

Analysis and Design of Rehabilitation Device in Sensory Integration Therapy for Autism Children

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Abstract: A group of complex disorders in terms of brain development is known as Autism Spectrum Disorder (ASD). The rehabilitation device playing vital roles in this institute which provide crucial assistance in the process of helping the autism people. Nowadays, the development of the technologies has led to the integration of the rehabilitation device with technology to sophisticating the function of the device. In this study, the integration of the electrical and the electronic technologies will be implemented for the purpose of attracting the learning desire of the autism children. The performance of autism children in the aspect of 'attention' will be identified and discussed. Overall data that had been collected showed an improvement in the performance of both of the autism children. Hence, autism children showed that they had improved their performance by paying attention on the task that had been given and less doing unnecessary things that can keep their attention away.

Keywords: Autism Spectrum Disorder (ASD); rehabilitation device.

1. INTRODUCTION

Autism is also known as Autism Spectrum Disorder (ASD). ASD form a complex disorder in terms of brain development. There are different aspects in these disorders which are the problems in social form, verbal and nonverbal communication, and repetitive attitude [1]. In 1943, Dr. Leo Kanner published a report based on eleven of his patients at the Baltimore clinic which titled, "Autistic Disturbances of Affective Contact". The term of Autism spread since the paper is published and became the source of reference for all experiments about autism [2].

The number of peoples diagnosed with an ASD are becoming more prevalent in each passing year. According to the children born report in 1992 from the Centres for Disease Control and Prevention (CDC), 1 in 150 had a diagnosis of ASD by the age of 8 years old; for children born in 2002, 1 in 68 had a diagnosis of ASD by the age of 8 years old. Nowadays, autism is one of the important issues faced by all the community in the world. A newspaper article that discussed regarding an autism, where over the years, the attempts to treat autism have been replaced by the recognition that it is an example of neural diversity and that autistic people have their own unique capabilities

and strengths [3]. The article also encourages people to change their perspective towards the autism people and support the autism people.

ASD currently affects Malaysia and showed the number of children involved in this special program has been increased from 2006 to 2013 [4]. ASD can affect individuals in many different ways, but usually, the disorder includes difficulty in communicating, difficulty in social cues, and engaging in repetitive behaviours [5]. Examples of the perspective of others towards autism people is that "they cannot have successful live as a normal people to contribute to the community" [6].

In this situation, the improvement of technology helps to prove that those negative perspective towards autism people are false. Some of the difficulties that faced by the autism people can be solved by using the rehabilitation device or equipment. Those rehabilitation devices proved that some autistic people can overcome the difficulties by the helping of technology installed in the device. Technology helps in many perspectives, such as touching, hearing, focus, and relate to the psychomotor for sensory therapy.

2. LITERATURE REVIEW

"Autism" is an original word that is taken from the Greek word "autos", that has a meaning of "self". In 1911, Eugen Bleuler, a Swiss psychiatrist is the first person that has used the term. Eugen Bleuler discussed the symptoms of mental illnesses into a

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category and the term that has been used is confused with emotional problems [7]. During the 1940s, Leo Kanner and Hans Asperger were the pioneers that described children that obtained the characteristics that were recognized today as an autism [8]. In 1943, John Hopkins that worked as University Psychiatrist identified and classified autistic as a distinct neurological condition without a specific cause. He also changed the phrase "autistic" became "autism". During that time, Kanner found a new diagnostic category called "Early Infantile Autism". He categorized them as the Kanner Syndrome [7].

In 1944, Hans Asperger, an Austrian Paediatricians in Vienna has published five doctoral theses. The theses were described patients that have autism by using the term "autistic" [9]. Both of them (Hans Asperger and Kanner) have described the similar characteristics of social interaction and impaired communication. In 1981, "Asperger's syndrome" has become worldwide due to the propagation to the public [7].

There are two general terms that can be described to the group of peoples that have brain development problems. The terms were known as ASD or autism. ASD features a group of diagnoses that are considered clinically separate from another but are many times grouped together for learning purposes, as their characteristics often times overlap. These syndromes have been categorized as Asperger's Syndrome or High Functioning Autism (HFA) [7].

2.1. Autism

Autism also is known as Autistic Disorder. Eye contact, facial expression, body posture, and gestures are examples of Autistic Disorder. It is a social situation impairment caused when they failed to exchange nonverbal behaviour [10]. By the age of 18 months, the characteristics of autism can be observed. The important signs of an autism are the problems in social interaction, communication, age-appropriate play, and reasoning. The lack of understanding of emotional, verbal, or body language have proved the problems of impairments faced by autism people [1]. Repetitive behaviour faced by autistic people that they may repeat actions or words in an obsessive manner. For instance, the echoing sounds and the hand flapping [7].

