

MIND CHAMPS: A LEARNING PLATFORM BASED ON BEHAVIOURAL AND EMOTIONAL ANALYSIS OF AUTISTIC CHILDREN

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Abstract—Autism Spectrum Disorder (ASD) affects how people communicate, learn, behave, and socially interact. Early intervention and effective educational practices can greatly improve the condition. Finding solutions for autism should be done from the early stages of diagnosis since helping a person's development in the child stage has a positive impact. There are limited opportunities for autistic students in the Information Technology space, so it is necessary to provide applications or technical assistance to help them. Developing an application for autistic children requires more experimental attention. In this research we are suggesting a solution to enhance the soft skills and learning skills of autistic kids based on the identification of emotions and behaviors over a constant average period of time.

Index Terms—Deep Learning, Image Processing and Computer Vision, CNN Image Classification, Object Detection, Transfer Learning.

I. INTRODUCTION

Autism can be considered as a Neuropsychiatric disorder which results in certain severe impairments with relevant to social interactions, communication, and behavioral patterns[1]. It is a lifelong condition and scientists have been unable to identify a proper solution to overcome autism in people and early intervention of autism is required to deliver better treatments for autism condition. To meet the diagnosis criteria for autism, a child must have persistent deficits in three areas with related to communication, interaction, and restricted and repetitive behaviors[2]. Autism begins in early childhood between two to three years of age. Some characteristics are common to most subjected people with autism while some are in unique nature. When it comes to the level of intelligence, some have a greater impairment in intelligence while many are in average level or above average level as well. Scientists are unable to find a proper cause for autism, but they predict that there is a tendency of causing autism via genes and different environmental factors[3]. Therefore, according to the nature of development levels, it is clear that the capabilities as well as the disabilities of autistic children differ from one another, and the characteristics displayed are unique in comparison.

Researches focused on brain growth structure, and connectivity of autism and the earliest indications of aberrant brain growth were identified from infants and children regarding the measurements of their circumference of the head[3]. According to the identification many studies have shown that the head circumference is abnormally enlarged around the age of diagnosis of autism. In order to treat autism, other than medications a variety of therapies are being recommended such as applied behavior analysis, sensory

integration, cognitive behaviors therapy, music therapy play therapy etc. These therapies are learnt by parents or guardians of the child and the professionals in providing the support and guidance physically. In addition, Variety of autism centers and teachers with special education knowledge are being guided to take care of autistic children. Although the recommendations are given as such, it is to be identified that the pressure on the teachers, parents and the time and effort required are very high. Providing therapies and treatments physically are rather difficult by parents daily and when considered teachers, their attention must be divided to a certain number of autistic kids and it requires a high effort and knowledge to identify the characteristics in providing the guidance and support for their overall development. The pressure of managing daily life tasks with parent-mediated therapies and teacher guidance led to the exploration of automating developmental support for kids. By identifying emotions and behaviors, the web application offers automated therapies and lesson plans to improve learning and soft skills. This technological approach benefits children aged six, requiring less physical effort from educators and parents while enhancing their development.

II. LITERATURE REVIEW

The following literature review focuses on the impact of the behaviors and emotions of children with autism on their aesthetic skills and education.

A. *The effect of education on the avoidance of autism*

There is a significant body of research examining the relationship between education and autism, particularly in terms of the potential for education to help children with autism in order to avoid negative outcomes associated with the disorder. One study conducted by Anderson examined the impact of early intervention and education on outcomes for children with autism[4]. The study found that children who received early intervention services showed greater improvements in social communication, language, and adaptive behavior than those who did not receive these services. Research indicates that early education and intervention are crucial for improving the quality of life for children with autism and avoiding negative outcomes. One study by Taylor focused on the impact of education and intervention on social skill development in autistic children[5]. The findings revealed that children who received such intervention showed significant improvements in initiating social interactions, responding appropriately to social cues, and engaging in reciprocal communication. Overall, the literature supports the idea that education and intervention can be instrumental in helping children with autism to enhance

their social skills, communication abilities, and adaptive behavior, leading to better outcomes for them.

