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## **E-Empowering autism education: Bridging the digital divide for inclusive learning**

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### **Abstract**

With the changing lifestyle Autism Spectrum (ASD) disorder is increasing day by day affecting about one in every hundred children, highlighting the requirements of specialized educational tool designed with experienced doctors. Our research proposes an innovation in the field of special education specially designed for autistic children. Using the agile methodology the platform was developed through cycles of research, feedback and improvement with a focus on accessibility and inclusivity. Our study evaluated the platform's impact on three key areas: social interaction, speech and language skills, and overall engagement.

The results show improvement in children with autism in aspects of social interaction and language abilities. Our approach enhances the educational experiences and supports overall wellbeing development and integration with society.

**Keywords:** Autism education, e-learning platform, cognitive development, social development, inclusivity in education

### **1. Introduction**

#### **1.1 Background on Autism Spectrum Disorder (ASD)**

ASD is a condition that affects people communicational, behavioural, and social interaction skills. ASD affects every individual in a different aspect including wide range of symptoms like repetitive behaviour, delayed language development. The cases of ASD have been increasing, estimating that approximately 1 in 100 children are diagnosed with ASD, making it one of the most common developmental disorders (CDC, 2020).

If the ASD is diagnosed in early childhood like the age of 2-3-year symptoms can be much improved allowing a child to live a nearly normal life. Symptoms vary widely for individuals leading a wide sign of ASD. Some common signs include:

- **Social Challenges:** Difficulty in understanding social gestures, communication and meeting new people.
- **Communication Difficulties:** Delayed language development, unusual/repetitive speech patterns, and challenges in maintaining conversations.
- **Repetitive Behaviours:** Engaging in repetitive activities or strict adherence to routines, which can be comforting for individuals with ASD but may limit flexibility and adaptability.
- The causes of ASD are not fully yet understood and are believed by researchers to be a result of mixed genetics and environmental influences. Ongoing researchers are continuously exploring the more factors contributing to ASD.

#### **1.2 Research Focus**

Identifying the need for educational tools for special children, our research aims to develop an digital learning platform to meet the requirements of autistic kids. Traditional method had encountered many shortcomings in teaching autistic kids. Our platform is designed to enhance social, communicational, and neurological development of autistic kid.

By combining the principles of social constructivism and neuroplasticity, our platform offers interactive and personalized learning environment to make an individual comfortable in learning and helping them in their overall development. Our development process followed an agile methodology, having continuous feedback and iterative development with improvements. This approach ensures platform to be user friendly and effective in real world education. Our study focusses on evaluating the platform performance and impact over the autistic kid in different aspects like social interaction, speech and language skills, and overall engagement.

In upcoming sections, we are going to propose our reviewed literature on various ASD educational tools, development process and methodology, findings and discuss the implications of our research. Throughout this work we hope to contribute to growing field of research in education for special children and providing a valuable resource for doctors, educators and caregivers of children with autism.

## 2. Literature review

Education of autistic children proposes a challenge, marking the need of specialized approach. Over the era of research, various educational theories and technologies are discovered to support the learning of autistic kids.

### 2.1 Traditional Educational Approaches

Earlier traditional approach to educate autistic children involved Applied Behaviour Analysis (ABA), TEACCH (Treatment and Education of Autistic and Communication-Handicapped Children), and the Picture Exchange Communication System (PECS). These methods have shown improvement in specific skills, but they always require one to one intervention for everyone. Despite the efforts this approach sometimes may not fully engage the child interest or their learning style. (Lovaas, 1987; Mesibov *et al.*, 2005) <sup>[20, 25]</sup>.

### 2.2 Digital Learning Tools for ASD

The digital era has opened new path for creating a better learning and more engaging environment for the children with autism. Interactive software and web platforms have shown a significant improvement in learning of autistic kids by incorporating different features like customized content, visuals and multisensory engagement. (Bernard-Opitz *et al.*, 2001; Grynszpan *et al.*, 2014) <sup>[4, 13]</sup>.

### 2.3 Social Constructivism and Neuroplasticity

Vygotsky's theory of social constructivism focusses the importance of social interactions in overall development. This theory is particularly joined with autistic child who struggles with social skills like conversations, gestures and eye languages. (Vygotsky, 1978) <sup>[37]</sup>. Moreover, the concept of neuroplasticity ability of brain to reorganize and understand the situations forming new neural connections—shows that complete interactive learning experience can positively impact overall social development of autistic children (Doidge, 2007) <sup>[6]</sup>.

