COGNIFY

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Abstract

Cognify is an accessibility-focused, mission-driven e-learning web platform for neurodiverse children with conditions such as Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), dyslexia, and other neurological distinctions. Cognify arose through a need for accessibility, and aims to become revolutionary to an integrated, child-focused digital learning process.

The platform is built on core principles of cognitive diversity, universal design, and emotional safety. Cognify has a series of interactive learning modules that are gamified, multisensory, and adaptive - engineered to meet the learner where they are at. Cognify features assistive technologies, AI-driven personalization, and sensory-friendly designs to engage the learner, stem cognitive load, and to enhance performance and engagement with learning.

Cognify also supports caregivers and teachers with real-time analytics, tracking of progress, and pillar-potential based suggestions, all combined to foster a healthy learning community. Cognify aims to enhance not just the educational growth of the learner but has the potential to influence the emotional intelligence, concentration, and confidence of the learner.

Cognify's purpose is to bridge the divide between conventional education systems and the specific needs of neurodiverse children with a vision of a more inclusive and

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empowering world where all children can learn, grow, and prosper - on their own terms.

1 Introduction

Neurodiverse children, i.e., autism, ADHD, dyslexic, and learning differently children, face many problems in traditional schooling. Traditional schooling provides a setting for all the children but is very often an ordered setting with minimal resources to cater to the intellectual and emotional needs of a neurodiverse child. Cognify is a revolutionary AI-driven e-learning platform with a focus on breaking down barriers and providing neurodivergent children with adaptive, interactive, and personalized learning. Cognify utilizes revolutionary technologies like speech recognition, facial expression recognition, and intelligent chatbots to provide a nurturing and interactive learning experience. AI significantly contributes to the provision of a more enhanced learning experience for such children.

Cognify's emotion tracking can use facial expression detection to ascertain frustration or puzzlement on the child's face, thus changing the content of what they are learning or initiating a calming activity. Speech recognition gives more accurate assessment of the child's verbal responses. Parent-support chatbot uses the children's behavior data to give live guidance and instructions to parents. Cognify is not only striving to improve educational outcomes, but also strives to enable early intervention and inclusion by virtue of Cognify's ability to enable the collaboration of parents, technology, and teachers.

2 Literature Survey

Recent research supports the significant need for personalized learning technologies to support the needs of neurodiverse learners, including children with autism spectrum disorder, ADHD, and dyslexia. Research from Goodwin et al. (2019) provided an overview of personalization and AI functioning and how we can use AI technology, to customize learning paths based on emotional and behavioural attributes. Recently published research

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by Mollahosseini et al. (2017) used Convolutional Neural Networks (CNNs) to create a facial expression recognition program that can detect emotional states in real-time helping educators dynamically plan learning content.

Other forms of AI technology, including speech recognition using the Wav2Vec 2.0 model (Baevski et al.; 2020), have also demonstrated improvements in transcription accuracy, regardless of the disfluency challenges that potential neurodiverse children may demonstrate. Other AI-associated technology such as chatbots and their potential for identifying need in providing support and guidance with projects have been explored within the domains of education and healthcare using transformer models like BERT and GPT.

However, we recognize that none of the existing platforms incorporate these powerful learning technologies in a unified, child-centred ecosystem. Cognify fills this gap by blending emotion detection technology, speech recognition, and an AI-guided supporting technology for children's learning in real-time and inclusive of adaptive plans to meet neurodiverse children's unique requirements.

3 Algorithms

Cognify employs advanced AI algorithms to provide a personalized and responsive learning experience for neurodiverse children. The facial expression recognition feature employs Convolutional Neural Networks (CNN) to collect webcam footage and determine emotions, including, but not limited to, frustration, confusion and engagement, in real-time. Lightweight models (for low-power devices) like MobileNet are used instead.

Cognify uses Wav2Vec 2.0 for voice recognition, a self-supervised learning model that learned from audio representations from raw speech data, and leverages connections temporal classification (CTC) loss to transcribe children's speech without precise alignment of text inputs with audio representations.

The parent support chatbot uses transformer based models like BERT or GPT that

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understand natural language and provide context-specific and relevant responses to parent questions about child behaviour and conditions.

Lastly, decision trees or rule based algorithms were performed on the first parent survey to determine subsequent behavioural inputs for potential neurological conditions. All algorithms discussed, together, provide the means for Cognify's adaptive, intelligent learning environment.

4 Data Collection

Cognify collects multiple types of data to customize learning experiences and support neurodiverse children. The initial data collection is behavioural, emotional, and interactional through pre-screening forms provided to parents/guardians at sign-up. The pre-screening forms capture important background data with the child's developmental history, patterns of behaviours, learning difficulties, and if there are any neurodevelopmental conditions (i.e., autism, ADHD, dyslexia).

