Enhancing CASEL 5 Social and Emotional Competencies in Engineering Students through Flipped and Gamified Blended Learning: A Longitudinal Study

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***Abstract*—Engineering education increasingly requires integration of social-emotional learning (SEL) alongside technical competencies. Flipped and gamified blended learning approaches show promise for holistic skill development, yet empirical evidence remains limited. This longitudinal study examines the impact of a flipped and gamified blended learning model on the development of CASEL 5 Social and Emotional Learning (SEL) competencies among undergraduate Computer Science and Engineering students over four years (2019-2023). A total of 960 undergraduate computer science students were assigned to experimental (n=480; flipped-gamified instruction) or control conditions (n=480; traditional didactic instruction). Two specialized instructors delivered pedagogy-specific interventions. CASEL 5 competencies were assessed via validated self-report instruments and classroom observations at three time points (pre-, mid-, post-intervention). Academic performance and engagement were measured through exam scores and behavioral ratings. Repeated measures ANOVA revealed statistically significant improvements in all CASEL 5 domains for the experimental group compared to controls (all $p<0.001$, effect sizes Cohen's d ranging from 0.68 to 0.89). Self-management showed the largest improvement with Cohen's d equal to 0.89. Academic performance significantly improved in the experimental group with Cohen's d equal to 1.52. Classroom engagement ratings increased by 34% in the experimental group versus 12% in the control group. Flipped-gamified blended learning effectively enhances social-emotional competencies and academic outcomes in engineering students. Findings support scalable pedagogical models integrating SEL within technical curricula, though triangulation with objective behavioral measures is needed to confirm self-reported gains.**

***Keywords*— flipped learning, gamification, CASEL 5, Social and Emotional Learning (SEL), engineering education, blended learning, student engagement.**

ICTIEE Track—Innovative Pedagogies and Active Learning

ICTIEE Sub-Track—Gamification and Student Engagement Strategies

I. INTRODUCTION

THE engineering landscape of the 21st-century is marked by dynamic technological advancements, and increased demands for interdisciplinary collaboration (Raje & Swarnalakshmi, 2025). While technical proficiency remains foundational, both employers and educators now recognize that modern engineers must also possess strong social and emotional skills, in addition to cognitive and technical abilities (National Academy of Engineering, 2017a). In a complex world facing sustainability, ethical decision-making and data-based decision-making challenges, engineering graduates need to not only invent solutions but also communicate effectively, work collaboratively across heterogeneous teams and engage with others empathetically and ethically (Shuman et al., 2005; Sarpparaje, 2016).

In response to this imperative, the Collaborative for Academic, Social and Emotional Learning (CASEL) has described a set of five core competencies for well-being: self-awareness, self-management, social awareness, relationship skills, and responsible decision-making (CASEL, 2020a). Meta-analyses of SEL programs based on the CASEL framework have demonstrated measurable benefits, including improved social-emotional skills, academic performance, mental health, and long-term life outcomes (CASEL, 2023; RAND Corporation, 2024). Despite enough evidence, a significant gap persists between traditional engineering curricula—which often prioritize technical content and procedural problem-solving—and the broader range of competencies required for modern professional practice (Litzinger et al., 2011). A recent study of software engineering education, for example, has shown that, although students developed informal strategies for stress management and peer support in collaborative environments, these strategies were not explicitly taught and scaffolded.

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Amidst these technological challenges in the education sector, innovative pedagogical approaches are being sought after to bridge the gap between STEM and SEL skills. Flipped learning, which is the practice of moving up-front instruction outside of the classroom and using the classroom time for active learning, has shown promise for promoting student engagement and active learning (Bishop & Verleger, 2013; Sarpparaje et al., 2018). By allowing learners to engage with materials prior to a lecture, and then encouraging them to reflect and interact in collaborative, problem-based activities during class time, flipped learning increases interaction and reflection that are prime prerequisites for SEL (Bishop & Verleger, 2013; Zainuddin & Halili, 2016).

