Study With Us": An Immersive Learning Platform Integrating Emotion-Based Feedback And Attention Detection For Self-Directed Learning

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Abstract:

Background: *The widespread adoption of remote learning environments has resulted in emotional isolation, reduced concentration, and weakened learning persistence among learners.*
Aim: *This study aims to address these issues by designing and implementing an immersive learning platform called "Study With Us."*
Material & Methods: *"Study With Us" integrates emotion-based feedback, attention detection technology, and real-time video communication. The system monitors on-screen movements in real time through OpenCV-based attention detection and analyses emotional states in learning journals using a LoRA-based large language model (LLM), offering personalized empathetic feedback and progress recommendations. A pilot test was conducted with 10 users to evaluate subjective satisfaction and perceived engagement for each function, using a 5-point Likert scale.*
Result: *Results from the pilot test showed a high overall system satisfaction score (average 4.8), with positive feedback particularly regarding learning immersion and emotional support. Features such as Video Study Room Engagement, Accuracy of Attention Detection, Empathy of Emotional Feedback, Usefulness of Progress Recommendation, Interaction via Chat Function, and Overall User Experience (UX) all received average satisfaction scores above 4.5.*
Conclusion: *This study successfully designed and implemented "Study With Us," demonstrating the feasibility of an immersive learning platform that enhances learner engagement, emotional stability, and the continuity of self-directed learning through emotion-analysis-based feedback, attention detection, real-time interaction, and progress recommendations.*
Keywords: *Emotion Feedback, Attention Detection, Self-Directed Learning, OpenCV, LLM, WebRTC*

1. INTRODUCTION

A. Motivation and Problem Statement

After the COVID-19 pandemic, remote learning environments have rapidly proliferated, forcing many learners to study in isolation. This environmental change has led to problems such as reduced concentration, accumulated emotional fatigue, and decreased learning persistence. In particular, the lack of a feedback system that allows learners to share emotions and difficulties in real time hinders the effectiveness of self-directed learning. Most existing online learning platforms are function-oriented, focusing on features such as time tracking, progress management, and schedule sharing, while rarely integrating users' emotional states or immersion levels.

For example, Park et al. (2023) developed a real-time attention detection system using OpenCV and MediaPipe, achieving an accuracy of 97.85% [4]. However, it did not incorporate real-time feedback based on emotional states. This highlights a limitation of existing technologies that primarily focus on behavioral data while neglecting emotional support. As a result, learners experience psychological isolation, lack of motivation, and insufficient engagement, which can lead to decreased long-term academic performance. To address these challenges, this study proposes the "Study With Us" platform, which integrates emotion analysis, attention detection, and real-time interaction features. The platform goes beyond being a simple learning management tool and serves as a next-generation EdTech model that technically supports learners' internal states.

B. Research Objectives

This paper aims to construct an immersive learning environment by integrating LLM-based emotion analysis, OpenCV-based attention detection, and WebRTC/WebSocket-based real-time video

communication. While previous research has primarily focused on gaze tracking, biometric data analysis, or single-function platform design [9, 12], this study differentiates itself by comprehensively implementing emotional feedback, attention state analysis, and real-time interaction. The proposed Study With Us platform is designed to achieve the following:

• Classify learners' emotional states based on their learning journals and automatically generate empathetic feedback to provide emotional support [8]

• Recommend study progress tailored to learning flow to guide self-directed learning planning

• Detect off-seat status in real time and trigger alerts or automatic logout if prolonged absence is detected [5, 6, 7]

• Enhance emotional connection and learning immersion through video study rooms and chat features [10, 11]

C. Summary of Technical Achievements

The Study With Us project achieved the following key technical outcomes:

• Customized LLM models (based on Polyglot-ko and LLaMA) to automate emotion classification, empathetic feedback generation, and learning progress recommendations from journal entries

• Developed OpenCV-based facial recognition for real-time attention analysis and off-seat detection, including automatic logout functionality

• Implemented real-time multi-user video conferencing and chat using WebRTC and WebSocket

• Integrated frontend (React), backend (Spring Boot), and AI server (FastAPI) with Docker-based deployment environment

• Designed planner and MyPage UIs to visualize learning goals, journals, feedback, and statistics

