

CHAPTER I

INTRODUCTION

1.1 Project Background

Over the last several years, our education system has improved, especially with the incorporation of technology into the industry. The latest and perhaps most important of these changes is the COVID-19 pandemic. It allowed schools and universities to implement remote pedagogy after having to make emergency transitions from in-person to distance learning. This abrupt transition was, and continues to be, a double-edged sword. It marked the beginning of a new learning era while also presenting unique and perplexing challenges to participants on both sides of the education divide, as well as to facilitators. Asynchronous learning, remote education, and access to educational materials and content from any location worldwide are benefits of the online academic environment, especially for students in remote learning settings. Nevertheless, academic approaches to student disengagement from traditional education were sharply intensified by shifts.

Technology designed specifically for education, especially for children, does not address students' emotional needs. This yields feelings of apathy, frustration, and confusion which negatively impact learning outcomes. Research demonstrates that emotional engagement directly influences academic performance: positive emotions such as joy and curiosity enhance motivation and achievement, while negative emotions such as frustration and confusion diminish learning (Pise et al., 2022). For instance, a child who is frustrated by a lesson and challenged to understand it is likely to disengage and miss learning. On the other hand, those who feel positive emotions tend to persist longer, show greater engagement, and are more likely to understand and retain more (Rentzios et al., 2025).

The wall that such e-learning systems face hinges on how little they understand students' emotions and how little they engage them. Current systems understand and respond to students' emotions on platforms but offer them little to no emotional support or engagement. Students become even more disengaged and less motivated to learn when emotions are disregarded. Creating e-learning platforms that respond to students' emotions and adapt content accordingly to support them is critical to mitigating this issue. Emotion analysis systems will make this solution more accurate and sophisticated. Such systems will make emotionally disengaged students more active on the platforms (Gupta et al., 2023).

1.2 Problem Statement

Most current e-learning systems do not analyze students' emotional states during learning activities. Students' emotions are ignored on existing platforms as they come across learning content. Students may be frustrated, confused or deeply involved, and learning platforms are unable to identify these states. Students are left in emotional and cognitive distress, and the traditional learning platforms that cause emotional distress do nothing to assist. Teachers are unable to identify which students are emotionally struggling, so they cannot offer support. The inability to assess emotional states at this age is a serious challenge for e-learning, as 7-9-year-olds can be especially susceptible to losing focus and disengaging from the activity (Zhang & Wang, 2024).

Furthermore, The e-learning system still cannot recognize emotional states or dynamically tailor learning content. Even though the platform or the teacher finds students' emotional situations hard, they still cannot adjust the real lesson difficulties, and scaffolding, or teaching strategies. Existing systems still offer the same tasks to every student. If a student is fidgeting or between tasks (frustrated), the tasks do not adjust to the student's level. If students are confused, the tasks do not adjust to their level. This is still the same contradiction as before and will always maintain students' loose emotional state and lack of intrinsic motivation to learn. This is the most significant barrier to the real learn process. It was evident that students' emotional situation strongly influences academic performance. Positive joy and interest will motivate learning on the desired level. Even in a NIL emotional situation, the system still does not respond to this stimulus (Tulsani et al., 2024).

The tools available to educators provide little analysis and monitoring tools related to emotional engagement. For example, there is no dashboard that integrates emotional engagement data and provides actionable data for instructional adjustments. Without the ability to see and understand where students are on the emotional engagement spectrum (e.g., happy, frustrated, confused, or actively engaged), teachers cannot adjust task complexity, provide necessary support, or differentiate their instruction according to students' emotions and cognitive levels. A reporting system that tracks emotional data is a critical component of an optimal learning experience and helps educators manage the emotional climate of students, both individually and as a group. Without such a system, the learning experience is not as practical as it should be (Rentzios et al., 2025).

1.3 Objectives

1. To assess student emotional states based on facial emotion recognition.
2. To personalize learning content based on emotional engagement.
3. To generate report on the student performance.