2.2. Motor Learning and Technology

In this project, children with autism behaviours most likely related to the soft motor skills which also related

to the sensory therapy. One of the platforms of learning for autism children is motor learning programme. Motor learning refers to the learning process through practice and repetition, which are led to the acquisition of motor skills [11]. This motor learning process is viewed by the improvements in speed, accuracy, or precision which the given motor movement (or sequence of movements) is performed. Over time with extensive repetition, movements can also become automated and no longer requiring over attention control for the execution [12]. Individuals with ASD are able to execute an aimed motor movement with accuracy comparable to that individual development. The motor learning process will be more efficient with the help of the installation of technology.

Nowadays, technology playing withal roles in the process of teaching and learning in the education system. The situation is similar towards the autism people which the requirement of technology in the education system also helps the process of learning and teaching become more efficient. The rapid development technologies such as robotic provide a way to perform a more accurate analysis of ASD and will become more effective and consistent [13]. For example, simple applications that have been designed for autism are presented to improve the skills of communication including social behaviour. These applications are created to be played through any touch-enabled devices or can be used as keyboard or mouse [14].

Furthermore, a more advanced review on using the applications to teach autism people to improve their social interactions and emotion has been provided by Grossard *et al.* [15]. The researchers in the study aimed for the skills development of several different applications, the designed concept of the applications also focus whether or not the applications are suitable in a clinical population.

2.3. Busy Board

On the other hand, the busy board is one of the rehabilitation devices which can also contribute to helping autism people especially autism children. Busy board is known as a board that consists of several games or applications on the board that can be played by the normal or autism children. Games or applications that can be installed on the busy board can also be categorized in many aspects such as numbering, alphabets, shaping, and colouring.

Furthermore, the applications for daily activities or daily routine such as tie a shoe, locking a door and wear a belt can also be installed on the busy board. The output that needs to be observed is the performance of the autism children. With the practice in daily life or repetitive movement, the performance of autistic children should become better from time to time. Implementation of technology on the busy board will also help the data or the performance of autistic children to record and observe.

The safety of the busy board is already guaranteed because the size of the busy board is not bigger as humanoid robots. Besides, the price of the busy board is also affordable due to the size and technology is much lesser compared to the humanoid robots. Lastly, the busy board can also be one of the important rehabilitation devices for autism people, especially for the autism children.

3. METHOD

Three objectives in this project, including:

- i. To investigate the effect of therapy process on the autism children's soft motor skills in term of performance by using the rehabilitation device.
- ii. To design a rehabilitation device equipped with soft motor skills assessments for therapy process.
- iii. To evaluate the rehabilitation device performance in terms of time completion for the test during the therapy process.

Data collection is the method of gathering, measuring and collecting information and feedback on targeted variables which include the process of questioning and answering. Data collection is one of the important elements in a research of the fields of study such as physical and humanities. The data collection is consistence and efficient to maintain the integrity of a research. The process of data collection provides a reference form to measure and function as an indicator of improvement. The goal or objective of data collection is to obtain the quality evidence that can prove the research requirement.

In this project, a survey form had been done in the Google form and being distributed through communication media such as WhatsApp and E-mail. The process of answering the survey questions become easier through the communication on the

media because it saves the cost of printing the survey form and also save the time to travel and collecting the data and feedback. The Google form will record the data and feedback received in the form of table and pie chart showing the percentage based on the answers and questions.

Data collected was limited to 50 respondents with a range of age from 18 to 30 years old. The survey consisted of five simple questions about the perspective of autism and the idea of a busy board related to one of the rehabilitation devices. All the data and feedback that had been collected were presented as the result of this project.

Figure 1 shows the amount of percentages of Malaysians understood about autism, where 90% of the respondents are already understand the issue of autism happened in Malaysia. Therefore, efforts should be done by the society to encourage all the Malaysian to take the issue of autism seriously. The understanding should be strengthened by supporting and helping those people that facing autism problem in Malaysia.