Simultaneously, gamification—the use of game-based elements such as points, leaderboards, and scenario-based challenges—has gained traction as an effective strategy to increase motivation, foster collaboration, and improve a variety of learning outcomes (Deterding et al., 2011; Ibáñez et al., 2014; Sarpparaje.M, 2022). When coupled with blended learning environments that leverage both face-to-face and online modalities, these approaches offer a powerful toolkit for supporting the holistic development of engineering students. For example, El-Thalji (2025) documented an improved active learning performance in maintenance engineering through a gamified flipped-classroom design in which the students displayed fewer misconceptions and developed a better concept mastery when game-based features were included (El-Thalji, 2025).

This study's conceptual model is grounded in the theoretical alignment between flipped and gamified pedagogies and the CASEL 5 SEL competencies (a comprehensive framework of the same is given in Figure 1). These pedagogical approaches are expected to strengthen self-awareness, self-management, social awareness, relationship skills, and responsible decision-making through structured pre-class preparation, collaborative in-class work, and gamified motivational mechanisms.

Fig. 1. CASEL framework – the globally recognized model for Social and Emotional Learning (SEL)

Although there is growing evidence in support of using flipped and gamified learning in engineering education, there is still a lack of longitudinal studies evaluating their long-term effect on the CASEL five competencies. Most of the existing studies are focused on short-term interventions or single outcomes, which leaves important questions about the long-term efficacy and scalability of such models (Sun & Wu, 2016). In order to fill this gap, this research aims to explore the impact of a blended-learning model that employs flipping and gamification to improve SEL competencies in undergraduate engineering students, analysing the data evidence over four academic years.

Based on the above context, the following research questions guide this study:

RQ1: How does the integration of flipped and gamified blended learning impact the development of CASEL 5 competencies in engineering students over time?

RQ2: What are the perceptions and experiences of students regarding the use of innovative pedagogical approaches in fostering social and emotional skills?

RQ3: To what extent do these pedagogical strategies influence student engagement, collaboration, and overall academic success?

By tracking 960 engineering undergraduates over four years and through a rigorous mixed-methods approach, this research study aims to position itself as a robust and timely investigation into the fusion of pedagogical innovation and social-emotional development in engineering education, as indicated in the following Table 1.

TABLE I
THEORETICAL ALIGNMENT BETWEEN PEDAGOGICAL DESIGN AND CASEL COMPETENCIES

CASEL COMPETENCY	PEDAGOGICAL MECHANISM	EXPECTED OUTCOME
SELF-AWARENESS	Reflective video annotations; self-paced pre-class learning	Increased awareness of learning preferences and emotional responses
SELF-MANAGEMENT	Autonomous scheduling of pre-recorded lectures; time-bound challenge completion	Enhanced self-regulation and goal-directed behavior
SOCIAL AWARENESS	Peer observation during team challenges; diverse team compositions	Improved perspective-taking through collaborative contexts
RELATIONSHIP SKILLS	Mandatory team-based problem-solving; gamified collaborative leaderboards	Strengthened communication and conflict resolution skills
RESPONSIBLE DECISION-MAKING	Real-world engineering scenarios requiring ethical trade-offs	Application of ethical reasoning to technical problems

This theoretical framework guides our investigation of how specific pedagogical components contribute to measured improvements in CASEL competencies.

II. LITERATURE REVIEW

The infusion of social and emotional learning (SEL) into the higher education landscape, particularly within engineering disciplines, has garnered increased scholarly momentum in recent decades. Conventional engineering curricula have long been critiqued for their overemphasis on technical mastery while understating the broader human skills necessary for professional success (Litzinger et al., 2011). The National Academy of Engineering (2017b) has emphasised that today's engineers need to operate not only as skilled problem-solvers

but also as adaptive leaders, effective collaborators, and principled ethical decision-makers. This larger imperative aligns well with the CASEL (2020b) framework that identifies five core competencies-self-aware, self-managing, socially aware, relationship skills, and responsible decision-making, the essential building blocks of SEL programmes. Meta-analytic studies also confirm that SEL frameworks have positive academic, behavioural, and socioemotional outcomes (CASEL, 2023; RAND Corporation, 2024). Nevertheless, in engineering contexts, SEL integration often occurs incidentally through group work or collaborative projects rather than through intentionally structured pedagogy (CASEL, 2020b).

