social interactions, and the duration with which they maintain any social interactions. Secondly, this is one of the few interventions identified in the ASC literature with strong evidence that the empathy education generalizes beyond the lab and out to the play ground and lives of the participants. Historically, achieving generalization of learning or knowledge transfer into the real world of these kids has been problematic.

The third important finding from long-term LEGO therapy research is particularly powerful [20, 21]. The generalization of learning mentioned earlier is measurable when ASC children decrease and replace their maladaptive behaviors with those that are more socially appropriate and relationship enhancing. The maladaptive behaviors that shift fall in the social difficulties domain. Lack of reciprocity (no turn taking, no dialogue, just monologue), difficulty reading other people's emotional expressions via faces, voices and posture, atypical eye contact (either staring too long and invading your personal space or little to no eye contact), and difficulty mind reading (understanding or empathy for someone else may feel), temper tantrums, teasing or bullying, showing lack of respect, lying, cheating, stealing, defiant or extremely negativistic, and too physically aggressive [10, 20, 21].

Historian Lynn Hunt proposes that the amount of empathy a culture embraces changes with time. Cultures have not always valued empathy [22]. Hunt argues that as the 17th century French people became engrossed in the new media of their time, like the popular novels *Julia* and *Clarissa*, their brains changed chemically. Gradually, as readers were transported by stories of women who strove for autonomy, Hunt believes, and neuroscience supports this hypotheses, that stories changed their brains. This in turn resulted in the growth of empathic perspectives and eventually the 18th century birth of human rights. If Hunt is correct, then this is not the first time in human history that technology and narrative found the perfect dance partner in empathy, and changed us for the better.

4 Conclusion

Educators in a position to purchase tools that meet criteria for NEET can draw on the wisdom gleaned by researchers in the field of Neuro-Education. To identify sophisticated NEET, three questions need to be answered in the affirmative. First, does the science the Neuro-Education purview: is the product built on good brain science? Second, best in class interventions are those where the designers designed the tool to capitalize on the power of story, as well as the latest gaming and learning theories, which includes assessment of knowledge mastery. In particular the intervention outlines a clear learning object to enhance empathy such as with increased emotional vocabulary.

Ultimately, these interventions are built on years of research. They are designed to provide individuals with AS practice collaboration, improve social competence. Ultimately, the intervention will help them grow and stretch their empathy brain circuits. Affective computing, cognitive neuroscience, biomedicine, clinical behavioral science studies, and robotics are some of the academic domains with dedicated research centers and teams leading this research.

By now, best-in-class have long-term studies to back their findings. They have been tested on real children and families who live with the chronic and severe stress of this pervasive social and behavioral challenge. Desperate and tired parents are vulnerable to the latest "hype." Therefore, it is crucial to consult with international or national autism research organizations as well as the professional literature to identify any scientific evidence of effectiveness [8].

Educational technologies that teach empathy are pivotal to evidence -based interventions that target autism spectrum conditions (ASC). This paper has argued that the most sophisticated interventions are those that effectively improve socio-emotional cognition in individuals with ASC. These technologies will meet two important criteria. First, they are inspired by Neuro-Education disciplines in order to address the neural bases of a student's hypo-empathizing, or hypersystemizing tendencies. Second, best-in-class interventions create a learning environment that integrates each of the three NGBLOs. Specifically, they are steeped in learning, gaming and narrative theories. The first two combine traditional pedagogic (assessment) methods with state of the

art gaming approaches. Storytelling approach transports the learner to the world of meaning and emotion. Since social competence predicts academic success and ultimately the quality of life for students with this empathy disability, there is an urgent need for further research and development of these sophisticated technologies that promise to teach us the art and science of empathy.

Conflict of interest statement
The author has no conflicting interests with any persons, products, organizations or interventions discussed in this paper.

Correspondence: Kimberlee A. Comfort, M.A, L.P., Licensed Psychologist, email: kimberleecomfort@yahoo.com

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Independence of a child with an autism spectrum disorder is possible only if you follow the rules of safe behavior, which we will consider as behavior that does not harm yourself and others.The indicator of this behavior is the level of formation of the ULA and the development of life competencies.Â Diagnostics of the level of ULA formation of the students with ASD provides an opportunity for an objective assessment of the problems of students, for identifying the available resources of the child and for assessing of the effectiveness of the psychological and pedagogical support, provided within the framework of corrective work, aimed at the formation of life competence [4].Â Disorders of the autism spectrum. For students on the autism spectrum structured teaching approaches need to be in place across all areas of the curriculum. Teacher's recognition of a student's patterns of strengths and abilities, as well as need provide the necessary level of adjustment. Adjustments ensure that the child on the autism spectrum can access the content of the curriculum. Teaching needs to be clear and explicit and tasks broken down into manageable steps with easily understood expectations for successful completion. 10 ways to support students on the autism spectrum.Â The diagnostic criteria for autism changed in 2013 with the latest edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5).Â And while technology can be a powerful tool, Cooper suggests using it judiciously. â€œWith kids on the spectrum, it shouldnâ€™t be used as a crutch or a babysitter, but it can be used to help facilitate,â€ he says.Â Using â€œsocial stories,â€ a technique developed by Carol Gray, president of the Gray Center for Social Learning and Understanding, can help guide students through interactions with peers and teach social norms. Willis had a student with autism who would become physical when it was his turn to use the computer and someone else was still on it.