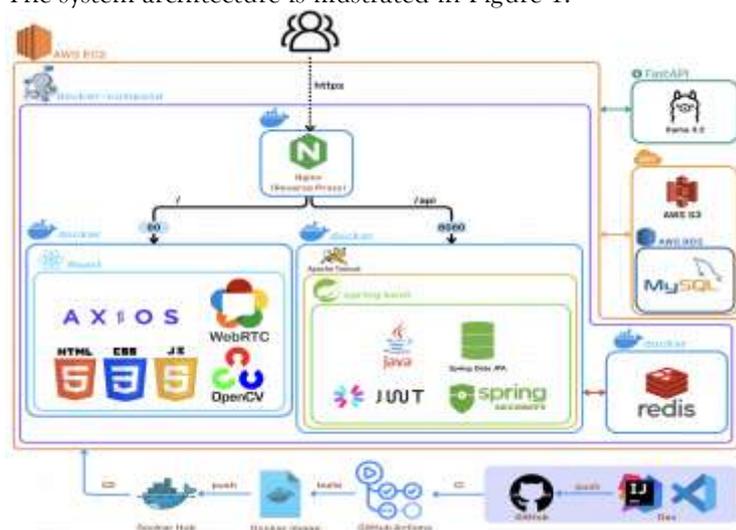The system architecture is illustrated in Figure 1.

Figure 1. System Architecture Diagram.

These achievements demonstrate the feasibility of a self-directed learning platform that goes beyond traditional learning management systems by combining emotional support with attention state awareness.

2. RELATED WORK

A. Emotion Analysis-Based Learning Feedback Systems

With advancements in natural language processing and large language models (LLMs), it has become feasible to automatically detect learners' emotional states and generate corresponding feedback. While earlier studies focused on improving emotion classification accuracy, recent research has expanded into providing learning advice and progress planning based on emotional understanding. Goel et al. (2022) proposed a model that generates empathetic feedback using a Transformer-based emotion encoder, offering an approach directly applicable to learning journal analysis [1]. Study With Us builds on this trend, distinguishing itself by integrating emotion analysis with real-time progress planning to enhance the continuity of self-directed learning.

B. Attention Detection Technologies

Computer vision-based attention measurement has evolved toward quantifying user focus through facial recognition, gaze tracking, and motion analysis [9, 12]. Park et al. (2023) implemented a real-time posture analysis system using OpenCV and MediaPipe, achieving an accuracy of 97.85% [4]. This study adopts

similar techniques to monitor real-time seat presence and on-screen facial recognition. If inactivity exceeds a set threshold, the system triggers alerts and auto-logout [5, 6, 7]. This approach goes beyond simple activity logging, aiming to technically support learners' engagement.

C. Real-Time Video Learning Platforms

Real-time learning platforms have advanced significantly with the adoption of WebRTC and WebSocket technologies. Liu et al. (2023) proposed a dynamic frame transmission algorithm in WebRTC-based video conferencing systems to address connection degradation in multi-user scenarios [2]. This research lays a technical foundation for resolving issues like latency or video quality drops that could hinder learner immersion. Study With Us implements real-time video conferencing and chat based on this infrastructure, integrating them with emotion analysis and feedback functions to deliver an immersive learning experience [10, 11].

D. Integrated Self-Directed Learning Systems

Conventional online learning systems tend to focus on schedule management, content delivery, and attendance tracking, often overlooking internal learner experiences such as emotional state or concentration. Xu et al. (2020) proposed a framework integrating emotional, behavioral, and cognitive data within a WeChat-based learning environment, demonstrating its effectiveness in enhancing learning persistence [3]. Study With Us follows a similar integrative approach but takes it further by delivering a fully implemented system that combines emotion-based feedback, attention-driven alerts, and progress recommendations—within a single platform—to enable a truly immersive learning environment.

3. METHODOLOGY

A. System Configuration Overview

Study With Us is a platform designed to integratively analyze and support learners' emotional states, attention levels, and learning flow. It is structured based on six key technological domains, as summarized in Table 1.

