



EXPLORING THE ROLE OF AI-POWERED EMOTION RECOGNITION IN CLASSROOM SETTINGS TO MONITOR CHILD ENGAGEMENT AND EMOTIONAL STATES

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ABSTRACT

This study explores how emotion recognition systems based on AI can work in educational classrooms to analyse the emotional state of students and their engagement levels. The AI implemented was able to collect real-time emotional reactions of students attending primary and middle schools based on facial expression analysis, eye-tracking, and the evaluation of voice tone of the students aged 8-14 years. The methodology was qualitative and experimental in nature and based on logs of AI-generated emotion and logs of teacher observation. The result showed that the most prevalent emotional state identified was Attentive and Happy which means that they were broadly engaging. Nevertheless, a large number of students demonstrated negative emotional states of Confused, Bored, and Frustrated especially during the second part of the classes. With a maximum of Attentive and minimum of Confused, they found that the match of AI-teacher emotion is going to be the most accurate, which indicates that both human and automation tools should be used because they enhance each other. It is concluded that the state of emotion recognition based on AI can be used as a valuable support tool of an educator in real-time, which can be used to make timely alterations in the pedagogy. Nevertheless, the moral aspect, error constraints, and situational meaning are still major elements of the prudent utilization of such technologies.

Keywords: *AI-powered emotion recognition, student engagement, classroom monitoring, emotional states, educational technology*



1. INTRODUCTION

The adoption of artificial intelligence (AI) in schools is a new direction in the education sector in which a learning experience of students is enriched. Among the new trends here is the AI-powered emotion recognition that will bring about the understanding and recognition of emotional states in students by tracking facial expression, voice modulation, body language, and other behavioural clues. Emotion and cognitive involvement are the key drivers affecting the academic performance of students and at the same time are the most ignored or poorly evaluated factors in the classroom session. As more and more intelligent technologies are becoming available, teachers can now obtain real-time data about the emotional condition and the level of engagement of their students to be able to react to them in more direct and personalized ways in teaching them.

1.1 Background of the Study

The general approaches used with traditional methods on learning involvement and emotional health of students are mainly based on the teacher through observation, self-reports through questionnaires or assessment sessions. The methods however may be subjective and not very frequent and also fails to give a real-time emotional mood of the students. Over the past few years, AI-driven technology, especially the one based on computer vision and machine learning tools, was able to analyze non-verbal communication as well as physiological readings to identify emotions even more accurately.

Emotion recognition systems can also be useful tools to teachers in classroom, so that they can spot those students at risk to be disengaged, stressed or even extraordinarily emotional, to take remedial action. Moreover, these systems may also play a role in inclusive education, as they can assist the emotional needs of various learners (those with learning problems, with problems on an autism spectrum, or with language barriers).

Although the predictions are rather optimistic, when such technology is applied to the educational setting, the issues of ethical considerations, data privacy, accuracy, and the place of human judgment are very much open. This study aims to investigate these aspects by comparing the potential of AI-based emotion detection devices to implement in the classroom in a teaching and efficient manner to observe and increase the rates of student engagement and emotional well-being.

1.2 Objectives of the Study

The primary objectives of this research are:

1. To study the efficiency of using emotion detection technologies software on AI to determine the state of emotions and the level of engagement in children at the time of attending a classroom.
2. To assess teaching strategies, participation of students and resulting learning outcomes because of real time monitoring of emotions.
3. To examine the social, ethical, and technical issues that surround the use of AI-based emotion recognition in the learning setting.

2. LITERATURE REVIEW

Akintayo et al. (2024) explored the combination of the artificial intelligence and emotional and social learning in the primary school to develop holistic and adaptive learning ecosystem. Their work pointed out that emotionally sensitive AI systems are necessary in identifying and fulfilling the numerous emotional and behavioural requirements of young learners. By integrating emotional recognition ability operated by AI into the technologies used in a classroom, the researchers proved that students became more engaged in the classes, were more emotionally stable and adaptable in social situations. That study highlighted the significance of AI in monitoring academic achievement not just, but also the reactivity to emotional expressions within a child-focused learning set-up.