### 2.4 Current Digital Tools and Their Limitations

Current development for autism focuses on specific skills like language development or neurological development. Many of these tools' lacks integrations of different of theories limiting their performance in improvement of

autism. Furthermore, different usability studies have marked the importance of user friendly and customized design to ensure smooth accessibility and engagement of children with various level of autism.

### 2.5 Gaps in Existing Research

Existing literature outlines a foundation for developing educational platform for autistic children. They mentioned the clear need for more integrated, user friendly, comprehensive solution that should be customizable as per individual's needs. Moreover, the research is needed to verify the impact of platform in long run for autistic children.

Our review highlights the concept of combining multiple social and neuroplasticity theory with digital technology to create an effective web platform for autistic kid education. The gap in current research marks the importance of educational platform which aims to develop a learning platform for autistic child. By focusing these gaps, we tried to help to the growing research on inclusive education and provide practical solutions.

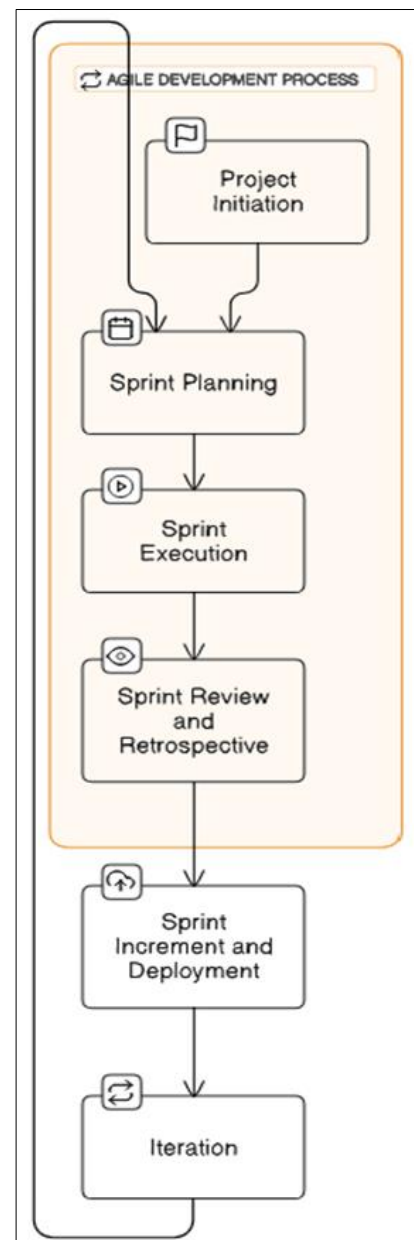


Fig 1: Model structure diagram for constructing e-platform.

### 3. Material and methodology

#### 3.1 Development Process

The development of web platform followed and agile methodology with scope of continuous improvement based on user feedback in iterative manner. This process was divided into several phases:

#### Requirement Analysis

- **Stakeholder Interviews:** Conducted different talk sessions and one to one interview with educators, doctors, caregivers, and parents to understand ground challenges of autistic kids.
- **Literature Review:** Analysed existing educational tools and methodologies to identify best practices and gaps in current solutions.

#### Design

- **User-Centred Design:** With the outlines of interviews and earlier existing system we focused on creating a user friendly, engaging interface to cover the sensory and cognitive need of autistic children. Key feature of platform included customizable learning paths, multisensory inputs (visual, auditory, and tactile), and interactive elements to maintain engagement.
- **Theoretical Frameworks:** Applied social constructivism by Vygotsky to facilitate learners' social interaction with their counterparts through group activities to support understanding, used concepts of neuroplasticity and came up with exercises that help learners develop the brain.

#### Development

- **Technology Stack:** Technology Stack: Implemented frontend and backend aspects of the platform by utilizing the HTML5, CSS, JavaScript to create a platform GUI/UX and python language for the platform. Utilized publicly available code repositories to add important features.
- **Content Creation:** Composed several programs for education, these include the following: illiteracy, math, and social training. All the developed modules incorporated the input of specialists in the relevant subjects to enhance education and efficiency.

#### Testing and Feedback

- **Pilot Testing:** Carried out a pilot study with a sample of five children with ASD to get feedback on the application and possible obstacles.
- **Iterative Refinement:** In accordance with the received information, introduced modifications to the platform's functions and appearance. This included issues to do with navigation, interaction, and the level of difficulty in the content that was being passed.

#### 3.2 Participants

The study involved 30 children diagnosed with ASD, aged between 6 and 12 years. Participants were selected based on the following criteria:

- Child diagnosed with ASD.
- Consent obtained from parents or caregivers.