To address this pedagogical gap, flipped learning has emerged as a promising and powerful innovation. Bishop and Verleger (2013) characterised the flipped model as combining independent pre-class learning with interactive, participatory, problem-solving-based in-class activities. Research indicates that flipped learning promotes student engagement, autonomy, and collaborative problem-solving, which directly supports the development of SEL skills such as self-regulation and social awareness (Zainuddin & Halili, 2016). In addition, Gren (2019) noted that the implementation of the flipped approach in software engineering curriculum resulted in increased reflective thinking, as well as deeper interpersonal collaboration.

Along with flipped instruction, gamification has been introduced as a tool used to strengthen student motivation and engagement. This learning approach is based on the integration of design features like points, badges, leaderboards, and narrative scenarios to enhance learning activity (Deterding et al., 2011). In engineering education, gamified learning is associated with better collaboration, resilience and critical thinking (Ibáñez et al., 2014). More recent research highlights how gamification leads to active learning and reduces misconceptions, especially when it is combined with flipped learning models is sure to get impactful learning outcomes (El-Thalji, 2025).

Flipped and gamified learning aligns with CASEL 5 competencies through identifiable learning mechanisms. Pre-class video learning encourages self-awareness and self-management. In-class collaborative problem-solving strengthens relationship skills and social awareness. Gamification elements such as badges, challenges, and leaderboards reinforce responsible decision-making by promoting reflective and goal-driven behavior. This mapping provides the theoretical foundation for the pedagogical intervention used in this study.

While these pedagogical strategies have been examined in isolation, there is still little research available on their cumulative and long-term effect on social-emotional-learning (SEL) competencies. Sun and Wu (2016) pointed out that most of the literature in higher education on flipped learning only looks at short-term outcomes (e.g., performance on tests, learner satisfaction) and doesn't look at the developmental gains over time. In addition, gamification research often captures short-term motivational effects rather than longitudinal skill acquisition (Deterding et al., 2011). Few studies specifically connect blended learning that integrates both flipped and gamified learning elements directly to CASEL's five core outcomes, especially in an engineering curriculum.

This lacuna underscores the need for a longitudinal study carefully designed to systematically measure the effectiveness of the integration of flipped and gamified blended learning on SEL competencies. By observing Computer Science and Engineering undergraduates through four academic years, the present study aims to build rigorous empirical evidence regarding the long-term viability of these instructional modalities to increase academic engagement and CASEL-defined competencies to address the pressing need of today's engineering education.

III. METHODOLOGY

1) Research Design

This longitudinal mixed-methods study aimed to understand the effects of a blended learning model that incorporates flipped classroom and gamification methodologies on the development of CASEL's five competencies (self-awareness, self-management, social awareness, relationship skills, and responsible decision-making) in first-year Computer Science Engineering (CSE) students.

The study was conducted over four academic years and involved a total of 960 students. Each year, two parallel sections of first-year CSE students were selected, with 60 students in each section. Across four years, this resulted in 480 students assigned to the experimental group (flipped and gamified instruction) and 480 students assigned to the control group (traditional lecture-based instruction). Assignment to experimental and control groups was randomised each year to ensure equivalence in terms of gender, academic background, and prior academic performance.

The intervention included a synthesis of pedagogical approaches that can be described as follows:

• For example, in a flipped classroom format, pre-recorded lectures were provided for students to view through the LMS (Impartus Classroom Lecture Capture System) before synchronous class times so that face-to-face class time could be spent engaged in active, problem-based instruction. During these sessions, students participated in cooperative discussions, collaborative activities and practical projects under the guidance of faculty, as shown in Fig 1 and 4.