Alam and Mohanty (2022) discussed the comparative design of facial analytics and virtual avatars in online education platforms powered by the AI. Their research targeted on the opportunities of these technologies facilitating more interesting communication between students and teachers in web-based environments. They described the skills necessary to accomplish such systems and gave a presentation on the same at the International Conference on Communication, Networks and Computing which include emotional accuracy, responsiveness and real time adaptability. Their results showed that AI with emotional intelligence, especially with the help of facial recognition devices, made classroom

collaboration more effective since teachers could adjust to the signals on emotions and adapt to the needs of the students using them.

Chen et al. (2025) performed a systematic literature review and text mining analysis of the research on student engagement supported using AI. In their study, they were able to gather various sources of literature on the subject to outline the curve of AI use in educational engagements monitoring. Among the regularities discovered by the authors with respect to the use of AI technologies and the analysis of emotional and cognitive states, the change in purpose of the usage of the AI tools in the classroom context was observed shifted to more comprehensive emotional and behavioural analysis as compared to the previous usage pattern of tracking and analysing the performances of the classroom participants. The study has noted increasing scholarly support in the necessity to have real-time and non-invasive scanners that would aid an educator in reading the fluctuating emotional condition of students and through this increase adaptive approaches within the teaching paradigm.

Darejeh et al. (2024) presented a framework of AI-based decision making, to create adaptive e-learning environments to react to the emotional cues of the learners. They presented their framework at the International Conference on E-Learning and E-Teaching (ICeLeT), showing how AI could analyse emotional reactions using multimedia data facial expression, tone of voice, interaction patterns and so on to adapt the learning material on the fly. The authors arrived at the conclusion that the educational application of emotion-based processes of decision machine could substantially boost the level of satisfaction enhancing drops and level of knowledge retention of learners especially in virtual and blended learning environments.

3. RESEARCH METHODOLOGY

Being able to identify the dynamic states of engagement and emotions of the students in real-time contexts will require a sufficiently structured and ethical research methodology that will employ the help of technology sources without interfering with the learning environment. The present research is a qualitative and experimental researched which discusses the possibilities of successful implementation of emotion recognition systems driven by artificial intelligence to the classroom environment. Through the lens of informal processes in the classroom and the discussion of behavioural indicators using AI, the study will produce information on patterns

of student involvement, emotional changes, and the application of such systems in the practice of educators. Research design, setting, configuration of AI system, data collection procedures, and ways of analysis of the research are discussed in the following sections.

3.1 Research Design

This paper will use a qualitative and experimental research design approach aimed at understanding the usefulness and the implication of AI-enabled emotion recognition systems in true classroom environments. The study is qualitative and relates to the implementation and tracking of AI-enabled tools that would help recognize and understand emotions and the level of engagement of students with the help of facial expressions, voice tone, eye-tracking, and body language.

3.2 Study Setting and Participants

The research was carried out in the guided classroom settings at a few primary and middle schools. The age of the students was between 8 and 14 years. After attending regular classroom instruction, AI emotion recognition tools were also applied in a non-intrusive way in classrooms. The administrators and teachers were initiated on how the system operated before the implementation. Personally identifiable information of the students was not stored and data processing adhered to the ethical and privacy standards.

3.3 AI Tool Deployment and Configuration

The classrooms were equipped with AI-based emotion recognition system that would include computer vision, analysis of facial expressions, detection of engagement algorithms. The tool could do the following:

- Real-time facial emotion detection (e.g., happy, confused, bored, attentive, etc.)
- Eye-tracking to assess focus and attention span
- Voice tone analysis to detect emotional fluctuation during oral responses

The system was trained with pre-trained machine learning models and tested on publicly accessible emotion datasets (including FER2013, Affect Net, or CK+) so that the generality of the approach is guaranteed to be applicable to different student cohorts.

3.4 Data Collection Procedure

The data collection process consisted of two main phases:

1. Classroom Observation Sessions: AI systems monitored the emotional reactions of students in various forms of instructional event (lectures, discussions, multimedia sessions, and so on). The system automatically tracked time-stamped records of emotion as well as engagement statistics.
2. Teacher Feedback Logs: The instructors were observed to have collection logs which served to give corresponding observations on apparent patterns of behaviour and participation. These logs assisted in comparing and interpreting the findings of AI.

3.5 Data Analysis

The collected data was analysed using a combination of descriptive statistics and qualitative analysis:

- Descriptive statistics of the level of emotions, engagement and attention span in different activities in classrooms.
- Temporal patterning patterns to determine changes in emotions through the course of the sessions.
- The ability to make cross-comparisons between the patterns identified by teachers and the metrics recorded by AI in order to determine the reliability and contextual correctness.