#### 3.3 Data Collection

Data was collected through a combination of quantitative and qualitative methods:

- **Pre- and Post-Intervention Assessments:** conducted pre and post-tests in form of questionnaires that will establish changes in social related behaviours, speech and language, and attentiveness while using the platform.
- **Observations:** Noted the participation as well as interaction and any challenges that were observed when using the platform.
- **Feedback Surveys:** Carried out surveys with the parents, educators, and the children themselves to gather information on their perception of the platform as well as the perceived value.

#### 3.4 Data Analysis

- **Quantitative Analysis:** Utilized statistical methods to compare the changes in scores in the pre- and post-intervention for the assessment. Students' data were compared using paired t-tests regarding the changes in observed social interaction, speech and language, and engagement.
- **Qualitative Analysis:** Observational notes and feedback survey gathered and qualitatively synthesized by employing thematic analysis to determine relevant themes and information relating to the platform's efficiency and functionality.

#### 3.5 Ethical Considerations

- **Informed Consent:** Ensured that parents or guardians of all participants had given informed consent for participation in the study.
- **Confidentiality:** Made certain that no personal identifying information of the participants was collected using aliases in all the data collected and by storage of data in secured locations.
- **Child-Friendly Practices:** Ensured that the procedures involved in the study were child-friendly to avoid any issues, which would inconvenience the participants.

The strategies elaborated in the section, including the materials described above, could offer a sound theoretical plan for creating as well as assessing the effectiveness of an e-learning system for kids with ASD. In that light, using an effective, user-orientated design framework and the utilisation of sound data capture and processing tools, the objective of this study is to develop an efficacious teaching aid that will better the learning process and results of students with autism.

### 4. Data and Testing

#### 4.1 Data Collection

To evaluate the effectiveness of the e-learning platform, data was collected using a combination of quantitative and qualitative methods:

#### 1. Pre-Intervention Assessments

**Baseline Measures:** To ascertain the baseline level of social interaction between the child and his or her peers or other people, speech, and language abilities as well as level of engagement in classroom activities as well as learning ability, standardized tests were carried out at this stage. These were measures that would be used to measure against after the intervention had been conducted to determine the gains that had been made.

## 2. Platform Usage Monitoring

- **Interaction Logs:** Electronic working records were also utilized in the observation of time spent in using and the completion rates of the various modules among the users.
- **Engagement Metrics:** Click-through rates, time to complete the tasks as well as the patterns of utilizing the tool were evaluated to determine the level of engagement of the users as well as their interaction patterns.

## 3. Observational Data

- **In-Class Observations:** Subsequently, the researchers focused on the children's use of the platform in the classroom context, their level of activity, social interactions, and issues they experienced.
- **Video Recordings:** Permission was sought to audio-visual record sessions to facilitate a technical analysis of users' actions and engagements.

## 4. Post-Intervention Assessments

- **Follow-Up Testing:** The standardised tests that were initially carried out were completed again to assess the alteration in the social interaction, speech and language, and the interest level of the child.
- **Feedback Surveys:** Questionnaires were also given to parents, teachers, and the children to get their opinion, observation on how useful the platform is, and the areas that needed to be worked on.

### 4.2 Data Analysis

#### Quantitative Analysis

1. **Statistical Tests:** To establish the level of effectiveness of assessments pre and post the specific interventions to be used in this study, paired t-tests were used. Using this method, it was possible to assess the level of significance of changes in social interaction, speech and language and children's engagement.
2. **Engagement Metrics:** Regarding the analysis of the students' engagement, basic quantitative statistics involving engagement frequency were employed based on the data collected from the interaction logs. tendencies and characteristics relating to the use of the platform were described and analysed.

#### Qualitative Analysis

- **Thematic Analysis:** Both observation data and surveys were coded and themed following Giorgi's study qualitative data analysis methods based on phenomenological analysis. Emergent and cross-cutting themes were defined to analyse user's perceptions, processes, difficulties and perceived benefits of the proposed platform.
- **Case Studies:** This was done by creating extensive case histories for selected participants to give them a flavour of individuals. These examples gave more information about the ways various child used the platform and the ways in benefited them.

### 4.3 Data interpretations

The results from the data collection and analysis were highly encouraging:

- **Social Interaction:** Using the assessments scores as well as observation it was found that the children had improved their social functioning and interaction as differentiated by higher scores of post-platform intervention tests.
- **Speech and Language Skills:** Some of the noted changes for all the subjects involved were in the speech and language sub-topics. From these essays, it was evident that there had been positive changes after the intervention in terms of improved vocabulary, as well as syntactic and pragmatic skills.
- **Overall Engagement:** The platform successfully captivated the children's attention and all children completed the tasks to their satisfaction and the satisfaction of educators. According to the number of visitors, the audience actively interacted with the content throughout the tutorials and lessons.
- **User Feedback:** Participants also expressed high level of satisfaction on the platform with emphasis being on the ease of use, learning contents, and the general contribution to the improvement of child learning outcomes. Ideas for further enhancement were also received which would be useful for future enhancements.