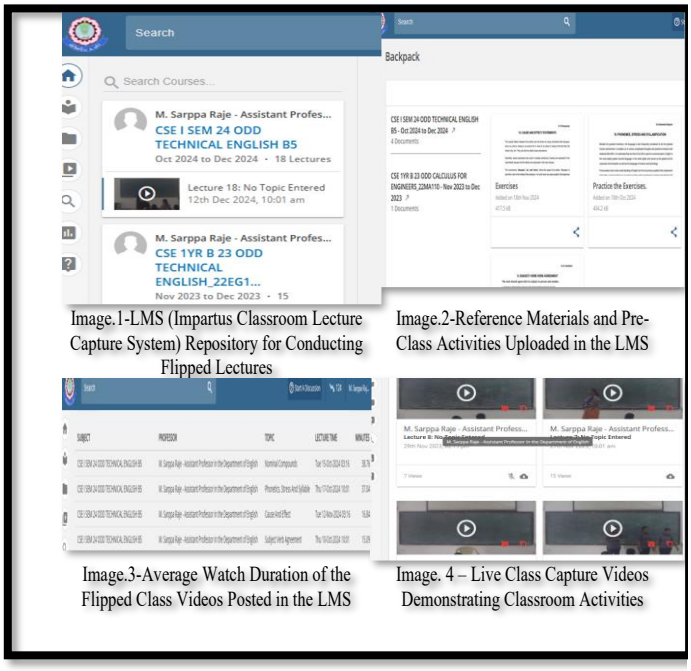

Image.1-LMS (Impartus Classroom Lecture Capture System) Repository for Conducting Flipped Lectures

Image.2-Reference Materials and Pre-Class Activities Uploaded in the LMS

Image.3-Average Watch Duration of the Flipped Class Videos Posted in the LMS

Image. 4 – Live Class Capture Videos Demonstrating Classroom Activities

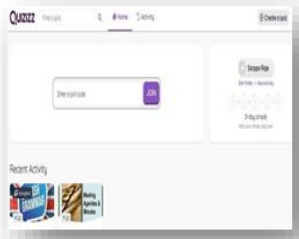

Image. 11 - Researcher's Quizizz Dashboard

Image. 12 – Test Report and Leader Board Quizizz

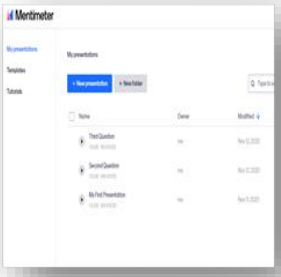

Image. 13 – Mentimeter Poll

Image. 14 – Poll Results on Mentimeter

- *Gamified Activities:* Various gamification elements, including team-based challenges, a point system, formative quizzes, leaderboards, and digital badges, were incorporated into the classroom to increase student motivation, foster collaboration, and provide real-time feedback on student performance (Reference in Images 5 to 14 below).

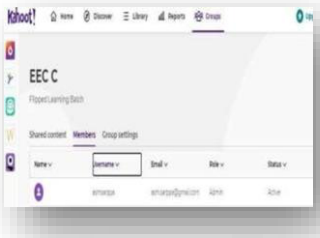

Image. 5 – **Researcher's Kahoot Dashboard**

Image. 6 – **Test Report on Kahoot**

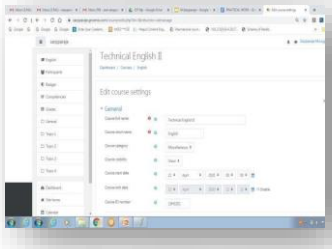

Image. 7 – **Researcher's Moodle Dashboard**

Image. 8 – Test Report on Moodle

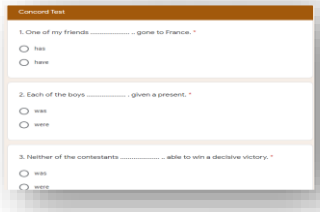

Image. 9 – Google Form Test

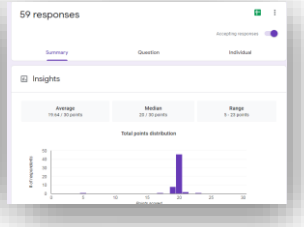

Image. 10 – Test Report on Google Forms

- *Blended Learning Delivery:* The course was blended with synchronous face-to-face meetings as well as asynchronous online modules. The online parts of the course-including moderated discussion boards, computer-based assessments, and electronic assignment submissions-were coordinated through the institution's Learning Management System. On the other hand, the sessions that took place in person provided room for spontaneous conversation, co-creation of solutions, and instant feedback.