All information was anonymized, and only aggregate patterns are analysed to make a conclusion concerning emotional dynamics and engagement rates.

4. RESULTS AND DISCUSSION

In this part, an in-depth observation of the results obtained using AI-based emotion recognition systems and teacher-confirmed observation data will be displayed on a sample of 105. Real-time data during classroom sessions was gathered in non-intrusive way through monitoring means to cover a large scope of emotional expressions and engagement levels presented in various activities during the course of instructions. The primary goal of the study is to access

intensity, trend and situational pattern of the following emotions: attentiveness, confusion, boredom, frustration, and happiness and find out interesting information about how students become emotionally and cognitively engaged in response of different teaching.

4.1 Emotion Detection Frequencies

Table 1, the distribution of dominant emotional states that the AI-powered emotion detection system detected in the classroom sessions with 105 children as a sample is shown in terms of frequencies and percentages. The effects of the emotional states caught are; Attentive, Happy, Confused, Bored, Frustrated and Neutral. The main emotional state of each of the students within a particular session of learning was labelled into one of six categories and presented a clear picture of the general emotional atmosphere as it was witnessed in the classroom.

Table 1: Frequency of Detected Emotions Across Sessions (N = 105)

Emotion	Frequency	Percentage (%)
Attentive	39	37.1%
Happy	21	20.0%
Confused	17	16.2%
Bored	13	12.4%
Frustrated	9	8.6%
Neutral	6	5.7%
Total	105	100%

The affective evidence indicates that most of the students (more than 57 percent) either showed attentiveness or happiness in classroom activities implying a fairly favorable and invigorated educational environment. Presence, however, of negative emotional states, such as confusion, boredom, and frustration, which have impacted about 37.2 percent of the students is a sign that a significant percentage of the students might have had problems with content delivery, pace or teaching method. A comparatively low percentage of a neutral state (5.7%) might suggest it

was active experience and expression of emotional responses, not passive responses of the students.

The given figure 1 shows a share of six prevailing emotional conditions, Attentive, Happy, Confused, Bored, Frustrated, and Neutral, founded by AI-assisted emotion determination tool during classroom lessons. Every emotion indicates the main condition of students at a certain moment, and percentages are counted according to the entire sample.

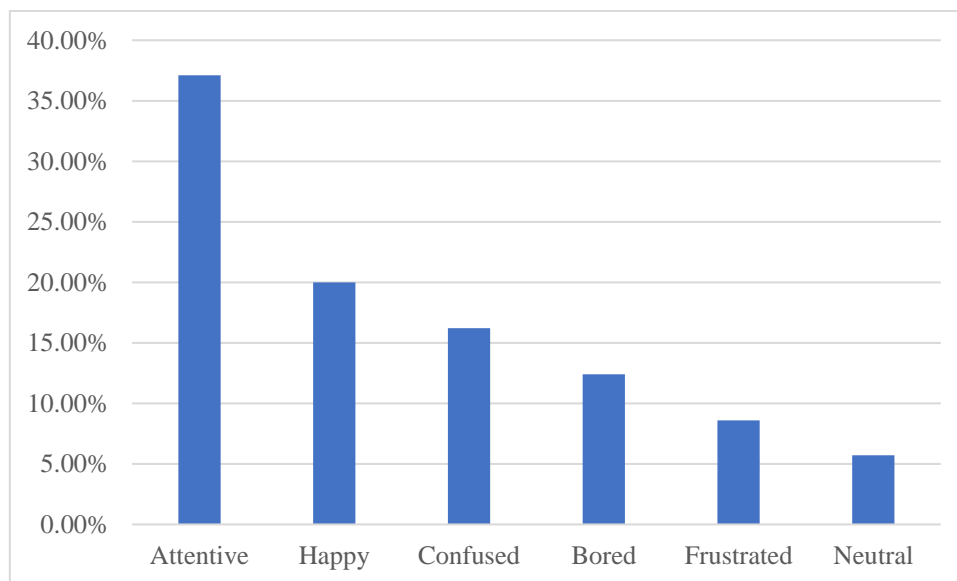


Figure 1: graphical representation of the percentage of Detected Emotions Across Sessions

Attentive was the most commonly observed emotion (37.1%) which means that the level of the classroom engagement was generally high. Happy came in the last with 20.0%, which means a positive emotional appeal in a large percentage of students. Confused (16.2), Bored (12.4), Frustrated (8.6), on the other hand, point to the idea that a great number of students had problems related to mental or emotional issues during the session. The least observed state was neutral (5.7%), which means that the majority of students revealed rather definite emotional reactions. These results identify the significance of tracking emotional interactions in real time to keep individuals engaged and support them in a time prompt fashion.