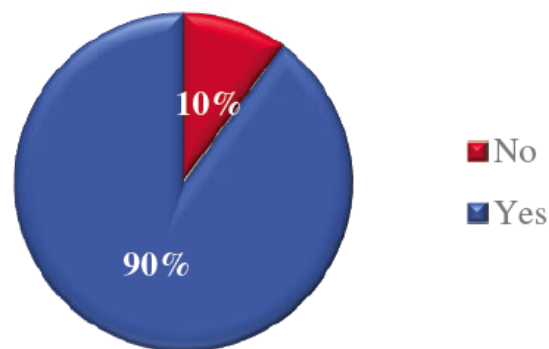


Figure 1: Percentage of Malaysian that Understand About Autism.

Figure 2 shows the percentages of Malaysians family that have autism among their family member. According to the survey, only 12% of the respondents have an ASD member in their family. By referring to the Figure 1, even though the percentage of the peoples in Malaysia that facing issue of ASD is only 12%, however, the percentages of the peoples that understand about autism are very high which are 90%. The data demonstrates the Malaysians society have aware of the existence of the autism issue, but only few of them facing autism issue in their family.

Figure 3 shows the percentage of Malaysian that understood the features of busy board towards autism people, and the highest percentages are 78% whom

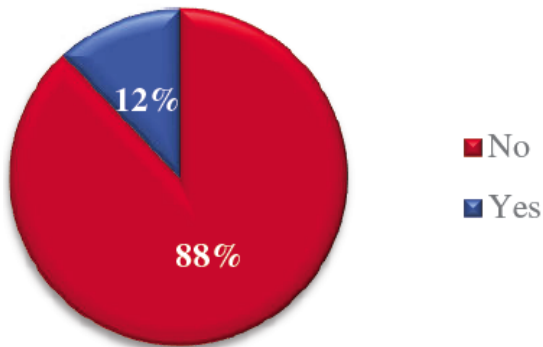


Figure 2: Percentage of Malaysian Family that Have Autism.

have answering "NO". From the data obtained, it is clearly shown that most of the Malaysian did not understand the busy board can also be one of the rehabilitation devices that help and support autism people in the therapy. Therefore, the project is needed to be proved and encourage the Malaysian peoples regarding the helps and supports that can be provided by busy board.

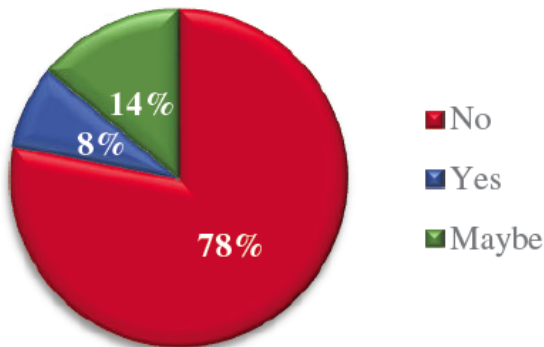


Figure 3: Percentage of Malaysian Understandings about Busy Board.

3.1. Hardware Development

For the hardware development, hardware refers to the technology itself that will be used in this project. Technology that will be used in this project is Raspberry Pi 3 B+ with the touchscreen as shown in Figure 4. While the basic electrical components that will be used in this project are wire jumper and push button. Model B+ has 40 GPIO pins, four USB 2.0 ports, and 5V/2.5A of Direct Current (DC) power supply. It can also be connected using Display Serial Interface (DSI) display port to connect the touchscreen display.

3.2. Software Development

Computer software is one of the examples of software development and the software that will be

used in the project is Python, which is developed by Guido van Rossum. One of the modern computers languages is Python and it is also one of the earliest programming languages. Python is an open source language and can integrate the systems more efficiently. Programming Language that is high-level language encourage the users to create solutions to programming problems in the forms that are similar to natural language such as English. Examples of a high-level programming language are C, C++, and Java.

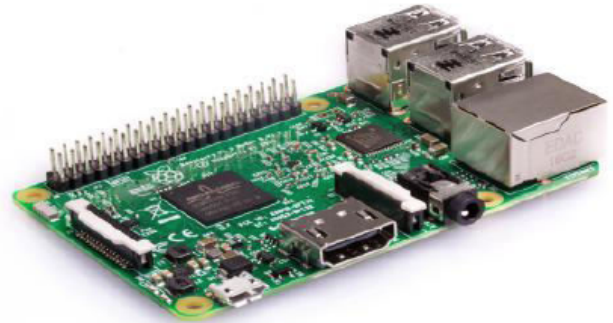


Figure 4: Raspberry Pi 3 B+.

Development of Graphical User Interface (GUI) also had been done in this project. GUI designed to the simplest display to avoid the autism children getting confused with other display.