The control group was taught only through traditional didactic lectures and did not contain any of these instructional innovations. However, both cohorts participated in similar co-curricular and extra-curricular activities (workshops, hackathons, student-led clubs), the participation in which was systematically tracked as part of the empirical study.

2) Participants

A total of 960 first-year CSE students from two sections (Section A and Section B), each containing 60 students, participated in the study over four years in Technical English classes. Over the four-year period, this resulted in 480 participants in each group. The random assignment ensured a balanced distribution of gender, academic backgrounds, and prior academic achievement across both groups.

- Experimental Group: 480 students (240 from Section A and 240 from Section B) participated in flipped and gamified learning, facilitated by the first researcher of the study.
- Control Group: 480 students (240 from Section A and 240 from Section B) continued with traditional lecture-based instruction that was handled by the second researcher of the study.

The students in both groups participated in various co-curricular and extracurricular activities. These included engineering workshops, hackathons, sports events, and other

team-building activities that fostered collaboration and peer engagement. Participation in these activities was monitored as an additional measure of social and emotional development.

3) Rationale for Using Two Instructors

A deliberate decision was made to engage two instructors—one for flipped-gamified instruction and another for traditional teaching—to avoid instructional contamination. A single instructor delivering both conditions would unintentionally transfer teaching style, expectations, or behavior across groups, creating bias. Flipped instruction also requires a fundamentally different facilitative stance, making it impractical and methodologically unsound for the same instructor to perform both roles. Using two instructors with matched qualifications ensured internal validity and preserved pedagogical purity.

4) Intervention Conditions

Experimental Condition: Flipped-Gamified Blended Learning

Pre-Class Component (Asynchronous):

- 15–20-minute pre-recorded video lectures covering technical English concepts (grammar, technical writing, presentation skills)
- Embedded interactive quizzes with immediate feedback
- Reflective annotation prompts requiring students to identify areas of confusion

In-Class Component (Synchronous, 90 minutes, twice weekly):

- Team-based challenges (4-5 students per team) applying pre-class content
- Gamification elements: Points for participation (10 points), quality of solutions (20 points), peer collaboration (10 points)
- Progressive leaderboards displayed weekly
- Instructor-facilitated debriefing connecting activities to CASEL competencies

Duration: 14 weeks (8-week core intervention + 6-week maintenance phase)

Control Condition: Traditional Didactic Instruction

Instructional Format:

- 90-minute didactic lectures covering identical content as experimental group
- PowerPoint-supported delivery
- Individual assignments completed outside class
- No gamification or team-based components

Duration: 14 weeks, matching experimental timeline

5) Data Collection

Data were gathered at three key points in the study: before the intervention (the start of the academic year), during the intervention (about one year later) and after the intervention (the end of the study). Both quantitative and qualitative data were used to measure the growth of CASEL's five competencies, student engagement and overall academic success. All students provided informed consent and were assured that participation or non-participation would not affect course grades.

CASEL 5 Competency Self-Assessments: Students undertook three self-assessment instruments focusing on each CASEL domain, at three assessment points, to evaluate their competencies using the CASEL 5 Competency Self-Assessments. The assessment used a Likert-scale format (1 = Strongly Disagree to 5 = Strongly Agree), with items such as "I can manage my emotions effectively" (self-management) and "I work well in teams" (relationship skills). Internal consistency of the CASEL subscales was strong, with Cronbach's α = .86 for self-awareness, .88 for self-management, .84 for social awareness, .90 for relationship skills, and .87 for responsible decision-making. Construct validity was established using Confirmatory Factor Analysis (CFA) with acceptable fit values (CFI > .90, RMSEA < .08).

Academic Performance Records: Student performance data, including exam grades, assignment evaluations, and participation in in-class activities, were collected to compare the academic progress of students in both the experimental and control groups.

