

# ExpressionTracker: Facial Expression-Based Emotion Analysis for Dyslexic Children during Educational Gameplay

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**Abstract** - Children with dyslexia often face challenges in reading, writing, and learning, which can reduce their confidence and engagement during educational activities. Although educational games provide interactive learning experiences, they generally do not consider the learner's emotional state. ExpressionTracker is a proposed web-based application that monitors the facial expressions of dyslexic children while they play educational games. Using a webcam, the system captures facial images and analyzes them with a pre-trained deep learning Facial Emotion Recognition (FER) model from Hugging Face. The proposed model classifies seven emotion categories: happy, sad, angry, fear, disgust, neutral, and surprised. Each prediction is associated with a unique Session ID, timestamp, and gameplay information and is stored in MongoDB. A React.js-based administrative dashboard is designed to visualize emotion distributions and session-wise trends so that teachers and developers can identify activities associated with engagement, confusion, frustration, or other emotional patterns. The proposed system combines computer vision, deep learning, web technologies, and learning analytics to support emotion-aware educational games and more inclusive learning experiences for children with dyslexia.

**Keywords:** ExpressionTracker, Facial Emotion Recognition, Dyslexia, Educational Games, Hugging Face, Vision Transformer, React.js, Node.js, Express.js, MongoDB, Learning Analytics Learning, Emotion Analysis, Hugging Face.

## 1. INTRODUCTION

### 1.1 Background

Dyslexia is a common learning difficulty that affects reading, writing, and spelling in children. The learning process can also influence confidence, motivation, and engagement during classroom and educational activities. Educational games are increasingly used to make learning more interactive, but the gameplay experience is commonly evaluated through task performance or observation rather than through the learner's visible emotional state.

Facial Expression Recognition (FER), deep learning, and adaptive learning techniques provide a way to observe facial cues and connect them with learning activities. ExpressionTracker builds on this direction by proposing

a web-based educational gameplay environment in which facial expressions are captured through a webcam and analyzed during the game session. The resulting emotion information is linked with session details so that it can be examined as learning analytics rather than as an isolated facial-recognition output.

### 1.2 Motivation and Need

Existing educational games for children with dyslexia primarily emphasize content, interaction, and game mechanics. They do not necessarily provide teachers or developers with an objective, real-time view of whether a learner is engaged, confused, frustrated, or disengaged. Manual observation can be subjective and is difficult to maintain consistently across many gameplay sessions.

The motivation for ExpressionTracker is therefore to connect the emotional state observed from facial expressions with the actual educational gameplay session. A session-level record can help organize emotion observations around the activities being performed and provide a basis for identifying patterns that may be useful when improving educational content and game design.

### 1.3 Problem Statement

Current educational games for dyslexic learners can provide interactive learning but often overlook the learner's emotional state. As a result, teachers and developers lack a measurable, real-time method for understanding emotional responses during gameplay. The problem addressed by ExpressionTracker is the design of an intelligent system that can unobtrusively capture facial expressions during educational gameplay, classify the observed emotions, and transform the observations into session-level analytics that can support learning and game-design decisions.

### 1.4 Objectives

The objectives of ExpressionTracker are: (1) to develop a web-based educational game integrated with real-time Facial Emotion Recognition for monitoring the emotional state of dyslexic children during gameplay; (2) to integrate a deep learning-based Hugging Face FER model for emotion classification; (3) to design a teacher-facing analytics dashboard for storing, visualizing, and analyzing session-level emotion data; and (4) to provide actionable

emotion-based insights that can support personalized learning experiences and improvement of educational game design.

### 1.5 Scope

The proposed scope covers a React.js frontend containing the educational game and webcam capture module, a Node.js and Express.js backend for processing requests, a pre-trained Hugging Face FER model for emotion classification, MongoDB for session and emotion data storage, and a React.js administrative dashboard for visualization. The work focuses on connecting facial emotion information to educational gameplay sessions and learning analytics. It does not claim a complete adaptive-learning engine or a clinically validated diagnostic system.

### 1.6 Scope

The main contribution of the proposed work is the integration of facial emotion analysis into an educational gameplay workflow designed for children with dyslexia. Instead of treating emotion recognition as a separate computer-vision task, ExpressionTracker connects each observation to a Session ID, timestamp, and gameplay details and makes the resulting information available through an analytics dashboard. This provides a practical foundation for studying emotion-aware educational games.

## 2. LITERATURE REVIEW

The literature survey supplied with the ExpressionTracker project covers facial emotion recognition in children with learning disorders, emotion analysis in virtual learning environments, game-based learning for dyslexia, AI-based FER, behavioural studies, and related learning analytics. The studies identify several gaps that motivate the proposed system.

