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Research paper

Robo therapist: a sustainable approach to teach basic expressions for special needs children in Malaysia

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Abstract

Social interaction is an essential component for development of both normal and special needs children. However, many special needs children suffer from a lack of social interaction because they are unable to interpret social cues as well as a failure in social gaze when communicating. One of the ways to cope with these problems is to improve their social cognitive skill by teaching basic emotions through facial expressions. This paper describes the development of a new and sustainable teaching and learning approach using robotics to promote social interaction among special needs children of aged 4-6 years old. The robotic tool can teach basic facial expressions such as happy, sad and angry to increase emotion recognition skill among special needs children. The growing demand for technological innovation to enable empowerment of developing communities requires new and creative educational initiatives. Malaysia has also address it concerns on sustainable education for all spectrum of communities. RoboTherapist is a new teaching and learning method in Malaysia's special education which targeting the special needs children. The special needs children are children with Autism, children with Down Syndrome, children with ADHD and slow learners. The aim of this research is to make teaching and learning more attentive for special needs children and hence to improve their social interaction in daily is life and gain confidence to communicate with the people around them.

Keywords: *Robotics; Special Needs; Sustainable; Emotions.*

1. Introduction

Special needs children are defined as children with developmental disabilities, mental retardation, emotional disturbance, sensory or motor impairment, or significant chronic illness who require special health surveillance or specialized programs, interventions, technologies, or facilities [1-2]. Special needs are an umbrella term for staggering array of diagnoses [3] but this research will focus on special needs children who are either a slow learner, Down syndrome or autistic. These children suffer from a common characteristic impairment which appear as disability to interpret social cues as well as a failure in social gaze when communicating [4-6]. They are having some difficulties to recognize and respond appropriately to emotional expression with the people around them. As a result, special needs children often get frustrated when they are unable to expressively share their feeling and socially interact with the community.

A sustainable approach in education is not just a simple 'add-on' of sustainability concepts to the curriculum, but a cultural shift in the teaching and learning. Rather than a by-book response which leaves the traditional mainstream education static, it implies systemic change in thinking and practice, informed by what can be called more ecological thinking and values. Sustainable approach is a new paradigm emerging around the concept of holism, systemic thinking, sustainability and complexity. According to Sterling [7], Sustainable education implies four descriptors: educational

Policy and practice which is sustaining, tenable, healthy and durable.

2. Problems

There are some problems that have been identified related to special needs children and their access to proper education.

a) Common Characteristic Impairment

Social interaction is a skill that begins developing at birth. The development of this skill lays the foundation for success in the classroom, at home, and in the community [8]. The reason is that, special needs children suffer from a common characteristic impairment which appear as disability to interpret social cues as well as a failure in social gaze when communicating [4-6]. For instance, they are having some difficulties to recognize and respond appropriately to emotional expression with the people around them which leaves them to isolate themselves from other people.

b) Lack of Resources

It has been mentioned that it is a major responsibility of teaching special needs children because of many challenges raised in the process [9]. For instance, resources are one of the major challenges faced in special needs education sector in Malaysia. Resource issues such as financial constraints, lack of trained special education teachers as well as facilities for special needs children [10]. All these issues can be solved with proper human capital development and management so that enough resources can be employed in special education sector.

c) Human's Natural Behavior

Dealing with special needs children is a very difficult task for everyone particularly parents, teachers and therapists. They struggle in handling the special needs children are real especially when the kids

are melting down or throwing tantrums [11]. This is due to the nature of human to have limited level of patience even though they are highly trained. Our observation found that the special needs children are too dependent on the teacher. A one-to-one session is required for each student as their attentiveness and focus are very low.

3. Current teaching methods in Malaysia

In Malaysia, the curriculum of special education for primary school is known as Kurikulum Standard Sekolah Rendah (KSSR) Pendidikan Khas which was prepared by Ministry of Education (MoE) Malaysia. All methods used by teachers in special education schools in Malaysia to teach emotions among special needs children are based on KSSR Pendidikan Khas (KSSR Special Education). Among the teaching methods used are:

a) Music Intervention

Multiple findings suggest music interventions may help education processes and development of children [12]. In addition, according to [13], music also has been proposed to facilitate social and language skills of special needs children. Because of that, many teaching materials used in special education have applied music as interventions to help the learning processes.

b) Video-Modelling

Video modelling is a visual teaching mode in which children learn desired behaviours by watching a video demonstration and then imitating the behaviours of the model [14]. There is a variety of model that may be employed including adults, peers, video-self modelling (VSM) and mixed model where a combination of models are used in a video. A study by [15] shown that all types of models are effective, but some are more effective than others. On top of that, special education teachers are using video modelling as teaching material because it has been shown to be effective in teaching a variety of skills to special needs children specifically children with ASD [16].

c) Role-Playing

Role-playing is an activity that allows special needs children to explore realistic situations and to teach them how to respond appropriately in the situations. It allows them to practice new skill before applying it with other individuals and friends. Role-playing is an active learning experience and has been used by therapists and counsellors for many years [17]. The learning outcome of this activity is students managed to differentiate between sad and happy facial expressions. The only tool that is used in this activity is a mirror. In conclusion, role-playing helps special needs children to understand emotions by putting themselves in someone else's shoes.

d) Role-Playing

A study conducted by Conallen & Reed (2016) shows that children with ASD could match emotion cards as in Fig. 1 to respective situational cues. Emotion cards are a deck of cards that have pictures of facial expressions and the word of the emotion that fits the expression. It is commonly used as teaching materials to facilitate emotion recognition among children.