4. ANALYSIS

Analysis had been done on both previous device that was Board Kinesthetic for Autism Rehabilitation (BKFAR) and the new rehabilitation device that had been designed as depicted in Figure 5. Data were collected on both devices to compare the performance of autism children. Data were collected in three days to monitor the performance of autism children.

Board Kinesthetic for Autism Rehabilitation (BKFAR) is a device to improve focus, thinking skills and the way they handle their life activities for the autism person. The BKFAR design is very attractive and interesting to play. The main idea of this design is to improve autism person's motor skill, focus and attention, cognitive development, sensory and social/pretend play.

From the product of BFKAR, a lot of soft motor skills can be practiced but with a lot of applications on the board, attention of autism children can be easily distracted from the main task that had been given. The design of BFKAR can easily confuse the autism children with the arrangement of the applications on the

product. Therefore, the idea of this project is to develop only one application in educations that can help autism children to improve their performance in term of attention that can be applied on any daily activity that they will do in their life.



Figure 5: Front view of BFKAR.

Figure 6 shows subject 1 and subject 2 of the BFKAR product had completed the task for 3 days in row. The data have been recorded and tabulated in Table 1. First day of the test, subject 1 takes 183 second to complete the all the task. Then the second day subject 1 manage to finish all the task quicker than

the day 1. For the 3rd day, subject 1 even getting faster to finished all the task then day 1 and 2. By taking 3 days result of the student we conclude that an autism student can remember very well if they continuously been expose or teach a daily activity in row. Their memory still can remember and will more creative to solve the problem. Another reason is because subject 1 from the full functioning class and that's make subject 1 learn quickly then the other class.

Subject 2 is from the lower functioning classes. Subject 2 has some problem with his motor skill. Day 1, subject 2 finish all the task helped by the teacher because subject 2 cannot hold anything properly, the teacher guides him at every task given. But second day, subject 2 manage to do some task by its own. Some task is very difficult to do, so subject 2 still need to finish the task help by his teacher. For the 3rd day, subject 2 can finish all the task with shorter time. Even though subject 2 still need help by his teacher, but subject 2 still can finish the task without any objection.

5. RESULTS AND DISCUSSION

All the results and data that have been obtained from the project are tabulated and presented in the form of tables and graphs. In this project, the performance of the children with ASD to complete the

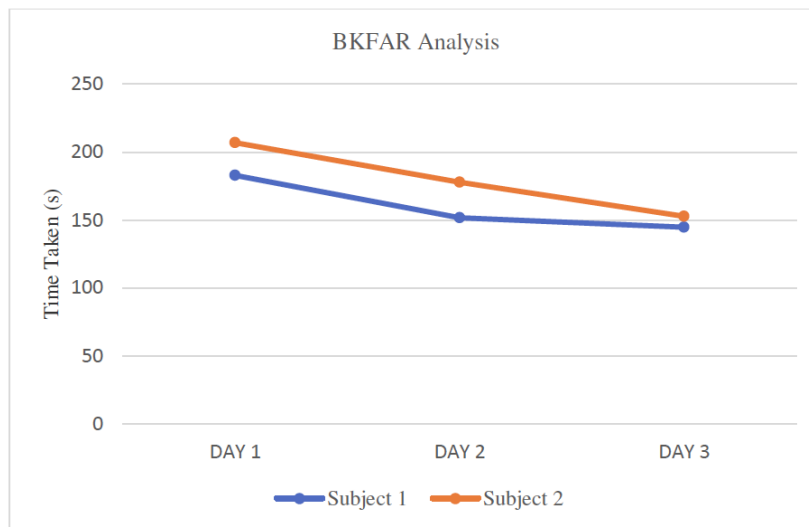


Figure 6: Line graph analysis taken from BFKAR product.

Table 1: Data Collected from BFKAR Device

STUDENT	DAY 1 (Sec)	DAY 2 (Sec)	DAY 3 (Sec)
Subject 1	183	152	145
Subject 2	207	178	153

given task on the busy board is observed in terms of time taken (seconds). Two boys with the age between 6 to 8 have been selected as test subjects. The data have been collected from Tuesday to Wednesday for a month at National Autism Society of Malaysia (NASOM) Melaka with the help and support from the teachers.

The test that has been conducted is given to the autism children starting from September 25th, 2018 until November 7th, 2018. There are three trials in the test and the given task is the numbering buttons need to be pushed by them based on the 12 numbers that have been prepared. The 12 numbers start from 0 to 9. Their performance had been analyzed based on the time taken (seconds) to correctly complete all the numbers.