B. The importance of identifying and addressing the emotions and behaviors of children with autism for their educational success

Autism is a neuro developmental disorder that affects social interaction, communication, and behavior. Children with autism often experience difficulties in identifying, expressing, and regulating their emotions and behaviors, which can negatively impact their educational success. Several studies have investigated the relationship between identifying and addressing the emotions and behaviors of children with autism and their educational success. For example, a study conducted by Sarnoff [6] found that a social skills intervention program that focused on identifying and regulating emotions and behaviors led to significant improvements in social competence, emotional regulation, and academic performance in children with autism. Another study by White [7] examined the effectiveness of a program that focused on identifying and addressing the emotional needs of children with autism. The study found that the program led to significant improvements in emotional regulation, social skills, and academic achievement in the children who participated. Additionally, a study conducted by Lerner[8] found that individualized interventions that focused on identifying and addressing specific emotional and behavioral needs of children with autism were effective in improving their overall academic performance and educational outcomes.

C. Impact of interactive play in autistic children

The use of new technologies in play activities has proven highly success in engaging children during leisure hours. Activities related to technology are particularly attractive to children and enhance their interest. Interactive touch screens and playful interfaces are all assets which stimulates children’s motivation[8].Children with autism, in particular, show appreciation for programmed and predicted new technologies, as they find them engaging. It is essential to design attractive platforms which allows children to interact with the system, leading to improved learning, soft skills development, problem-solving abilities, creativity, and motivation. Such creative and interactive activities contribute a significant improvement to the overall development of children, especially those with autism, making effective use of new technology crucial for their progress.

D. Effect of art and music therapy in autistic children

Art therapy benefits autistic children by promoting flexibility, overcoming stereotypical behavior, and improving social and communicational skills. Digital painting is a user-friendly tool that allows easy interaction and reduces effort for autistic individuals. Providing quality art experiences in different developmental stages are essential, starting from scribbling to drawing shapes and objects. Art and color based therapies can help train their brains for color identification and drawing. The digital environment minimizes pressure and motivates autistic children to engage effectively. Additionally, music therapy enhances social interactions, calmness, and speech development in a shorter time. Using a combination of music that involves playing, movement, singing, and musical instruments has positive effects on autistic children. It increases eye contact, reduces feelings of isolation, gaze

aversion, and avoidance behaviors [9]. The combination of music with language are hierarchically arranged with lower levels of units such as keys or letters/ notes/syllables integrated to form higher level of units such as chords/ progressions/ words and sentences. Music and language share similarities in acoustic complexity, spatial notations, and cognitive processes, making it easier for learning to transfer between the two[10].

III. METHODOLOGY

The "MIND CHAMPS" web application is designed to assist autistic children, parents, teachers, and health professionals in identifying autistic children more easily. It aims to provide the required developmental support with reduced time and effort. The application uses a machine learning model to detect emotions in autistic children and then perform a second observation to confirm the presence of these emotions through accurate behavioral observations. By analyzing emotions and behaviors together, the system determines whether a child has autism or not. The web application focuses on addressing the challenges faced in the current strategies for the overall development of autistic children, emphasizing soft skills and learning skills development. To address the above mentioned problems “MIND CHAMPS” web application mainly focuses on the below four main areas to provide effective solutions.

1. Implementing an effective platform to detect and classify autistic suspected children through proper analysis of EMOTIONS.
2. Implementing an effective platform to detect and classify autistic suspected children through proper analysis of BEHAVIOURS
3. Implementing an interactive activity-based learning platform to develop the SOFT SKILLS of autistic children.
4. Implementing an interactive activity-based learning platform to develop the LEARNING SKILLS of autistic children

