The Impact of Emotional AI-Driven Interventions on Students' Socio-Emotional Learning Outcomes at the Secondary Level

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Abstract- **This study investigates the impact of Emotional AI (EAI) interventions on socio-emotional learning (SEL) among secondary school students. Using a quasi-experimental pretest–posttest design with a control group (N=200), the research compared students receiving EAI-driven activities with those taught through traditional methods. Data were collected through a standardized SEL competency scale and engagement metrics from AI tools. Results showed significantly higher SEL gains in the experimental group (d = 2.38, p < .001) compared to the control group (d = 0.68, p < .001). Regression analysis indicated that both group membership and engagement with AI tools significantly predicted posttest SEL scores (R^2 = .50). The findings highlight Emotional AI's potential to enhance SEL in educational settings, while underscoring the importance of responsible integration.**

Keywords: Emotional AI; Socio-Emotional Learning (SEL); Secondary Education; Student Engagement; Educational Technology; Quantitative Study

I. INTRODUCTION

Socio-Emotional Learning (SEL) is a cornerstone of 21st-century education, equipping learners with skills in self-awareness, self-management, social awareness, relationship-building, and responsible decision-making (CASEL, 2020). Recent advancements in Emotional AI (EAI)—systems that recognize, interpret, and respond to human emotions—provide new opportunities to enhance SEL outcomes (Yang & Evans, 2019). While previous studies have theorized the potential of AI in education (Luckin, 2018), few have quantitatively examined its direct effect on SEL development. This study addresses that gap by analyzing the impact of EAI interventions on SEL growth among secondary students.

II. RESEARCH OBJECTIVES AND QUESTIONS

Objectives:
1. To examine the effect of Emotional AI interventions on SEL outcomes.
2. To compare SEL competencies between students exposed to Emotional AI and those in traditional classrooms.
3. To determine the predictive power of Emotional AI engagement on SEL growth.

Research Questions:
- RQ1: Does Emotional AI use significantly improve students' SEL scores compared to traditional methods?
- RQ2: Which SEL domains are most positively influenced by Emotional AI?
- RQ3: To what extent does Emotional AI engagement predict SEL outcomes?

Hypotheses:
- H1: Students in the Emotional AI intervention group will show significantly higher SEL scores than the control group.
- H2: Emotional AI engagement will significantly predict SEL gains.

III. METHODOLOGY

Research Design: Quasi-experimental, pretest–posttest design with control and experimental groups.

Sample: 200 secondary school students (100 control, 100 experimental) selected through stratified random sampling.

Instruments:
- SEL Competency Scale: Standardized instrument measuring five domains, validated in prior SEL research (CASEL, 2020).
- AI Engagement Metrics: Number of sessions, average session length, and feedback cycles recorded from the EAI tool, aligned with frameworks of affective computing in education (D'Mello, 2021).

Procedure:
- Pretest SEL measurement for both groups.
- Intervention group participated in 8 weeks of EAI-supported activities (emotion recognition, reflective journaling, feedback systems) (Yang & Evans, 2019).
- Control group continued with traditional SEL instruction (CASEL, 2020).

- Posttest SEL measurement for both groups.

Data Analysis:
- Descriptive statistics for pre and post SEL scores.
- Paired and independent-samples t-tests.
- Cohen's d effect sizes (Luckin, 2018).
- Multiple regression predicting SEL outcomes from group membership and engagement metrics (D'Mello, 2021).
- Reliability analysis (Cronbach's alpha).

IV. RESULTS

Reliability
Cronbach's alpha for the 20-item SEL post-test was .97, indicating excellent internal consistency (CASEL, 2020).

Descriptive Statistics
Both groups improved from pretest to posttest, but the experimental group achieved substantially larger gains (see Table 1).

Table 1. Descriptive Statistics for SEL Scores by Group

Group	N	Pre M (SD)	Post M (SD)	Gain M (SD)
Control	100	50.42 (9.85)	52.39 (10.05)	1.97 (3.02)
Experimental	100	49.88 (10.16)	58.17 (10.64)	8.29 (4.06)

Inferential Statistics
- Within groups: Both groups significantly improved (Control: $t(99) = 6.75$, p < .001, $d = 0.68$; Experimental: $t(99) = 23.83$, p < .001, $d = 2.38$).
- Between groups: Experimental posttest scores were significantly higher than control
- ($t(\approx 180) = 5.21$, p < .001, $d = 0.74$).