All the data have been recorded and tabulated based on the date and the day. For the first day, all the

data are presented in Figure 7 with a bar graph of time taken (seconds) by the students to complete the test given on September 25th, 2018. The line graph in Figure 8 illustrates the supportive data that recorded with the time taken in seconds has been decreased from the first trial. The data on the first day had been tabulated in the Table 2. The line graph also shows their performance was better from in the third trial compared to the first trial. The data collection process has been continued for the first week.

Data had been recorded twice a week either on Tuesday, Wednesday or Thursday based on the school schedule until November 7th, 2018. Figure 9 showed that all the data had been recorded in a table and being presented in a bar graph. The supportive result showed in Figure 10 that is line graph which the time taken by the autism children to correctly complete the task given decreased.

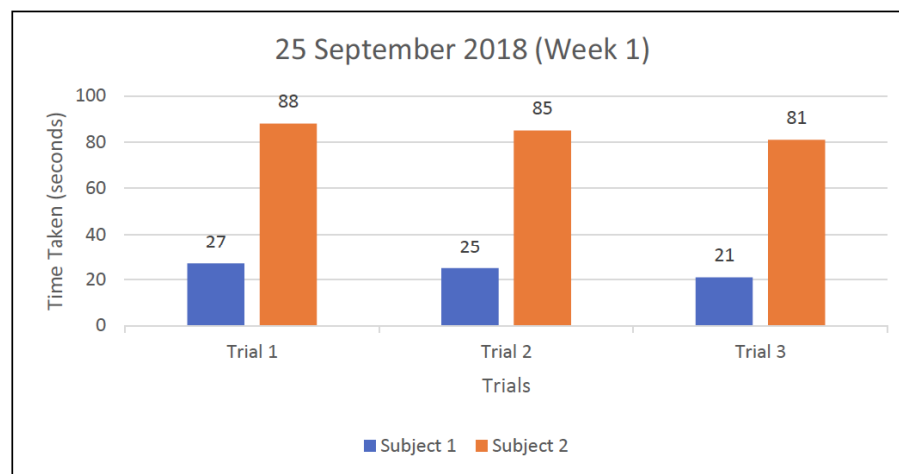


Figure 7: Bar graph analysis taken from new designed rehabilitation device.