1.4 Project Scope

The project aims to develop a web-based AI-interactive learning application with facial emotion recognition for teachers and students aged 7-9 in classrooms. The application includes a web-based facial emotion recognition feature that identifies and tracks students' emotional states in real time as they respond to learning questions and activities through any webcam application. During learning content, a trained CNN analyses the student's facial expressions and classifies them as Happy, Engaged, Confused, or Frustrated. Feed this into the engine to understand that Engaged would represent a neutral, on-task expression, assumed to indicate acquiescent learning. The interface of the application named Behave, with the output displayed as a teacher dashboard, organises emotional data by emotion group, including the student name, score, and accuracy for each emotion group. The platform consists of 3 languages: Bahasa Indonesia, English, and Bahasa Melayu, which students and teachers can swap during the session.

At the end of each learning round, the system automatically adjusts the difficulty levels for each emotion group according to predefined rules. Teachers may also manually override difficulty settings in the dashboard. The platform supports teacher-assigned subject content and is designed to be emotionally engaging for students and appropriate for 7-9 year-olds. The platform is a web application that runs in any web browser (Google Chrome, Mozilla Firefox) on desktop computers, laptops, and tablets, without needing to install any applications or special hardware. All activities related to emotion recognition are conducted in accordance with data privacy, with server-side processing of each facial expression frame and only emotion classification results stored in the database, and roles defined to protect students' emotional data (Pise et al., 2022).

1.4.1 Scope of System

Provide a system based on emotion recognition CNN technology, targeted only for children aged 7-9 years old. That will record, analyze and categorize real-time emotional reactions of students to their learning activities. The system keeps fetching each student's face expression frames from their webcams every 3 seconds, classifies them, stores this information on the server, and then transmits it to the teacher dashboard in real time. The dashboard will offer a centralized view of students' emotions, showing which students are currently Frustrated and need task simplification, which are Happy or Engaged and can be challenged with more difficult content, which are Confused and may need additional support, and which are actively engaged and progressing well. Teachers will also see the names of individual students and their current activities for every emotional grouping, as well as indicators of whether that student's emotional state is improving or deteriorating. The system sends push notifications to the teacher's device when all students have completed a round, triggering the automatic difficulty adjustment process so the teacher can intervene and adjust the content.

In the lesson's adjustments, teachers will be guided by emotion group analytics. At the end of every round, the system automatically adjusts the difficulty of questions for each emotion group. If the majority of students are identified as Frustrated or Confused, the question difficulty decreases. If the majority of students are identified as Happy or Engaged, the question difficulty is increased. These auto-adjustments can be overridden by the teachers on the dashboard. The platform presents questions in multiple-choice and essay formats, with optional video attachments that teachers may include per question. The system is designed to provide instructional content across subjects, as assigned by the teacher, presented through questions organized into five difficulty levels: very easy, easy, medium, hard, and very hard. All content will be presented through a web interface and supplemented by teachers, who will respond in real time to students' emotional reactions via the dashboard. To safeguard student confidentiality, facial expression video streams are processed on the server, and only emotion classification results are stored in the database. Raw video streams are not preserved. Emotion data from other students is not accessible to students, and teachers can access it only for their respective classes. Also, the results of emotion classifications are what they will see (Aly & Alotaibi, 2025).

1.4.2 User Scope

Students and teachers are the main users of the platform. Users are students aged 7-9 who will do learning activities from the web-based application. Teachers will supervise students' learning and monitor their emotional responses via a dashboard that groups students by emotional responses. Teachers may manually override difficulty settings, while the system automatically adjusts question difficulty at the end of each round based on detected emotional states. Students will create accounts and join classes using a unique class code to complete the teacher-assigned learning activities. The platform will use facial emotion recognition from students' webcams to monitor how sections react emotionally as they answer questions and problems. When using the dashboard, teachers will observe students' emotional states throughout a lesson and manually override the system's automatic adjustments to adjust the difficulty as needed. The platform does not include parent accounts, so parents cannot view students' emotional states, which emphasises student mental health. The platform aims to facilitate direct interactions between teachers and students and classroom teaching. The students' learning activities and the teachers' dashboards will be integrated into a single web-based application compatible with any browser. This will enable teachers to use the technological tools already available in their classrooms.