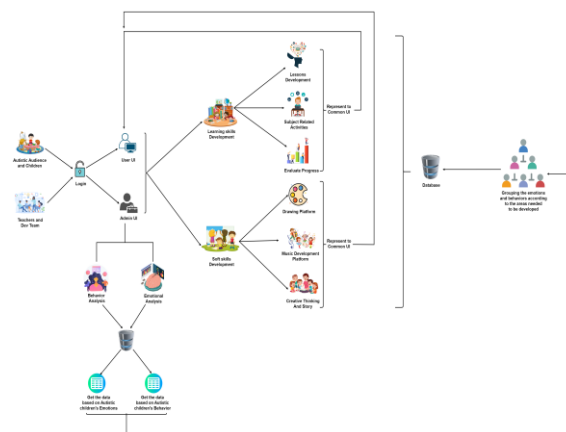


Fig. 1. The System Overview Diagram

A. Implementing an effective platform to detect and classify autistic suspected children through proper analysis of EMOTIONS

Data Collection: This data collection phase is represented and gathered from three main stages. The researchers' collected emotional data under four basic categories named Joy, Sad, Neutral, and Anger. The data may have been obtained through various sources such as surveys, interviews, or observation. Data Collection from Autism Schools: In addition to the available dataset images, the researcher collected images from autism schools in "Mathugama" area of Sri Lanka to augment the training and testing data sets. **Data Pre-processing:** The Methodology of Data Preprocessing is compromised with several approaches. As for the first step of image resizing, all images were resized to a fixed size to ensure uniformity and compatibility with the chosen models (e.g., 224x224 pixels). Then as for the normalization step, pixel values of the images were normalized to a specific range (e.g., [0, 1]) to enhance model convergence and stability. Then finally for data augmentation to increase the diversity and robustness of the training data set, data augmentation techniques such as rotation, horizontal/vertical flipping, and random cropping, zoom-in and zoom-out, shear up and shear-down techniques were utilized.

CNN Image Classification Transfer Learning Models: To get more enhanced predictions we use the modern deep learning approach to develop the model to predict the emotions of autistic children. **Model Selection:** To address the overfitting issue, the researcher explored CNN image classification transfer learning models pretrained on the ImageNet dataset. Several models were experimented with, including VGG-16, Mobile Net V2, Inception V3, Xception, and ResNet101V2.

Skill Development Prioritization: After coming up with the Image Classification deep learning model, a proper mechanism for Prioritizing Skills Development was taken into consideration based on these four basic emotional classes. The Focus Areas of the web application developed for autistic children focuses on two main skill development areas, Learning skills and Soft skills. As then ultimately discussions with physicians informed the decision making process during data gathering. **Emotion-based Prioritization:** If a particular child frequently exhibits Joy or Neutral emotions, the application prioritizes the development of learning skills. Conversely, if a child frequently shows Sad or Anger emotions, the application prioritizes the development of soft skills.

Web Application Development: Prediction and Skill Development Suggestion: The application predicts the correct emotion class for an uploaded image and suggests which skill to develop learning skill or soft skill based on the predicted emotion. This information is displayed on the user interface.

B. Implementing an effective platform to detect and classify autistic suspected children through proper analysis of BEHAVIOURS

The methodology for building an effective platform to detect and classify autistic suspected children through proper analysis of behaviors involves several steps:

Domain Study: The first step involves gathering information about the domain by visiting schools that are dedicated to differently abled children. Interacting with the children as well as teachers can provide an understanding of current learning

methods, challenges faced, and ways to improve the quality of education and life.

Data Collection: This data collection Phase is represented and gathered from two main stages. The first one is behavioral data which is the data collected by the researcher focusing on two basic categories as Head banging and Hand flapping. The data was obtained from various sources, including interviews, and observations. To further enrich the dataset and enhance its comprehensiveness, additional videos were collected from reputable autism schools located in the "Mathugama" region of Sri Lanka. These supplementary videos were incorporated into training and testing data sets to ensure a more extensive representation of the behaviors.

Collecting sufficient data to train the model: Libraries such as OpenCV in Python can be used to capture video feeds of the children. This data can be used with Media Pipe Holistic to utilize pose, face, and hand landmark models in Media Pipe Pose, Media Pipe Face Mesh, and Media Pipe Hands, respectively. This generates a total of 543 landmarks, which can be used to detect the behavior of the children. The resulting coordinates can be saved in a CSV file for further utilization.