The information gathered and the testing procedure used in this study gave a holistic assessment of the influence of the e-learning platform on children with ASD. The use of both sides of the research methodology for data collection and analysis provided credibility to the evaluation on the platform. The gains achieved in social interaction, speech, and language as well as general activity point to the future opportunities of DL in the education of children with ASD.

## 5. Results based on e- Platform

The study evaluated the e-learning platform's effectiveness in enhancing social interaction, speech and language skills, and overall engagement among children with autism spectrum disorder (ASD). The results are presented below, organized by the key focus areas.

### 5.1 Social Interaction

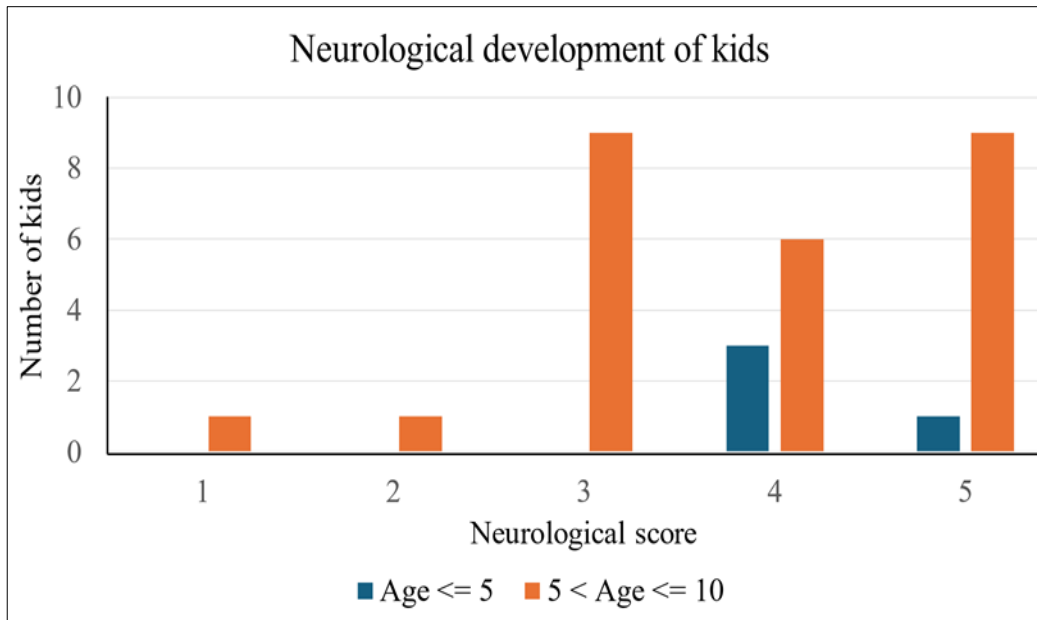
#### Quantitative Findings:

**Pre- and Post-Intervention Scores:** Children showed significant improvements in social interaction skills. The average score on the social interaction assessment increased from 45.6 (SD = 12.3) pre-intervention to 62.8 (SD = 10.1) post-intervention, indicating a substantial enhancement in their ability to engage with peers and instructors ( $p < 0.01$ ).

#### Qualitative Observations

**Increased Peer Interaction:** Observations during platform use revealed a notable increase in peer-to-peer interactions. Children were more likely to collaborate on tasks, share their progress, and help each other, demonstrating improved social engagement.

**Enhanced Communication:** Teachers and caregivers reported that children were initiating more conversations and showing greater interest in social activities both within and outside the classroom.