### 2.1 Literature Survey

- [1] Facial Emotion Recognition in Children with Specific Learning Disorders (2020) Deep Learning + FER; no real-time educational analytics.
- [2] Facial Emotion Recognition in Children (PMC) (2020) FER; no dashboard or adaptive learning.
- [3] Emotion Analysis in Virtual Learning Environment (2019) Facial Expression Recognition; no educational gameplay analytics.
- [4] Digital Games-Based Learning for Dyslexia (2017) Game-based learning; no AI emotion adaptation.
- [5] AI-Based Facial Emotion Recognition for Education (2023) AI + Deep Learning; no dyslexia-specific system.
- [6] Explainable Facial Emotion Recognition (2022) Deep Learning; not focused on education.
- [7] Gamified Dyslexia Screening (2019) Machine Learning; not a learning analytics system.

- [8] Face Processing Deficit in Dyslexia (2025) Review / Meta-analysis; no FER implementation.
- [9] Visual Cognition in Dyslexic Readers (2018) Behavioural Analysis; no emotion analysis.
- [10] Theory of Mind & Dyslexia (2025) Behavioural Study; no adaptive gameplay.
- [11] Enhanced Emotional Reactivity in Dyslexia (2021) Experimental; no dashboard.
- [12] Facial Behaviour Variability (2025) Behaviour Analysis; no educational integration.

### 2.2 Facial Emotion Recognition and Learning Disorders

The surveyed FER studies show that deep-learning and facial-expression methods can be applied to children and learning-related contexts. However, the project survey notes that several studies focus on recognition or behavioural analysis without connecting the detected emotion to an interactive educational gameplay session. This separation limits the direct use of emotion observations as learning analytics within a game.

### 2.3 Educational Games and Dyslexia

The literature on digital games-based learning for dyslexia demonstrates the relevance of interactive game mechanics to learning. The project survey identifies the absence of facial emotion recognition and emotional adaptation in this line of work. ExpressionTracker therefore places FER directly inside the gameplay loop so that emotional observations are associated with the learning activity.

### 2.4 Research Gap and Proposed Solution

The identified gaps can be summarized as follows: facial-emotion studies involving children with learning disorders commonly emphasize passive tasks or recognition; dyslexia-focused educational games emphasize content and game mechanics without FER; general AI-based FER research is not necessarily designed for dyslexia-specific educational analytics; and behavioural studies often remain at the study stage without a working dashboard. ExpressionTracker addresses these gaps by combining real-time facial emotion tracking, educational gameplay, session-level data storage, and a teacher-facing analytics dashboard.

## 3. METHODOLOGY

The proposed system follows a three-tier architecture consisting of a React.js frontend, a Node.js and Express.js backend, and a MongoDB database. The frontend hosts the educational game and webcam module. Captured facial images are associated with a unique Session ID and transmitted for emotion analysis. A pre-trained Vision Transformer (ViT)-based FER model from Hugging Face classifies the learner's facial expression into seven emotion categories. The resulting emotion, timestamp, Session ID, and gameplay details are stored in MongoDB

and later visualized through an administrative dashboard.

### 3.1 System Architecture

The frontend acts as the learner-facing layer. The educational game provides the interaction context, while the webcam module captures facial images during gameplay. The backend provides the processing and application layer, while MongoDB provides persistent storage for session-level emotion records. The dashboard uses the stored information to display emotion distributions and session-wise trends.

### 3.2 Gameplay and Webcam Capture

A gameplay session begins when the learner starts the educational activity. During gameplay, the webcam module periodically captures facial images without interrupting the game interaction. Each session is assigned a unique Session ID so that multiple emotion observations can be grouped with the corresponding gameplay session.

### 3.3 Facial Emotion Recognition

The proposed emotion-analysis component uses a pre-trained Vision Transformer (ViT)-based Facial Emotion Recognition model from Hugging Face. The model classifies the captured facial expression into seven categories specified in the project methodology: happy, sad, angry, fear, disgust, neutral, and surprised. The classification output becomes the emotion field of the corresponding session record.

### 3.4 Session-Level Data Management

For each observation, the system associates the predicted emotion with the Session ID, timestamp, and gameplay details. These records are stored in MongoDB so that the application can retrieve them for session analysis. The session-oriented design allows observations to be reviewed as a sequence of gameplay events rather than as independent facial predictions.

### 3.5 Teacher-Facing Analytics Dashboard

The proposed administrative dashboard is implemented with React.js. It is intended to display emotion distribution charts and session-wise emotional trends. These visualizations can help teachers and developers identify activities that are associated with engagement, frustration, confusion, sadness, or other observed patterns and use the information when reviewing educational content and game design.

### 3.6 System Workflow

The complete workflow connects gameplay, facial capture, emotion classification, session storage, and

analytics. A learner starts the educational game, facial images are captured through the webcam, the FER model predicts an emotion, and the prediction is associated with the session information. The data are stored in MongoDB and subsequently presented through the dashboard for analysis.