4.2 AI-Teacher Emotion Matching Accuracy

Table 3 shows the comparison of emotional states identified by the machine learning system with the one identified by the teachers on a case sample of 105. The table displays the amount

of the matching cases in accordance to the particular emotion and the percentage of the accuracy that is the percentage of the cases when the AI and the teacher reports were in line. The emotions compared are Attentive, Happy, Confused, Bored, and Frustrated which provides information about how good AI is at detecting emotions in real classrooms.

Table 2: AI-Teacher Emotion Matching Accuracy

Emotion	Matching Cases	Accuracy (%)
Attentive	40	38.1%
Happy	18	17.1%
Confused	10	9.5%
Bored	21	20%
Frustrated	16	15.2%

Attentive (38.1%), Bored (20%) and Frustrated (15.2%) had the highest similarity between AI system and teachers observations. Happy got a lower match of 17.1 and Confused 9.5%. This indicates that the artificial intelligence tool is superior in capturing visible and prolonged forms of emotions, whereas, human observers perform better in detecting other but less evident states such as confusion.

As the results of the data table show, this is the accuracy percentage of the AI-based emotion recognition system when it identifies five major emotional states according to students, as compared to teacher observations. The enumerated emotions Attentive, Happy, Confused, Bored and Frustrated are the cognitive and emotional state that is witnessed in the course of learning activities in classrooms. Accuracy (%) stands for the percentage rate of cases in which emotion detection by the AI system corresponded to a the assessment of the teacher.

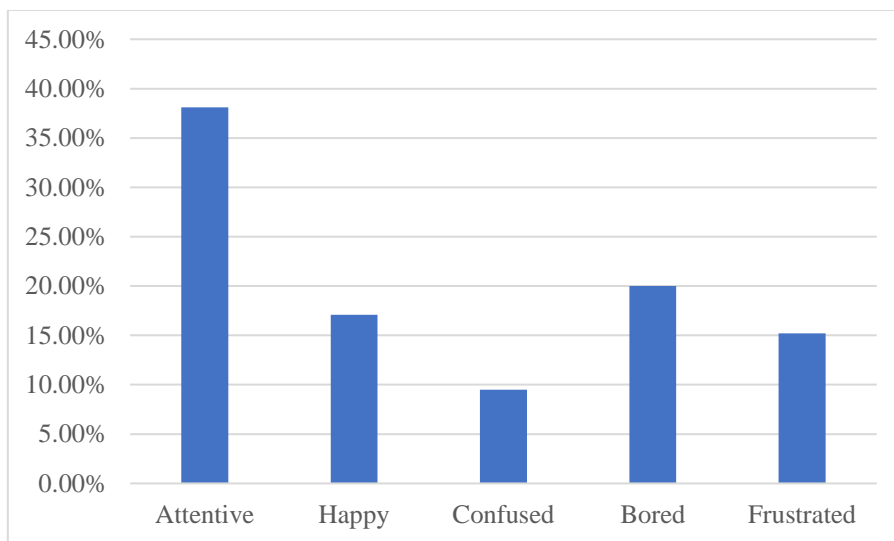


Figure 2: graphical representation of the percentage of AI-Teacher Emotion

The AI system was the best with regard to accuracy of detection of Attentive at 38.1 percent, which means that it was an effective system in detection Attentive student behaviour. It did not do too bad either in identifying Bored (20%) and Frustrated (15.2%). The accuracy rate was, however, lower in Happy (17.1) and, especially, Confused (9.5), implying that atypical or situational emotional cues are hard to discern. The findings allow concluding that AI can be successfully applied to recognize distinct and prolonged emotions conveyed in an emotional expression, and in combination with teacher knowledge can be applied to unitize more subtle student feelings.