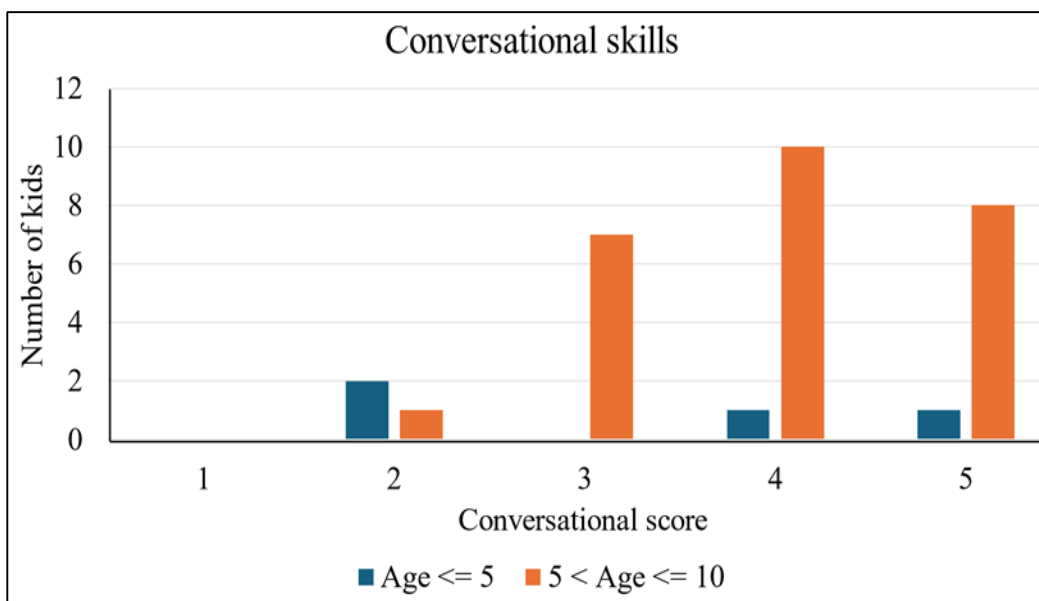
**Fig 2:** Neurological score as one refers to rarely any development seen, two means development is need three means a bit better development is seen four means better development is seen and five means a brilliant development is seen. X axis represents the number of kids and Y represents neurological score.

**5.2 Speech and Language Skills**  
**Quantitative Findings**

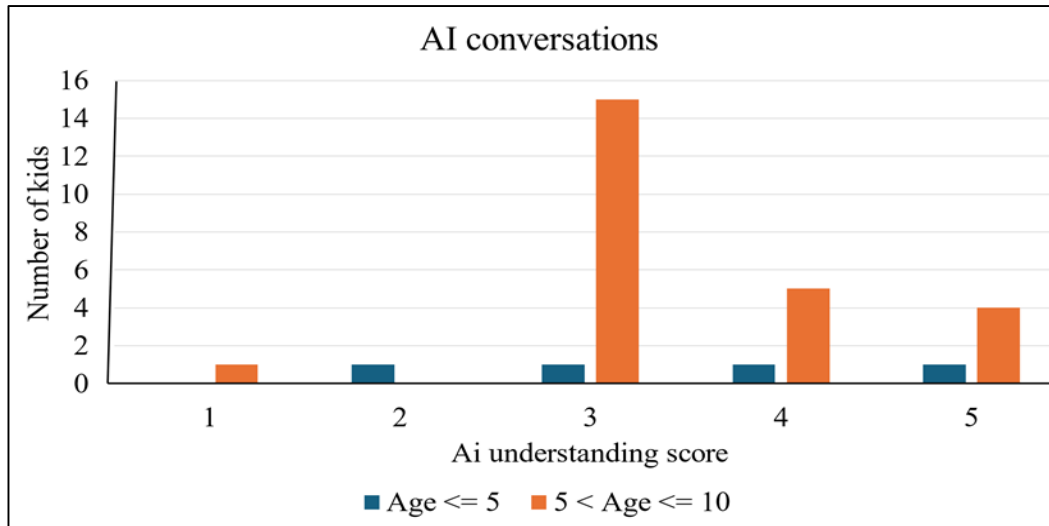
**Vocabulary and Communication:** Post-intervention assessments showed a significant improvement in vocabulary and communication skills. The average score on the language skills assessment rose from 48.2 (SD = 14.5) to 67.4 (SD = 11.2), reflecting enhanced verbal abilities and comprehension ( $p < 0.01$ ).

- **Improved Sentence Structure:** Children demonstrated better sentence construction and more complex speech patterns. Educators noted an increase in the use of complete sentences and more coherent expression of thoughts.
- **Greater Verbal Engagement:** There was a marked increase in verbal interactions during platform use, with children actively participating in language-based activities and responding to prompts more effectively.