TABLE 1. Summary of Components and Technologies Used in the Study With Us Platform

Domain	Technology Used	Role Description
FE	HTML, CSS, JavaScript, React.js	UI implementation, WebRTC/chat interface design
BE	Python, FastAPI, MySQL, Java, Spring Boot	API processing, database management, AI server integration
AI	polyglot-ko, llama-3-Korean-Bllossom	Emotion analysis and learning progress recommendation
Communication	WebRTC, WebSocket	Real-time video and text communication
Tools & Design	Git, GitHub, Notion, Discord, HuggingFace, Figma, Photoshop	Version control, collaboration, UI prototyping
Attention Detection	OpenCV	Screen movement detection, alert and auto-logout processing

B. Emotion Analysis and Feedback Flow

When a user submits a learning journal, the text is sent to the AI server via a FastAPI-based backend. A pre-fine-tuned LoRA-based LLM analyzes the text, classifies the user's emotional state, and automatically generates empathetic messages and learning progress suggestions accordingly [8]. This feedback is delivered to the client in real time and is presented in a context-sensitive manner based on the user's learning state and emotions.

C. Attention Detection Logic

The system uses OpenCV's Haar Cascade-based face recognition to monitor the presence and movement of the user's face on screen in real time. If no face is detected or if the user remains inactive for a set duration, the system issues a warning, and in the case of continued inactivity, the user is automatically logged out. The timeout thresholds are set at 10 minutes for initial warning and 15 minutes for forced logout. All processes are conducted in a non-storage, real-time manner to ensure privacy protection [5, 6, 7].

D. Real-Time Connection and Interaction Structure

WebRTC enables multi-user real-time video connections between browsers, while WebSocket supports session synchronization and text-based chat. Connection stability is maintained through STUN/TURN

servers. The chat system includes functions for asking questions, offering encouragement, and providing feedback, fostering real-time interaction. This technical design helps alleviate emotional isolation and enhances immersion by enabling timely emotional feedback [10, 11].

4. IMPLEMENTATION AND RESULTS

A. Key Functional Interfaces

The core features of the Study With Us platform are implemented through a user-oriented visual interface. The following two screens illustrate the main system functionalities.

The Study Room Page serves as a collaborative space integrating real-time video conferencing, attention detection, and chat functionalities. Participants are automatically connected via webcam, and inactivity beyond a certain threshold triggers a warning or automatic logout. The chat window enables learners to exchange questions, encouragement, and feedback, while the timer and status bar provide intuitive tracking of the ongoing session.
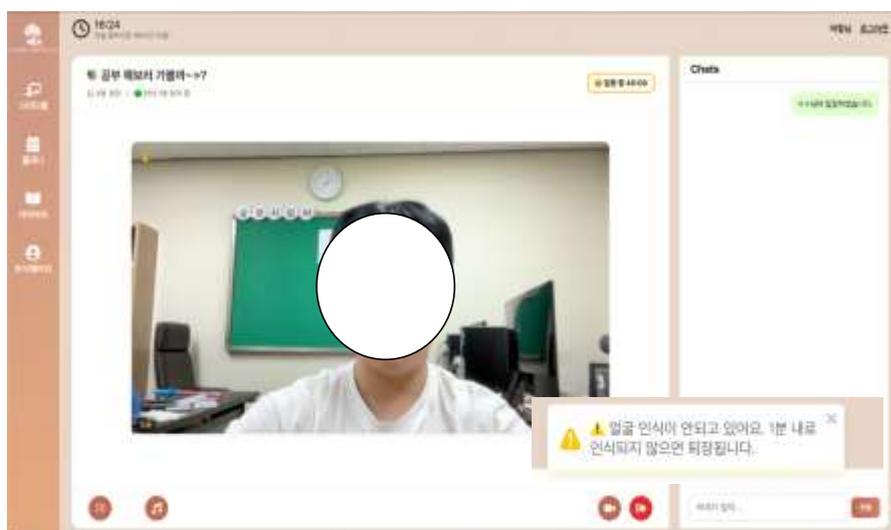

Figure 2. Study With Us Study Room User Interface Example.

The Learning Journal and Feedback Page allows users to write a daily reflection after each study session, recording both learning content and emotional state. After submission, the AI analyzes the text and returns emotion-based empathetic feedback along with a recommended learning direction. This feedback not only offers emotional support but also serves as guidance for future learning sessions.

Figure 3. Learning Journal Entry and AI Feedback Screen.