Data Pre-processing: Before training the model, the collected data must undergo pre-processing, involving tasks such as removing noisy or irrelevant data, normalizing or scaling the data, and converting it into a suitable format for the machine learning model.

Data Splitting: The data can be split into training and testing sets using libraries such as Scikit-learn. The data can be split in a ratio of 80% for training the model and 20% for testing.

Machine Learning Model: The next step involves building a machine learning model to classify the behavior of the children. Libraries such as Scikit-learn can be used to build the model. The pipeline introduced in Scikit-learn can be used to perform pre-processing, feature selection, and model training in a single step.

Model Evaluation: The accuracy of the model can be evaluated using metrics such as precision, recall, and F1- score. The model can also be evaluated using cross validation techniques to ensure that it is robust and generalizes well to new data.

C. Implementing an interactive activity-based learning platform to develop the SOFT SKILLS of autistic children

Painting Skills Development platform: When conducting this research based on developing the soft skills of autistic children, necessary steps were followed to uniquely identify whether development of soft skills could be done in a technological phased environment and necessary solutions and recommendations are being made upon the observations.

Conducting a data gathering session to identify the required approach in developing painting skills: Analyzing the painting skills was done taking maximum amount of 50 to 60 autistic children. The observations were done in a manual phased learning environment initially and later required solutions were identified. Through this study it was identified that, children are already capable of painting but, unique color identification and accuracy of thinking skills are yet in the development stage. Frequent practicing enabled the children to enhance their level of accuracy in painting. Therefore, necessary effective solutions was taken to consideration during the next phase in providing a technical solution.

Analyzing the gathered data to conduct the Implementation process via a better solution: The system aimed to enhance the effectiveness of autistic children by developing their skills based on identified levels suitable for their age. To replicate

the classroom experience, actual paintings from teachers and professionals were gathered and provided as activities for the children. The objective was to familiarize the children with the images, enabling repetitive practice and improving their soft skills. The system includes progressively complex images, encouraging the child to use one color in beginner level, two colors in intermediate level and three different colors in advanced level. Images are locked to spark the child's curiosity and motivate them to unlock them by correctly painting the image.

Music skills development platform: Past researches have proved that musical therapy and experiences provided to autistic kids help enhancing their abilities in developing soft skills. Multiple researches have obtained successful results via interactive music. Through the analyzed data from autistic kids, it was recognized that autistic kids too are interested in interacting with music through their behaviors displayed while engaging in musical activities. Therefore, Mind Champs platform was designed to provide the same experience through an interactive approach with related to modern technology.

Analyzing music skills of autistic kids to conduct implementation via a better solution: When considering about the analyzing of music skills, it was identified the kids are capable in listening to music like a normal kid and thereby interacting accordingly to the rhythm of the beat. According to the analyzed researches autistic kids are allowed to interact with the use of musical instruments in improving their aesthetic values and soft skills[11]. Therefore, a virtual piano functionality was developed to enhance the aesthetic development of the kids. To address the lower interactivity of autistic children compared to their neurotypical peers, a progressive music development platform was created. The platform starts from basic levels of music and gradually advances to more complex levels. Successful completion of activities is rewarded with badges and certificates, motivating the children to continue and unlock the next levels. Animated videos with an engaging voice guides the children through the activities, increasing their curiosity and interest. It is suggested to utilize the system effectively, going through all the development levels in both painting and music functionalities. *Overall final identification of both painting and music functions in developing soft skills:* According to the responses given by the kids to the platform functionalities, it was identified the interactivity of the kids were high although the familiarity to the platform was new to them. The capabilities of the kids were different, and the time allocated to unlock next levels were unique to one another. Compared to the manual interactions with relevant to painting and music, the kids were enthusiastic enough to interact with the platform. As the functionalities were created to encourage the kids without disappointment, positive feedback of teachers, doctors, parents and kids were achieved as a successful outcome.