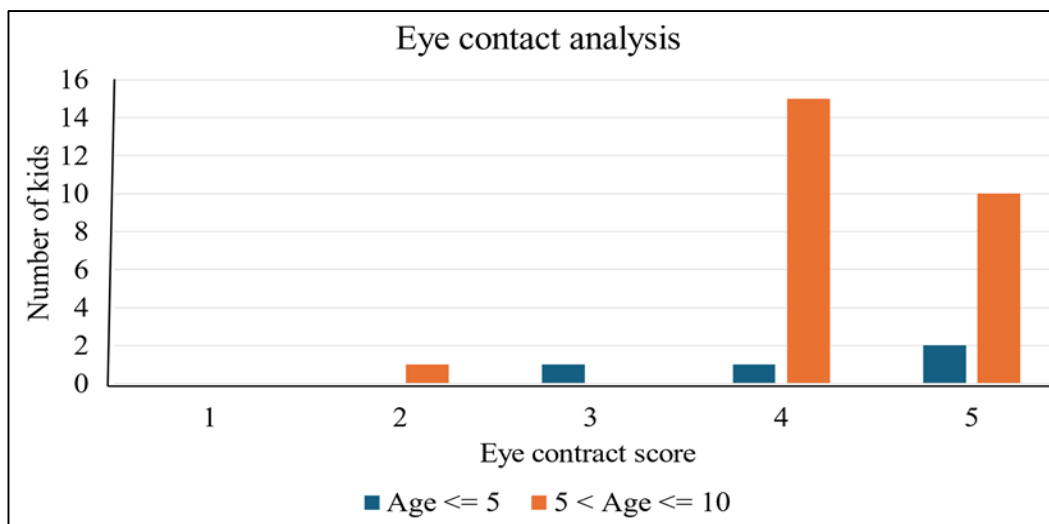
**Qualitative Observations**



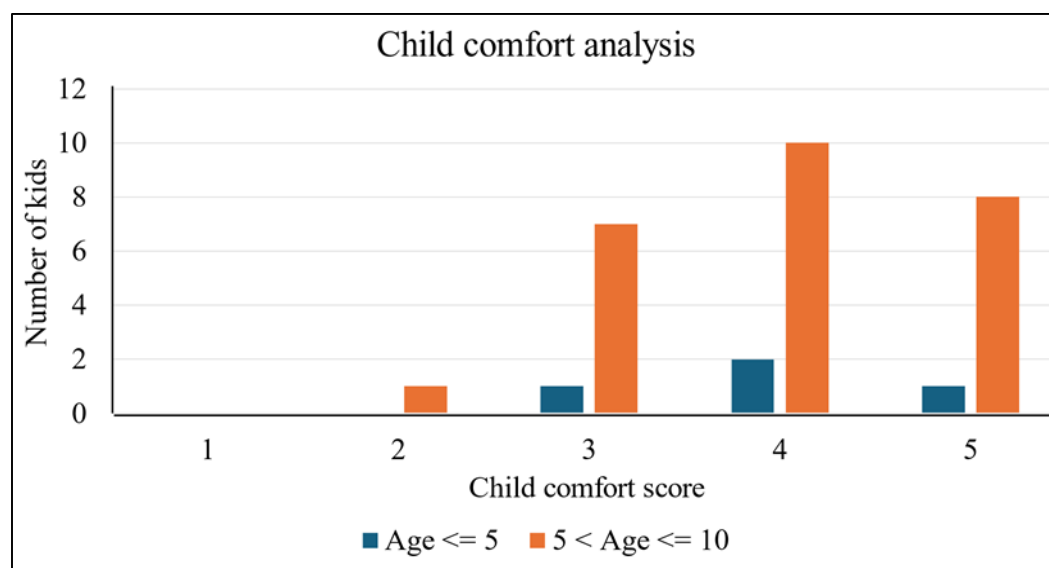
**Fig 3:** Conversational score as 1 refers to rarely any development seen, 2 means somewhat development is need 3 means a bit better development is seen 4 means better development is seen and 5 means a brilliant development is seen. X axis represents the number of kids and Y represents conversational score