B. User Evaluation Experiment

A pilot test was conducted with 10 users to evaluate subjective satisfaction and perceived engagement for each function. Participants rated features using a 5-point Likert scale. The test environment included a

laptop equipped with an Intel i5 12th Gen CPU, 16GB RAM, Chrome browser, and standard home Wi-Fi under controlled conditions.

TABLE 2. User Satisfaction by Feature (N=10, 5-point Scale)

Feature	Avg. Score	Key Feedback Summary
Video Study Room Engagement	4.8	"Felt like studying with others in real time."
Accuracy of Attention Detection	4.6	"Precise movement detection, but needs sensitivity control."
Empathy of Emotional Feedback	4.9	"Warm, emotional messages were memorable."
Usefulness of Progress Recommendation	4.7	"Reduced anxiety over what to study next."
Interaction via Chat Function	4.5	"Motivated by sharing questions and encouragement."
Overall User Experience (UX)	4.8	"Intuitive UI and fast responsiveness felt convenient."
Overall System Satisfaction	4.8	"Learning felt more efficient than studying alone."

C. Summary of Experimental Procedure
Participants experienced the Study With Us platform following the steps below.
1. Sign-up and login
2. Enter the study room → Experience real-time video and chat functions
3. Test the attention detection feature (including intentional seat departure)
4. Write a journal → Receive emotional feedback and progress recommendation
5. Complete final survey

At each stage, participants evaluated the system's response time, feedback accuracy, and interface intuitiveness. All features received an average satisfaction score above 4, 5.

5. CONCLUSION AND FUTURE WORK
A. Research Conclusions
This study designed and implemented Study With Us, an immersive learning platform integrating emotion-based feedback, attention detection, and progress recommendation features. The platform enhances learner engagement, emotional stability, and the continuity of self-directed learning through the following attributes and technical achievements:
• Emotion-Analysis-Based Feedback: Learners' journals are analyzed by an LLM to classify emotional states and generate empathetic messages, offering emotional support [8].
• Attention Detection Using OpenCV: Real-time face recognition detects seat absence and inactivity, triggering alerts and auto-logout to maintain focus [5, 6, 7].
• Real-Time Interaction via WebRTC: Video conferencing and chat capabilities foster a sense of presence and collaborative learning in remote environments [10, 11].
• Progress Recommendation Functionality: Suggestions based on emotional states and learning flow support autonomous study planning.
Results from a pilot test showed a high overall system satisfaction score (average 4.8), with positive feedback particularly regarding learning immersion and emotional support.

B. Limitations of This Study
• Limited sample size: The study was based on a pilot test with only 10 participants, limiting generalizability.
• Lack of feature customization: Users could not adjust feedback variation or attention detection sensitivity.
• Insufficient handling of exceptional conditions: Scenarios such as network instability or unauthorized camera access were not fully addressed, requiring future improvements.

C. Future Research and Development Directions
All emotion and video data are processed in real time and immediately discarded. Future development will include establishing ethical guidelines in accordance with GDPR and data protection laws.

Technical Aspects
• Adoption of GPT-4 Turbo: Future plans include the introduction of a next-generation LLM to enhance the diversity and contextual accuracy of emotional feedback. The integration of a multi-emotion classification model based on GPT-4 Turbo is also under consideration to improve emotional recognition precision.
• Enhanced Attention Detection with YOLOv8: System functions will be refined to detect not only faces but also postures, blinking patterns, and head tilts, allowing for more accurate attention tracking.
• Feedback Linked to Learning Achievement: A reward system will be designed based on an achievement index that integrates learning duration, emotional trends, and deviations from recommended progress.

Author's contribution: The study design, data collection and analysis, data interpretation, paper drafting, and critical revision were all equally contributed to by all authors. Taebeen Lee was responsible for the initial platform development and data collection. Hyoseok Seo focused on the implementation of the attention detection module and real-time interaction features. Changsuk Yu contributed to the integration of the AI server and the design of the user interfaces. Seungjae Lee, as the corresponding author and supervisor, provided overall guidance, supervised the research methodology, and critically reviewed the manuscript.
Conflict of interest: The authors declare that there are no conflicts of interest.
Informed Consent: Informed Consent was obtained from the participants.
Data and materials availability: Upon justifiable request, the corresponding author will make all of the data sets gathered during this investigation available.

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