Children aged 7-9 will be able to use an engaging student interface designed with simple navigation, interactive learning activities, and emotional response tracking. Clear visuals indicating students' learning progress and quiz scores. Teachers will receive a more complex dashboard interface structured by students' emotional states and grouped by class. This will enable teachers to see at a glance which students are happy, engaged, frustrated, or confused, and help them adjust instruction on the fly. Teachers will have data admin access restricted to their own class to ensure data privacy. This will also allow teachers to override question difficulty levels, track students' learning progress, and review emotional engagement data. A responsive, straightforward classroom web interface will be provided to both teachers and students, with no special software or complicated training required.

1.4.3 Overall System and User Interaction Flow

When teachers and learners access web-based platforms on their classroom devices, the user interaction flow begins (Google Chrome, Mozilla Firefox). Students sign in to their accounts and begin learning sessions in which they are presented with

questions across subjects as assigned by their teacher. Meanwhile, the webcam records their facial expressions as they tackle each activity. The emotion detection system analyzes and categorizes facial expressions into emotional categories (happy, frustrated, confused, and engaged). This data is sent to the teacher dashboard, organized by emotion group, with individual student names visible within each group. Teachers access the same platform and navigate to their dashboard, where they see all students categorized according to their emotional expressions: a “Frustrated” group depicting all learners showing frustration, a “Happy” group depicting learners showing happiness, a “confused” group depicting learners showing confusion, and an “Engaged” group depicting learners showing engagement. Teachers see learners’ names in each emotional grouping, the activity each learner is working on, the time they have spent on the activity, and their emotional status to determine whether they are improving or deteriorating. Teachers receive real-time notifications when a large proportion of students are frustrated or confused, enabling immediate instructional intervention.

After each round, the system identifies the most pronounced emotion in each group and adjusts the task's difficulty. Teachers receive a notification when all students have completed the task. Teachers can then start the next round, send the students their next question, and confirm the question's difficulty. If teachers prefer, they can also adjust the question difficulty in the dashboard based on each group's emotive response. Seeing that students in the “Frustrated” cohort are stuck on one question or concept, a teacher can review the system's automatic difficulty adjustment and manually override it if needed, or precede with the updated difficulty for the next round. These changes impact all students and take effect immediately. In contrast, when the “Happy” and “Engaged” cohorts demonstrate readiness and success, the system automatically increases question difficulty to maintain engagement, and teachers may further adjust the level through the dashboard. This cycle repeats throughout the lesson. Students answer questions while their emotions are continuously detected and grouped. At the end of each round, difficulty is automatically adjusted, and the teacher starts the next round. All that is needed is a standard webcam and an internet connection. Students interact with learning materials while their feeling states are continuously monitored and updated, and grouped by emotion on the teacher dashboard. Teachers identify and track patterns, respond to students by adjusting learning activities, and students respond to the modified

activities as triggered by their emotional and cognitive readiness. In response to the changes, students' emotions shift, and the cycle begins again. This process occurs all within a single platform. This makes it easy to use in any classroom that has basic technology.

1.5 Project Significance

This project aims to help close an important gap in educational technology by designing an integrated system capable of real-time facial emotion recognition and emotion-responsive content adaptation, tailored explicitly to classroom settings for young learners aged 7-9. Current e-learning tools and classroom technologies do not monitor and respond to students' emotions during the learning process. As a result, students experience frustration, confusion, and disengagement, and are left unsupported. The project's unique contribution to the realm of learning technologies emphasizes the emotional aspect of learning, an area of research that demonstrates the strong link between emotions and students' academic achievement, motivation, and learning outcomes. By using real-time facial recognition technology to adapt learning content to students' emotional states, the system adjusts question difficulty automatically based on students' emotions and equips teachers with tools to monitor emotional states and override settings when needed, thereby supporting both students who struggle with the content and those who advance more quickly. The emotion-grouped dashboard Design, which fosters the grouping of students by emotional states, as opposed to individual student visibility, allows teachers to rapidly recognize classroom phenomena, such as "the majority of the class appears to be struggling with this concept," and respond to evidence-based instructional problems in ways that are typically unfeasible in traditional instructional environments. This innovation is likely to be important for students aged 7-9, as they are more easily disengaged and, because of their emotional sensitivities, may need more emotional support to persevere on more difficult learning tasks and to bolster their confidence in their academic skills (Liu et al., 2022).