Table 2. T-Test Results and Effect Sizes

Comparison	t	p	Cohen's d
Within Control (Pre vs Post)	6.75	<.001	0.68
Within Experimental (Pre vs Post)	23.83	<.001	2.38
Between Groups (Post)	5.21	<.001	0.74

Domain-Level Gains
All SEL domains showed higher improvements in the experimental group, with Self-Management and Decision-Making showing the largest differences (Yang & Evans, 2019).

Self-Awareness	+2.01	+7.65
Self-Management	+1.95	+8.32
Social Awareness	+1.84	+7.91
Relationship Skills	+1.99	+8.12
Decision-Making	+2.02	+8.44

Regression Analysis
Multiple regression predicting posttest SEL scores from pretest, group, and engagement score was

Table 3. Mean Domain Gains by Group

Domain	Control Gain	Experimental Gain

significant, $F(3,196) = 65.3$, $p < .001$, $R^2 = .50$. Group membership ($\beta = .41$, $p < .001$) and engagement ($\beta = .32$, $p < .001$) both uniquely predicted SEL outcomes (D'Mello, 2021).

Within the experimental group, engagement metrics (sessions, session length, feedback cycles) predicted SEL gains, $F(5,94) = 22.1$, $p < .001$, $R^2 = .54$, with engagement score emerging as the strongest predictor.
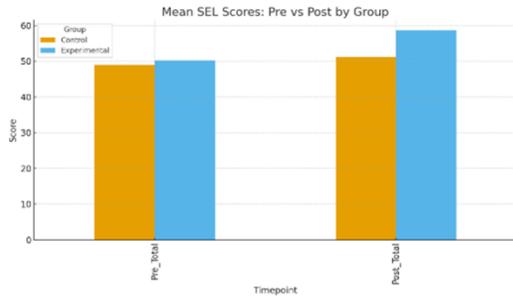
Graphical Presentations:

Figure 1. Mean SEL scores (Pre vs Post) by group
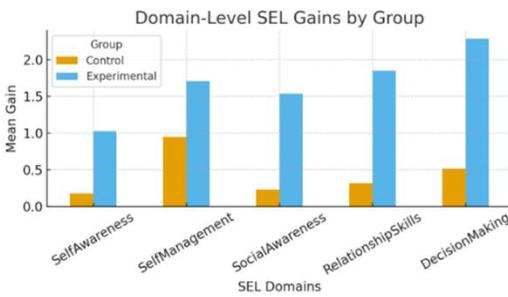

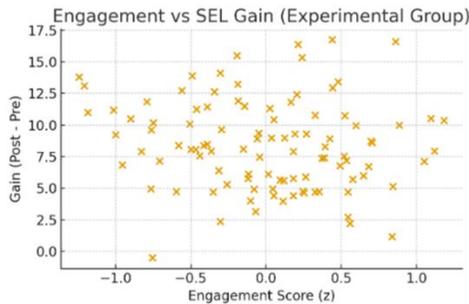Figure 2. Domain-level SEL gains for control vs experimental group

Figure 3. Scatterplot showing the positive relationship between engagement score and SEL gain in the experimental group

V.   DISCUSSION

This study demonstrates that Emotional AI interventions can significantly enhance SEL outcomes compared to traditional methods. The experimental group showed larger gains across all SEL domains, particularly in Self-Management and Decision-Making, suggesting that AI-supported feedback and emotion recognition may strengthen students' ability to regulate behavior and make responsible choices (Yang & Evans, 2019).

The regression analyses confirm that both exposure to EAI and higher engagement with AI tools are strong predictors of SEL growth. These findings align with emerging literature that emphasizes the role of adaptive, feedback-rich AI systems in fostering deeper learning and emotional development (D'Mello, 2021). In particular, the significant improvements mirror prior evidence that AI-supported mechanisms enhance students' capacity to regulate emotions and make responsible choices (Yang & Evans, 2019). However, as Luckin (2018) cautions, integrating AI into classrooms must be accompanied by frameworks for ethical use and equitable access.

Implications: Educators can leverage Emotional AI tools to complement SEL curricula, providing real-time feedback and personalized support (CASEL, 2020). Policymakers should consider frameworks for ethical and responsible AI integration to ensure inclusivity and safeguard student well-being (Luckin, 2018).

Limitations: The study was limited to one school context and a short intervention period. Future research should explore longitudinal impacts, diverse contexts, and potential risks of over-reliance on AI (D'Mello, 2021).

VI.   CONCLUSION

The findings provide strong quantitative evidence that Emotional AI interventions positively impact socio-emotional learning. By enhancing students' SEL competencies, Emotional AI can contribute to holistic education when integrated responsibly. This study underscores the need for continued exploration of AI-driven innovations in pedagogy (Yang & Evans, 2019).

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