Fig. 1: Emotion Cards.

Based on teaching module from KSSR Pendidikan Khas, there are several activities involving emotion cards. One of the activity is where the teacher shows two emotion cards which show sad and happy facial expressions. Then, the students need to say out loud the word "sad" or "happy" according to the card shown by the teacher. Later, the students need to explain the feelings based on the card shown. Fig. 2 shows the example teaching materials used in this exercise.

Fig. 2: Emotion Cards as Assistive Tools.

4. Relationship between colors and emotions

Color is an inseparable part of human's everyday lives and it presents in everything that human perceives. Color is characterized by hue, brightness and saturation. Many findings suggest that color has strong impact on human's emotions and feelings [19-21]. In 2004, an experiment has been conducted by [21] to study the relationship between color and emotion. In the study, ninety-eight college students were asked to indicate their emotional responses to five color which are red, yellow, green, blue and purple. Table 1 shows the result of the experiment.

Table 1: Emotional Reactions Frequency with Color

	Frequencies (%)				
Emotions	Red	Yellow	Green	Blue	Purple
Happy	21.4	75.5	28.6	10.2	21.4
Sad	4.1	0	0	8.2	13.3
Angry	28.6	0	0	0	0

5. Existing robotic tools

Previous studies proposed robotic approach as an assistive tool [22] to teach the special needs children as a sustainable approach. Robotic teaching aid uses programmable tool which has no feeling and can perform repetitive action without getting bored or stressed. In addition, robots have been found in many researches as therapeutic tools to facilitate social communication among children with special needs [22]. Below are some robotic tools found that deal with special needs children.

a) NAO

For special education sector, Aldebaran Robotics has created ASK NAO, a comprehensive software to revolutionise the education of special needs children. ASK
is the abbreviation for Autism Solutions for Kids and as the name goes, the software is designed specifically to assist teachers and therapists with in-class tasks and to facilitate communication with autistic children. ASK NAO provides a range of fun and educational applications to make learning experience better for these children. For example, an educational application called 'Guess Emotions' where the NAO mimics an emotion with body gestures and sound and provide several possible answers. Then, NAO will wait for the child to identify and recognize the emotion (Miskam et al., 2015).

b) Leka

Leka is an interactive robot designed for special needs children developed by a French start-up company. It provides fun and educational games that motivates social interaction among special needs children. It also helps in increasing motor, cognitive and social skills of special needs children ("Leka", 2015). It is developed based on published papers and from the perspective of parents, therapists and caregivers of special needs children.

c) Aisoy1

Aisoy1 is developed by a Spanish company called Aisoy Robotics. Aisoy1 is an interactive emotional robot that can promote the development of cognitive, motor and social skills of children with ASD ("Aisoy1 for Autism | Aisoy Robotics", 2017). It is designed with the help from researchers at Universidad Miguel Hernández (UMH) to expand the potential of Aisoy1 for the treatment of children with ASD. Aisoy1 provides a new method of thinking and playing via fun educational games and activities which promotes development of multiple skills. It acts as assistive tools for therapists during therapy sessions.

d) Buddy

Friend is a companion robot that is developed by a French company called Blue Frog Robotics to improve the everyday life of the user. Friend can protect home, provides entertainment, helps in kitchen, and offers edutainment to children. Buddy is 56cm tall, weighs 5kg, fully mobile and equipped with variety of sensors to perform various tasks. Blue Frog Robotics has done several tests in several institutes for autism in France to see the potential use of Buddy in special education. The result is positive where the children with autism seems to form a strong relationship with the robot. Buddy helps to improve the social interaction of children with autism by playing games, telling stories and doing small exercises with them

e) Milo

Milo is a humanoid robot developed by a company called RoboKind which based in Texas, United States. The robot has variety of sensors and motors to deliver various functionalities such as walks, talk and model human facial expressions. RoboKind has created a program called Robot4Autism which are designed to assist therapists and caregivers to teach social behaviours and emotional recognition to children with autism.

6. Rob therapist

The structure of the robot is illustrated using 3D model. The model is created using FreeCAD, an open-source Computer-Aided Design. The proposed actual design is shown in Fig. 3.

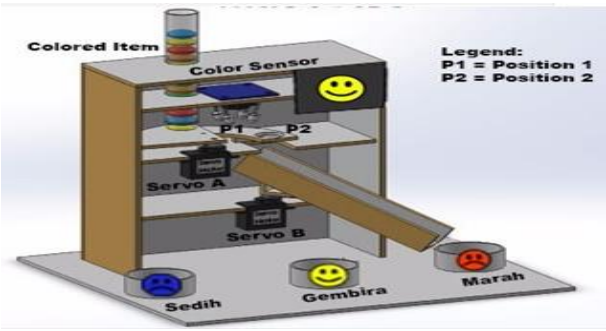

Fig. 3: Actual Robot Structure and Design.