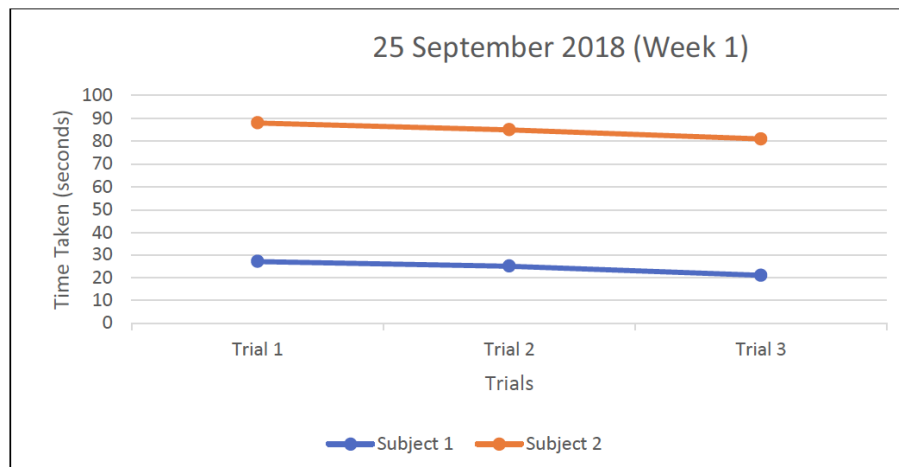
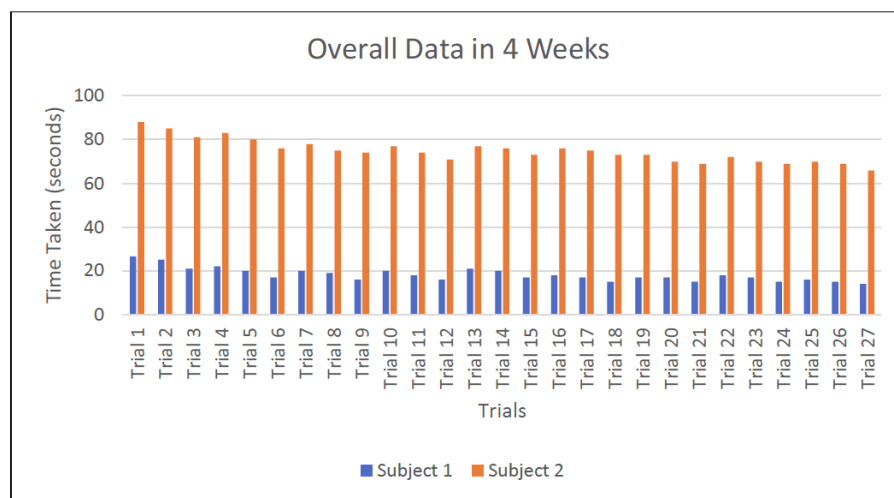
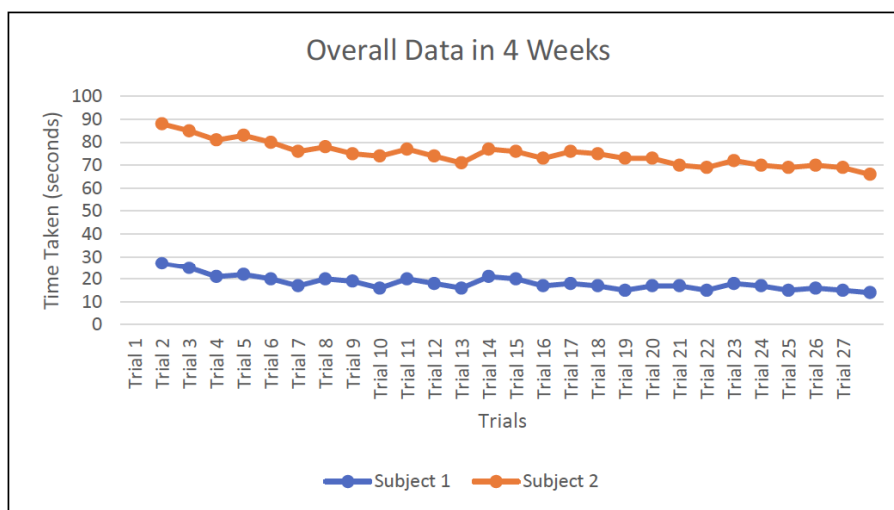


Figure 8: Line graph analysis taken from new designed rehabilitation device.

Table 2: Data Collected from New Designed Rehabilitation Device

Students	Time taken (seconds) to complete the test		
	Trial 1	Trial 2	Trial 3
Subject 1	27	25	21
Subject 2	88	85	81

**Figure 9:** Bar graph analysis taken from new designed rehabilitation device.**Figure 10:** Bar graph analysis taken from new designed rehabilitation device.

Based on both projects, subject 1 and subject 2 in both were not the same person but the data that had been taken was in the same form of time taken to finish all the task given. Product of BFKAR involved daily routine activities and the arrangement of the applications on the board can confuse the autism children. Therefore, the time taken from the BFKAR product was much longer than the product of this project. This project aim on the applications that helped autism children in their education. Both products

analysed the subject based on their focusses or attention to complete the task give to them.

6. CONCLUSION

In conclusion, based on the simple survey that has been done, the idea of autism is actually aware by the Malaysian society but the knowledge and detail information about autism have not properly deliver to the Malaysian society. Therefore, through this project,

the information of autism can be explained well to others with by prove of busy board can be one of the rehabilitation devices that help ASD children in a limited age. Busy board maybe not suitable for adult's ASD, but the treatment and therapy on autism should have been done since they are young to avoid ASD children faced difficulties when becoming older.

Furthermore, with the combination and implementation of technology in education such as the busy board, it helps to improve the level of thinking during the rehabilitation process and also improve the self-confidence. There are multiple ways that can be used to help ASD children in different life activities through the strategies and techniques that are effective in therapy. Hence, it will provide chances to encourage education for them. More advantages compare to disadvantages when there is the implementation of technology in the education system. Education with the implementation of technology not only for the ASD children but also the normal children so that the process of teaching and learning programme become more efficient.

In future, the number of busy board and the variety of applications installed on the busy board will affect the performance of ASD children's soft motor skills behaviour. The design of a rehabilitation device equipped with psychomotor assessments for soft motor skills therapy will also improve the performance of the children with autism in daily life activities. Hence, the soft motor skills performance can be evaluated through the rehabilitation device in terms of time taken to complete the soft motor skills for each activity during the therapy process.

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