4.3 Engagement Level Based on Detected Emotions

Table 4 summarizes the classification of the levels of student involvement based on the emotional status that is identified by AI during the lessons in the classroom. Depending on the nature and the degree of expressed emotions, student engagement was classified into three clusters namely: High Engagement, Moderate, and Low Engagement. Emotions rated as Attentive and Happy were put into high engagement category, Confused and Neutral into the moderate engagement category and Bored and Frustrated into the low engagement category. The table provides the frequency and percentages of the students in each category of the engagement based on a total of 105 students.

Table 3: Engagement Level Based on Detected Emotions (N = 105)

Emotion	Frequency	Percentage (%)
High Engagement	55	52.4%
Moderate Engagement	24	22.9%
Low Engagement	26	24.7%
Total	105	100%

The figures reveal that 52.4 percent of students exhibited the High Engagement where they were active and emotionally responsive in classroom practices. This is set in a good light in regards to the overall learning environment and the teaching practices carried out. Nevertheless, Low Engagement was also evident in 24.7 percent of all students who displayed such negative emotional states as feelings of boredom and frustration, which points to disengagement or dissatisfaction with what they are being taught. Moderate Engagement was 22.9%, which indicates the combined or transition states of emotional patterns, i.e., confusion or neutrality.

Emotion recognition using AI indicates the percent levels of engagement of students that can be categorized into High Engagement, Moderate Engagement, and Low Engagement levels as shown in this figure. Every level corresponds to a categorization of the general mood of the students and their level of attention over the learning process. The percentages are obtained in terms of a total sample size of 105.

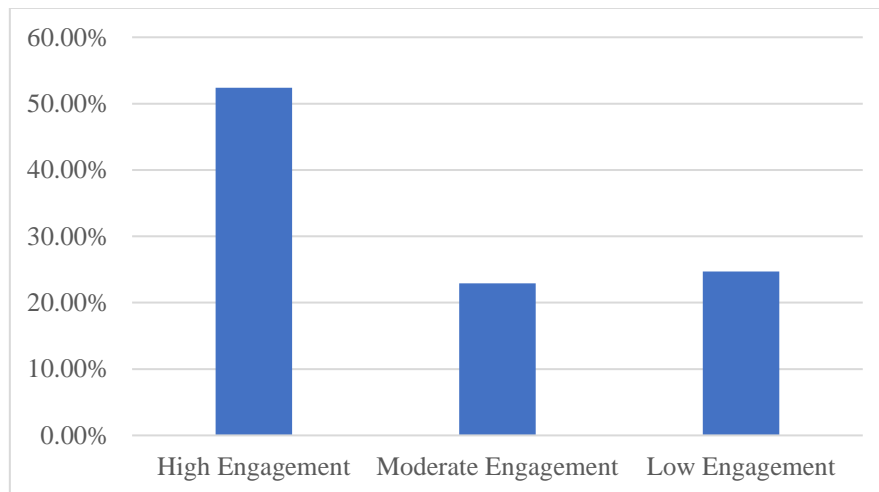


Figure 3: Graphical Representation of the Percentage of Engagement Level Based on Detected Emotions

As the figure shows, High Engagement was seen in 52.4 percent of students, which means that the students were rather attentive and emotionally positive about classroom activities. In students, the Moderate Engagement was found in 22.9 percent of the cases and is often associated with neutrality or slight perplexity depending on the nature of emotional reactions. In the meantime, Low Engagement was displayed by 24.7 percent of students, which is connected with unfavourable emotions such as boredom or frustration. Such understandings outline the significance of monitoring of emotions consistently to guarantee maintenance of attentiveness and the most effective teaching plans that reduce disengagement.

5. CONCLUSION

The paper reveals that emotion recognition systems based on AI have high potential to increase the engagement of a classroom, offering current information on the emotional state and attention of students. The results confirmed that with a positive trend in expressions such as attentiveness, happiness, the majority of students demonstrated that they were highly engaged, a considerable number of students expressed confusion, boredom or frustration, especially toward the latter stages of the sessions. In the case of the visible emotions, the AI model best matched the observed data by the teachers; nonetheless, the model proved unable to identify more subtle states such as confusion, which further makes the human interpretation necessary.

Altogether, AI emotion detection can become a worthy addition to the usual teaching principles that will allow an educator to refine their strategies to a greater extent in case ethical, contextual, and accuracy aspects are well be thought of.

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