## 4. IMPLEMENTATION

ExpressionTracker is designed as a web-based application using React.js, Node.js, Express.js, MongoDB, and a pre-trained Hugging Face FER model. The implementation plan follows the architecture described in the methodology and keeps gameplay, emotion analysis, data storage, and analytics as connected components.

### 4.1 Frontend

The React.js frontend hosts the educational game, webcam capture module, and administrative dashboard. The learner-facing interface provides the gameplay context in which facial expressions are observed. The dashboard provides the analysis view for stored session data.

### 4.2 Backend

The backend is planned with Node.js and Express.js. It provides the application layer between the frontend, emotion-recognition component, and MongoDB. Captured observations are associated with the session information before being stored for later retrieval and visualization.

### 4.3 MongoDB Data Layer

MongoDB is used to store emotion observations together with Session ID, timestamps, and gameplay details. This provides a persistent data layer from which session-level trends and emotion distributions can be generated for the administrative dashboard.

### 4.4 Technology Stack

The principal technologies specified in the project are React.js for the frontend and dashboard, Node.js and Express.js for the backend, MongoDB for data storage, and a pre-trained Vision Transformer-based Facial Emotion Recognition model from Hugging Face for emotion classification. A webcam is used as the input device for facial-expression capture.

### 4.5 Development Plan

The project work plan supplied with the presentation divides development into six phases. The literature survey and requirement analysis are marked completed, followed by frontend and webcam development, backend and model integration, MongoDB storage, dashboard development, and final integration testing, user evaluation, and documentation.

Phase 1 - Literature survey and requirement analysis: Completed.

Phase 2 - Design of frontend educational game and webcam capture module (React.js): Weeks 1–2.

Phase 3 - Backend setup and Hugging Face emotion-detection integration (Node.js / Express.js): Weeks 3–4.

Phase 4 - Session and emotion data storage in MongoDB: Weeks 4–5.

Phase 5 - Admin analysis dashboard for visualization: Weeks 5–6.

Phase 6 - Integration testing, user evaluation, and final documentation: Weeks 7–8 (Review 2).

## 5. EXPECTED OUTCOMES AND DISCUSSION

The supplied project material describes ExpressionTracker as a proposed system and lists expected outcomes rather than completed experimental results. Therefore, the outcomes below are presented as intended prototype behavior and evaluation targets rather than as measured performance claims.

### 5.1 Expected Prototype Behavior

The expected prototype should connect real-time facial emotion observations with educational gameplay sessions of dyslexic children. The system should retain the emotion observations with their Session ID, timestamps, and gameplay details so that the data can be examined after or during a session.

### 5.2 Expected Analytics

The expected dashboard should display emotion distribution and session-wise emotional trends. These views are intended to help teachers and developers identify which activities are associated with frustration or confusion and which are associated with engagement or happiness.

### 5.3 Practical Significance

By linking facial-expression information to the actual learning activity, ExpressionTracker is intended to provide a more structured source of emotional feedback than manual observation alone. The project material positions this information as a basis for improving educational content and supporting more personalized, emotion-aware gameplay.

### 5.4 Evaluation Plan

The project work plan specifies integration testing and user evaluation in the final phase. Evaluation can therefore focus on whether the prototype captures facial observations during gameplay, assigns them to the correct session, stores the records in MongoDB, and presents meaningful emotion distributions and session-wise trends in the dashboard.

## 5.5 Current Scope and Limitations

The supplied material describes a prototype-oriented system and does not provide measured model accuracy, a completed user study, or clinical validation. The project should therefore be interpreted as an educational technology prototype and learning-analytics approach rather than a diagnostic tool. The effectiveness of the proposed system would require further testing with appropriate participants, evaluation protocols, and privacy and consent procedures before real-world deployment with children.

## 6. CONCLUSION

ExpressionTracker proposes an integrated approach that combines computer vision, deep learning, educational gameplay, and learning analytics for children with dyslexia. The system captures facial expressions during gameplay, uses a pre-trained Hugging Face Vision Transformer-based FER model to classify seven emotion categories, links the predictions with Session IDs and timestamps, stores the resulting information in MongoDB, and presents session-level trends through a React.js administrative dashboard. The project material identifies this integration as a way to make dyslexia-focused educational games more emotion-aware and to provide teachers and developers with structured information about learner engagement and emotional patterns.

### 6.1 FUTURE WORK

Future work can extend the proposed prototype toward adaptive, emotion-aware educational gameplay in which emotion analytics inform changes to learning activities. Further work can also examine broader emotion-analysis methods, richer session analytics, more extensive user evaluation, and improved dashboard functionality. Any real-world deployment involving children would require appropriate privacy, consent, safety, and validation procedures in addition to technical evaluation.

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