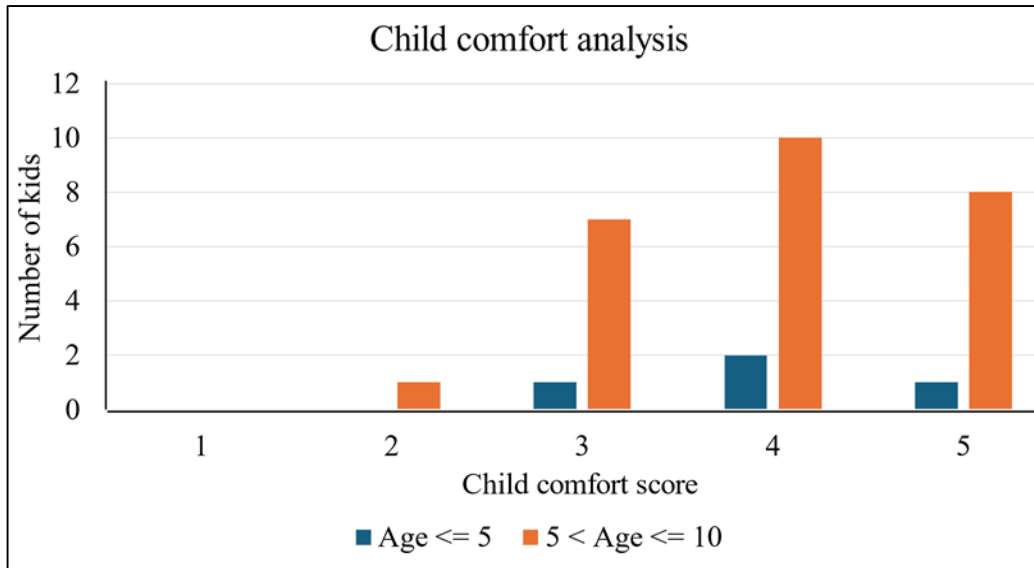
**Fig 4:** AI understanding score as one refers to rarely any development seen, two means development is need three means a bit better development is seen four means better development is seen and five means a brilliant development is seen. X axis represents the number of kids and Y represents AI understanding score



**Fig 5:** Eye contact score as 1 refers to rarely any development seen, 2 means somewhat development is need 3 means a bit better development is seen 4 means better development is seen and 5 means a brilliant development is seen. X axis represents the number of kids and Y represents Eye contact score



**Fig 6:** Child comfort score as 1 refers to rarely any development seen, 2 means somewhat development is need 3 means a bit better development is seen 4 means better development is seen and 5 means a brilliant development is seen. X axis represents the number of kids and Y represents child comfort score



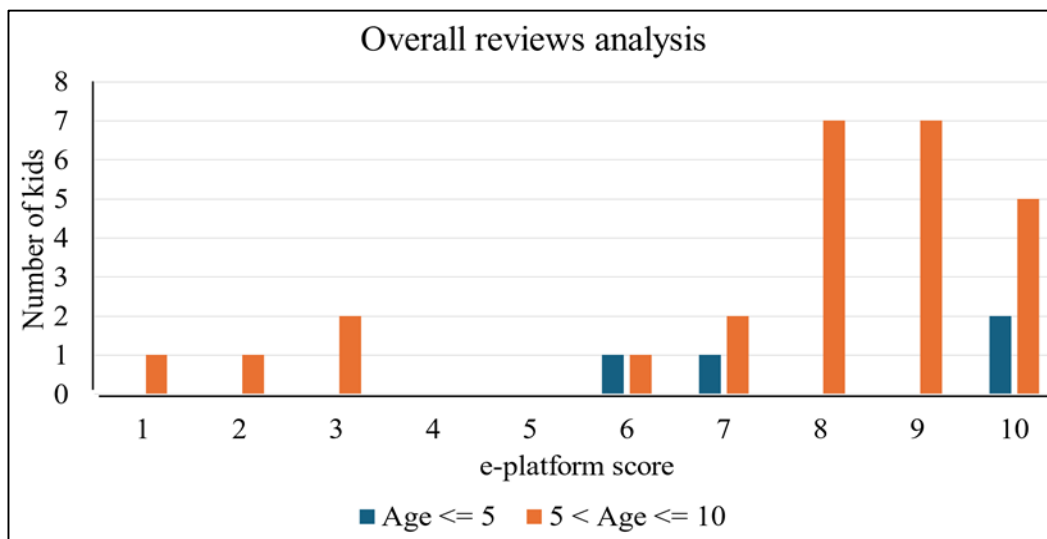
**Fig 7:** Digital interaction scores as one refers to rarely any development seen, two means development is need three means a bit better development is seen four means better development is seen and five means a brilliant development is seen. X axis represents the number of kids and Y represents Digital interaction score.

**5.3 Overall Engagement**

**Quantitative Findings**

**Engagement Metrics:** Analysis of interaction logs indicated high levels of engagement. The average session

duration was 35 minutes, with a 90% task completion rate. Children consistently returned to the platform, showing sustained interest over the study period



**Fig 8:** Reviews of e-platform based on the reviews and ratings given by the guardians of kids on the scale of 1-10.

**Qualitative Feedback:**

- **Positive User Experience:** Feedback from children, parents, and educators was overwhelmingly positive. Users appreciated the platform’s interactive elements, intuitive design, and the variety of learning activities. Many parents reported that their children were excited to use the platform and looked forward to learning sessions.
- **Customization and Adaptability:** The ability to customize learning paths was highlighted as a key strength. Educators found it easy to tailor content to individual needs, which helped maintain high levels of engagement and learning efficacy.

levels of social interaction, communication, speech, and overall activity. The outcomes of the current research resonate well with the theoretical guidelines that were incorporated into the platform development process, namely, Vygotsky’s social constructivism and the principles of neuroplasticity.