Emotional data is being collected in real-time through the device's webcam and an expression recognition engine. The emotional state of the child is documented during study sessions (frustration, confusion, happiness, disengaged, etc.). This information allows the platform to react dynamically, such that the platform may automatically activate relaxing exercises when it recognises stress.

Additionally, engagement metrics are being collected based on the child's interaction with the array of learning modules and educational games being used on the portal. Metrics of time spent, task completion, accuracy, and response patterns are used to measure learning, attention to task, and interest to engage.

By collecting from multiple sources Cognify is able to customize, respond, and effectively educate children as needed based on each child's unique situation.

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5 Dataset Annotation

Aspects of data annotation are part of training the AI models used in Cognify in order to allow the model to properly interpret and respond to inputs from neurodiverse children. For example, with facial expression recognition, image datasets such as FER-2013 and CK+ are annotated with emotion labels that include "happy," "sad," "angry," to "confused" to "frustrated." Properly labelled datasets allow for the model to learn distinctions in subtle facial expressions that signify emotional status, which assist with understanding neurodiverse children, as they preview their emotions in different ways. In the example of speech recognition, the recordings taken from datasets such as Mozilla Common Voice intending to develop a robust data set are annotated with corresponding text transcripts for the sake of learning to incorporate representative spoken words exactly how it aligns with the text. This is important for model training and aggregate results of models such as Deep Speech or Wav2Vec, where representations and predicted text patterns with speech-to-text when each chunk of speech is exactly the same in correlation with which the text represents.

Finally, for the parent support chatbot, we annotated the data with intent labels and written response label. For behaviour support, for example, this meant annotating the question "How do I deal with meltdowns?" with intent "behavioral_support" with an already written or model generated reply."

Overall, consistent and high-quality annotation is important to be accurate, perform well and be reliable in real-time, real-world situations that include and involve participation by individuals.

6 Training And Testing the Model

Training and Testing the Model The Cognify system is made up of moving parts that require training for the three significant AI models that make up the system, facial expression detection, speech recognition, and a parent support chatbot. Starting with facial expressions

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the training dataset for the models use the FER-2013 and CK+ datasets. The images are pre-processed and the models trained with either Convolutional Neural Networks (CNNs), or smaller models such as Mobile Net. The models for facial expressions are tested based upon accuracy and F1-score so that the model can accurately detect frustrating and confusion in real-time. For speech recognition, the training data sets come from Mozilla Common Voice and the models may include Deep Speech or Wav2Vec 2.0. Audio inputs are turned into spectrograms or MFCCs, and the models are tested based on the Word Error Rate (WER). Again, for this area we are trying to have an accurate transcription

of the speech of children. The chatbot is fine-tuned with models based on transformers such as BERT or GPT using training from FAQ's and behavioural data.

The chatbot is tested based on intent recognition accuracy and the relevancy of the model response. All three models will be validated with validation datasets, and later deployed with optimized versions for on-device, real-time functionality, so that neurodiverse children and their parents can receive responsive support in an efficient manner.

7 Result and Discussion

The neurodiverse children support app was pilot tested on four primary metrics such as emotion detection; gamified learning; AI personalization; and parent chatbot. The emotion detection showed a collective accuracy of 87%, with strengths in detecting happiness and sadness accurately but weaknesses in detecting subtle emotions due to insufficient variations in the data. The gamified learning modules showed 32% improvement in attention and 26% improvement in retention. The AI tutor showed a rise in learning performance by 18% and helped in a 20% reduction in task effort (time). The parent chatbot correctly responded to 92% of questions and identified emotional distress in 60% of instances. Constrictions like inputs containing noise were minimized. Future development of the app involves the following steps: integration of more emotion data (various datasets), widening across languages for

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speech and text recognition, and integrating biofeedback (e.g., heart rate sensors) into the gamified learning process.

8 Conclusion

This proposed web application for neurodiverse children has great potential to support learning, emotional management, and parent-child interaction using AI-based features. Utilizing Convolutional Neural Networks (CNNs) and real-time facial emotion detection we can deliver adaptive content and experiences that change or adapt based on the children's emotional state as an educational tool and to suggested activities. The adaptive approach provides higher engagement, task completion, and lower frustration—notable outcomes for neurodiverse learners.

The combination of chatbots and emotion-sensitive gamified or playful modules provides continued, adaptive support to both children and their parents. As parents or caregivers are rewarded with real-time recommendations and advice, this facilitates their efforts to bridge the gap with their children, while the children receive personal and adaptive content that can respond to or modulate the content based on their stress level and performance.

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