D. Implementing an interactive activity-based learning platform to develop the LEARNING SKILLS of autistic children.

This study aims to create a personalized learning approach for autistic children, taking into account their diverse learning styles and sensitivities. The approach implemented through Mind Champs, prioritizes practical activities, leading to improved engagement and learning outcomes. It is important to note that autistic children typically exhibit avoidance of eye contact from as early as two months old[12]. As a result, instructions are sometimes limited to auditory methods.

Therefore, the platform focuses on Mathematics and English, catering to auditory learners and encouraging verbal responses. The curriculum includes activities, knowledge tests, and lessons that cover topics such as numbers, addition, subtraction, shapes, patterns, letters, syllables, and spellings. categorized based on the children's progress levels.

Studying the importance of imparting knowledge of the language and identifying approaches to its education: The learning platform fulfills functional requirements by effectively providing educational materials that focus on basic language-related knowledge, particularly English language skills. It addresses the challenges some children face in writing, speaking, and paying attention, aiming to find suitable solutions. The platform currently offers a few English lessons, including the English alphabet, which plans to add more in the future. The first lesson involves alphabet identification, an engaging video tutorial, and a writing activity. The platform supports children in their writing practice and employs an OCR model for immediate feedback and positive reinforcement. Participants' confidence in writing improved due to encouraging messages. For children with ASD, the platform uses audio features to enhance auditory learning and language development. Interactive activities centered around letters and words further aid in language acquisition.

How can autistic abilities be used with mathematics and develop mathematical knowledge? Mind Champs is an interactive platform designed to teach children with ASD, which includes a variety of mathematical concepts ranging from simple to more complex. It offers engaging activities for addition, subtraction, shapes, and volumes. The platform effectively meets the learning needs of children through interactive and age-appropriate content, motivating them to improve their calculation skills and track their progress over time. With progressive learning structures and an accurate assessment mechanism, teachers and parents can effectively monitor the children's progress.

IV. RESULTS AND DISCUSSIONS

Mind Champs web based platform is originally designed for the purpose of enhancing soft skills as well as Learning skills of the autistic community. Basically, it is designed for the ASD children who are under the age category between 6 – 8 years which allows to perform web based learning and soft-skills development activities while maintaining their portfolio which is also accessible by teachers, parents, or any other medical officers to make further decisions with regards to the child's progression.

A. The performance distribution of the soft skills development within the period of 8 weeks in Mind Champs project

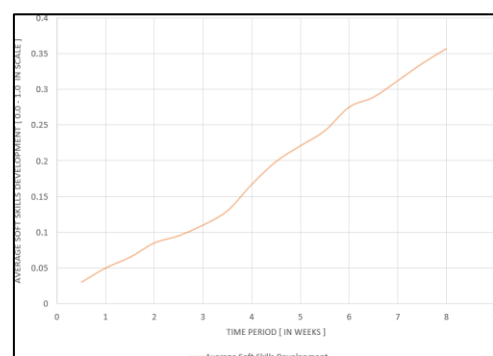


Fig. 2. The Average Soft Skills Development Distribution

The above figure illustrates how soft skills development is distributed over 8 weeks of time in the sample of 50 autistic kids aged between 6 to 8 years. From the above line graph, we calculate the overall development through the marks evaluated from the assignments given to each individual at the end of the day in each particular week. Ultimately, the average values are derived separately and represented with regards to the soft skills development corresponding to each week.

B. *The comparison of performance distribution of the soft skills sub activities, Music vs Painting skills development*

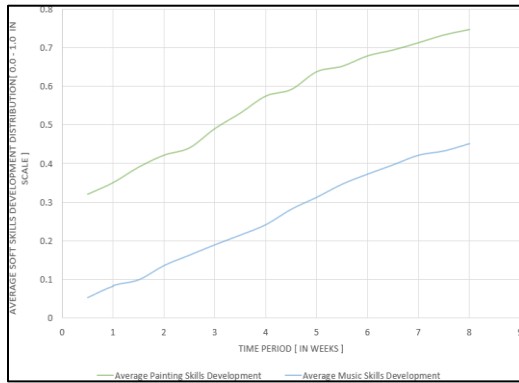


Fig. 3. The Music Vs Painting Skills Development

Autistic children develop painting skills more rapidly than music skills, which proves that they already had a pre-developed ability for painting, compared to music. we calculate these separate development levels relevant to music and painting skills through measured marks evaluated as mentioned in the description relevant to figure 2 which is finally plotted in a graph representation.