- **Social Interaction:** The improvement of the social interaction skills corresponds with the main postulations of the social constructivism; this theory holds the social interaction as the key to cognitive development. The common exercises of learning in the platform allowed children in interaction with their peers and thus improving their ability of social relation within the class. This is particularly crucial for childhood ASD as most of them are challenged in social interaction and peer relations.

**6. Discussion**

Based on these findings, it can be concluded that children with ASD benefit from e-learning by recording enhanced

- **Speech and Language Skills:** Related to the improvement in speech and language skills marked in this study is the richness of the material posted on the studied platform. Opening interactive games which waited for children's attempts and offering immediate feedback, the platform improved the children's usage of a target language and their communicative skills. Such conclusions can be explained by the existence of neuroplasticity, which presupposes the enhancement of cognitive capacities when specific exercises are performed.
- **Overall Engagement:** Concerning the level of children's engagement, both the quantitative data and qualitative responses suggest the effectiveness of the platform in generating and sustaining interest among children with ASD. The possibilities to choose the learning material and to explain it in different ways depending on the child's interaction levels were especially helpful in this case because all sorts of children want to use their brains and hands in some way and usually get bored at some point even if they are in special schools. This implies that digital learning tools if developed with the aim of addressing the user's needs could be significantly better than the traditional teaching techniques.
- **Limitations:** Nonetheless, there are certain lacunae that were detected in this research study. As such, some limitations include: The survey sample was small and the time of research was comparatively less. Future studies should enrol a sizeable diverse population; these studies should be conducted over several years to determine impacts of this intervention. Moreover, more profound analysis of the users' feedback provided understanding of their experiences lacking application of rigorous qualitative approaches.

## 7. Conclusion

As illustrated in this research, the successful implementation of an e-learning platform can positively improve the lives of children with ASD in their academics. The resulting improvements in social, communication, and overall behaviour mean that, when conceived and used properly, technologies can reflect the needs of the children with ASD. Thus, the ideas of social constructivism and neuroplasticity and a user-centric approach to the platform design helped to develop the concepts of experience and knowledge acquisition based on an effective approach to learning. Customisations made it possible to design the course in such a way that caters for diverse learners and the use of multisensory inputs addresses the needs of individual learners who need to spend time meaningfully online.

- **Future Directions:** Based on these results more research should.
- **Expanding the Study:** Expanding the sample size to ensure that different groups of people and in different settings receive similar results.
- **Longitudinal Studies:** Engaging in follow-up studies with samples to determine the platform's continuing effects on cognitive and socioemotional development.
- **Enhanced Data Collection:** Expanding the use of qualitative data analysis methods and including other data types, for example, neuroimaging to get better understanding of the cognitive shifts that occurred with help of the platform.

- **Feature Expansion:** Expanding of the options and content domains, including features like emotional regulation and executive functioning to enhance the child development with diagnosed ASD.

The effectiveness of this study shows the necessity for further advancements and investigations in the sphere of inclusive educational practice. I have an uphill task of ensuring that children with autism get the best education that will enable them to learn to the best they are capable hence the following innovations will be of great help I briefly described before.

## 8. Acknowledgement

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## Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Annexure 1

Section	Questions	Responses
Name:		
Age:		
Gender:		
Relation:		
<b>Social Interaction</b>		

a) Does your child maintain eye contact during interactions?	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Rarely	
b) How comfortable is your child in social situations?	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Rarely	
c) How much does your child interact with the digital world?	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Rarely	
Speech and Language Skills		
a) How well does your child engage in conversations (responses)?	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Rarely	
b) Does your child have difficulties in body language understanding?	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Rarely	
c) How well does your child understand AI voice?	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Rarely	
Assessment of Web Platform		
a) How frequently has your child used our platform during the last 30 days?	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Rarely	
b) For how much time has your child used our app?	Average time:	
c) Have you noticed any changes in the learning or behavior of your child since using the platform?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
d) How does your child react while using the app?	Reaction:	<input type="checkbox"/> Positive <input type="checkbox"/> Neutral <input type="checkbox"/> Negative

E) If your child would express, what are the features that he/she wants?

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F) Overall impression: on a scale of ten, how would you rate the platform?

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**Additional comments/ reviews**

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