ROBOTherapist is operated in two (2) different modes which are the teaching mode and learning mode. In the teaching mode, the robot is functioning autonomously without the need of human's intervention while in the learning mode, the robot is controlled by user via a controller. Teaching mode is used to complement the traditional teaching method prepared by the teachers while the learning mode is used to test their understanding from the observation done over the autonomous teaching. Users are able to switch between modes using a button.

a) Teaching Mode

The teaching mode allows the robot to demonstrate the teaching of the basic emotions without human intervention. They will have to simulate and response exactly as they observed the autonomous teaching program. The pseudocode is shown below:

1) A coloured item will be placed in the plastic tube on top of the prototype.
2) Servo motor A will push the coloured item toward Position 1 where colour sensor is located.
3) Colour sensor will scan the colour of the item.
4) The LCD display will display an expression followed by sound produced by the speaker based on the colour detected by the colour sensor.
5) For example, if red colour is detected, the LCD will show an angry expression (emoji) and the speaker will produce angry sound.
6) Servo motor B will move toward the correct expression box.
7) The item will be moved from Position 1 to Position 2 and will be sorted into the correct expression box.

b) Learning Mode

In the learning mode, the children will experience to interact with the robot via android apps that acts as a controller. The mode is explained in the pseudocode below:

1) A coloured item will be placed in the plastic tube on top of the prototype.
2) Servo motor A will push the item toward Position 1 where colour sensor is located.
3) Colour sensor will scan the colour of the item.
4) The speaker will produce sound based on the colour detected by the colour sensor. For example, if red colour is detected, the speaker will produce angry sound.
5) The user needs to position the servo motor B to the correct expression box using controller.
6) If the chosen expression box is incorrect, the LCD will display a 'X' symbol and the user needs to reposition the servo motor B to the correct expression box. If the chosen expression is correct, the LCD will display a '✓' symbol.
7) The item will be moved from Position 1 to Position 2 and will be sorted into the correct expression box.

7. Results

Several tests were conducted at a special school in Putrajaya, Malaysia. The tests are divided into two parts – observing the traditional teaching and learning methods by the teacher on eight (8) selected kids of different background and by using RoboTherapist as an assistive tool to teach basic emotions (sad, angry, happy) to selected kids with medium level of functionality who can deal with fragile items. This is due to the condition of the prototype that is still in alpha version. The traditional methods using flash cards was conducted for 10 minutes and the results are shown in Table 2. It can be summarized that number of distractions are higher and started to lose their focus at the first 3 minutes of the lesson. This could be due to the unattractive teaching aid used by the teacher.

Table 2: Traditional Method Assessment

No	Student	Learning Disability	Time of Loss Focus	No of Distraction
1.	Student 1	Autism	03.00	1
2.	Student 2	ADHD	02.00	3
3.	Student 3	Slow Learner	03.36	1
4.	Student 4	Down Syndrome	01.31	2
5.	Student 5	Slow Learner	03.87	3
6.	Student 6	Autism	07.34	2
7.	Student 7	Autism	NIL	0
8.	Student 8	Autism	02.41	3

As for the robotic approach, student 5, 8 and 7 have been chosen to undergo the assessment. The students are briefed on the functions and operations of the toolkit. In the same 10 minutes duration, the special needs kids explored both the teaching and learning modules. The results are classified into qualitative and quantitative as in table below:

Table 3: Robotic Approach Assessment

No	Student	Respond to Question	Participation Level	Focus Level
1.	Student 5	Very Good	Very Good	Good
2.	Student 8	Very Good	Very Good	Very Good
3.	Student 7	Good	Very Good	Very Good

The results in Table 3 shows that the students of different spectrums can quickly adapt to the new method with high level of interest. They responded to questions with accurate action and can sustain for more than 3 minutes with only single distraction. There is something interesting about student 7. He managed to remain his focus in both methods (traditional and robotic). The robotic approach promotes less dependency of the children with their teacher. They can operate the toolkit on their own. The interactive functions provided such as written instruction on screen and text-to-speech which produces sound from the attached speaker has captured their attentiveness level. The toolkit look so much like a toy has also introduced to the community of the school the concept of learn through play.

Fig. 4: Testing.

8. Conclusion

Emotion and facial expressions are always related to each other. Facial expressions are usually derived from someone's emotions. In education, robotics provides qualitative benefits through its precision, strength, sensing capabilities and computing ability. New applications and deployment models can be devised from the traditional pedagogy that improve sustainability and quality of life. Our results have shown that the increased of attentiveness and reduction of loss in focus from the robotic approach in teaching basic emotions. Robotics for sustainable development is an exciting challenge where research, education and industry in both developed and developing countries can equally contribute and benefit.

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