Implementing this system in classroom environments is a noteworthy advancement in educational technology because it demonstrates that emotion detection technology can be used in practice beyond empirical studies to enhance teaching and learning. While a plethora of previous studies investigated emotion recognition in silos or analyzed emotional study engagement retrospectively after

learning has occurred, the current study has established a real-time feedback loop that enables teachers to respond to students' emotional states as they occur during the lesson, rather than reviewing emotional data after the class has ended and circumvent frustration that leads to disengagement or confusion, resulting in off-task behavior. The system's web-based Design makes it accessible and inexpensive, with the only requirement that schools have standard devices with webcams, thereby supporting its potential deployment across a wide range of classroom environments and economic strata. By focusing primarily on classroom teacher-student interactions rather than broad e-learning platforms, this project addresses an important aspect of K-12 education: teachers are left with the frustrating task of gauging, empirically and without real-time feedback, their students' emotional states to balance the varying educational and emotional-cognitive levels of their students. The system's emotional intelligence in recognizing that tasks must align with contemporary educational theory and practice aligns with it. Thus, schools that integrate this technology are leading the way in using evidence-based, emotionally responsive teaching that enhances student engagement, motivation, and achievement (Aly & Alotaibi, 2025).

1.6 Chapter Summary

This chapter has laid the groundwork for the proposed AI-based interactive learning app with facial emotion recognition. The project background explains how existing e-learning platforms and teaching technologies fail to consider students' emotional needs, putting children aged 7-9 at risk of disengagement, increasing their frustration, and reducing their learning outcomes. The problem statement identified three critical challenges/limitations in the field of educational technology, Systems that cannot scan and evaluate the emotional conditions of students during learning activities, The absence of mechanisms for responsive adaptive learning that are emotional state driven, and The absence (or lack) of teaching aids that provide a comprehensive monitoring framework to enable the emotional responsiveness of lesson adjustments. These three challenges directly align with the three primary goals of the project: to assess students' emotional states using facial recognition technology, to apply adjustments to learning materials based on the students' emotional levels in real time, and to provide teachers with a report to analyze the emotional patterns of their students in order to respond appropriately.

A web interface system integrated with emotion recognition technology, with a recognition facet for children's emotions framed at four levels (happy, frustrated, confused, and engaged), was designed specifically for teachers and students aged 7-9. The system organizes students on a dashboard with emotion-group categorization, which teachers use to identify emotional states. The teacher's real-time dashboard controls adaptive responses to students' emotions, adjusts question difficulty levels automatically based on detected emotional states. The system monitors students' emotional responses during the closing of each round to understand the challenge presented by each question. It recognizes Confusion and Frustration as indicators to decrease challenge levels simultaneously, and Happy and Engaged responses as indicators to increase question challenge levels. Teachers can adjust the system's challenge levels as they see fit. The system has the following components: a dashboard with student emotions grouped by class, a web-based teacher dashboard with a real-time emotion detection system, an integrated, comprehensive system with protective measures, and a CNN-based emotion detection mechanism for real-time facial expression classification. The testing and evaluation will address the technical and educational parameters of the system.

The platform is designed specifically for teachers and students aged 7 to 9. Also, the platform is restricted to classroom teaching, thus excluding parent accounts or parental access to student emotion data. The flow of interaction in the overall system started with students solving learning tasks; during this time, emotional reactions were captured and sent to the teacher dashboard, grouped by emotion. Since the system adjusts question difficulty automatically at the end of each round, a teacher monitors pupil data through their dashboard. This cycle cycles throughout the lesson, supporting an emotional and cognitive sustainment loop. Prior emotion recognition research has been done in controlled environments, but this project fills an important gap by first applying it to the real classroom. The system uses active emotion detection in a real-world classroom scenario, enabling affordable, portable, and practicable integration of a method focused on engagement and learning outcomes, with feedback from learners. This project makes emotion-adaptive learning practical on the web, making it an affordable option for a wide range of classrooms and steering the educational technology field toward a system that addresses the emotional and cognitive aspects of learning.