C. *The performance distribution of learning skills development within the period of 8 weeks in Mind Champs project*

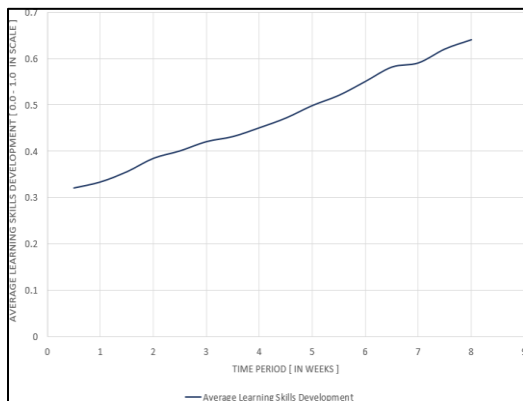


Fig. 4. The Average Learning Skills Development

Based on the study conducted on 50 Autistic children between the ages of 6 and 8 to measure their learning skills development over 8 weeks, it was identified that the kids were able to learn subject related materials such as English and Mathematics more easily than the development of soft skills such as Music and Painting. The study also found that the children’s learning skills development had a significant amount of initiating value, where they were able to learn new skills more quickly than expected. This is likely because the children were already familiar with the learning process in physical environment as well and were able to focus on the content of the lessons rather than the mechanics of learning. The Evaluation criteria mechanism is same as mentioned previously in the figure 2.

D. *The comparison of performance distribution of the learning skills sub activities, Mathematics vs English skills development.*

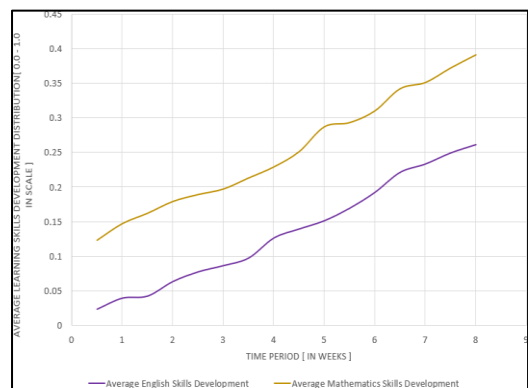


Fig.5. The Mathematics Vs English skills Development

Here Overall, ASD children who already have a natural aptitude for Mathematics develop their Math skills more rapidly and consistently than their English skills. This states that these children may not have a natural attitude for English, as their English skills did not develop at the same rate as their Math skills. The Evaluation criteria mechanism is same as mentioned previously in the figure 3.

V. CONCLUSION

The Mind Champs platform provides web-based learning activities and allows creation of portfolios that can be accessed by teachers, parents, and medical officers to assess child’s progression. The analysis of soft skills development over an 8-week period demonstrated that ASD children in the sample showed more rapid development in Painting skills compared to that of Music skills. It is worth noting that the sample already possessed some Painting ability, which may explain the higher rate of development in this area. On the other hand, the learning skills development graph showed a considerable amount of initial value, with a higher rate of development in Mathematics skills compared to English language skills. This could be attributed to the fact that the sample consisted of the children associated from a rural area in Sri Lanka,

where there may be a higher emphasis on Mathematics skills within their family backgrounds. In future works, the successful outcome can be achieved by incorporating additional activities, assessments, and personalized content based on emotional and behavioral analysis. Conducting research with a larger and more diverse sample, including children from different backgrounds would enhance understanding the platform's effectiveness. Collaboration with educators, therapists, and medical professionals can contribute in refining the platform and integrating it into existing intervention programs for children with ASD.

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