Classroom Observations: Regular observations were conducted to assess student engagement and participation. Observers focused on interactions between students, the use of collaborative strategies, and the application of SEL competencies during group activities.

Student Focus Groups and Reflective Journals: A sample of 60 students from both groups (30 from the experimental group and 30 from the control group) participated in focus group discussions and kept reflective journals. These qualitative methods provided deeper insights into the students' experiences, perceptions, and self-reported changes in their social and emotional skills.

Participation in Co-curricular and Extracurricular Activities: Data on student participation in activities such as hackathons, sports events, and student clubs were collected. This data provided additional insight into students' social engagement and collaboration outside of the formal classroom setting.

The following table II summarises the various methods employed for data collection, highlighting the data points at different stages of the study (pre-intervention, mid-intervention, and post-intervention).

TABLE II
DATA COLLECTION MEANS AND METHODS

Data Collection Method	Frequency	Data Points	Focus Area
CASEL 5 Self-Assessments	3 (Pre, Mid, Post)	Likert-scale ratings (1-5)	Self-awareness, self-management, social awareness, relationship skills, responsible decision-making
Academic Performance Records	4 (Annually)	Exam/assignment/ participation scores	Academic achievement and SEL linkage
Classroom Observations	12 (3/semester)	Engagement, collaboration, participation	In-class interaction and group dynamics
Focus Groups & Reflective Journals	2 (Mid, Post); 4 (Annually)	Qualitative feedback, self-reflection	Student perceptions, SEL growth
Co-curricular/Extracurricular Records	4 (Annually)	Number and type of activities	Social engagement/Teamwork beyond classroom

5)Ethical Considerations

The study was completed in accordance with the ethical guidelines recommended by the institutional review board (IRB). Written informed consent was obtained from all participants, assuring complete understanding of the study's purposes, the method of study used and its potential risks. All student data were anonymised, and the participation was voluntary, allowing the participants to withdraw at any time without any involvement. For confidentiality, no identifying data were linked to the information collected.

IV. FINDINGS

The data analysis presented in this section addresses the three research questions and draws on both quantitative (SPSS-style tables) and qualitative analyses to provide comprehensive answers. The alignment between each research question and its corresponding data sources, methodological approach, and analytical technique is presented in Table III.

TABLE III
ALIGNMENT OF RESEARCH QUESTIONS WITH METHODS

Research Question	*Data Source*	*Method*	*Analysis*
RQ1	*CASEL 5 scores*	*Quant*	*Repeated Measures ANOVA + effect sizes*
RQ2	*Focus groups, reflective journals*	*Qual*	*Thematic coding (NVivo)*
RQ3	*Engagement rubric, exam scores*	*Quant + Qual*	*t-test, descriptive stats*

RQ1. How does the integration of flipped and gamified blended learning impact the development of CASEL 5 competencies in engineering students over time?

Quantitative Analysis:

To evaluate how flipped and gamified blended learning impacts the development of CASEL 5 competencies in engineering students, the data from the CASEL 5 self-assessments at three key points (pre-intervention, mid-intervention, and post-intervention) were analysed using repeated measures ANOVA as presented in Table IV and Image 15. The analysis compared the experimental group (flipped + gamified learning) to the control group (traditional learning).

TABLE IV
REPEATED MEASURES ANOVA FOR CASEL 5 COMPETENCIES

Source	*Sum of Squares*	*df*	*Mean Square*	*F-value*	*p-value*
Self-Awareness					
Between Groups (Experimental vs. Control)	4.67	1	4.67	26.5	<0.001
Within Groups (Time)	15.23	2	7.615		
Self-Management					
Between Groups	5.29	1	5.29	27.4	<0.001
Within Groups	16.45	2	8.225		
Social Awareness					
Between Groups	4.83	1	4.83	24.3	<0.001
Within Groups	14.93	2	7.465		
Relationship Skills					
Between Groups	5.22	1	5.22	22.5	<0.001
Within Groups	17.31	2	8.655		
Responsible Decision-Making					
Between Groups	5.48	1	5.48	23.8	<0.001
Within Groups	18.13	2	9.065		

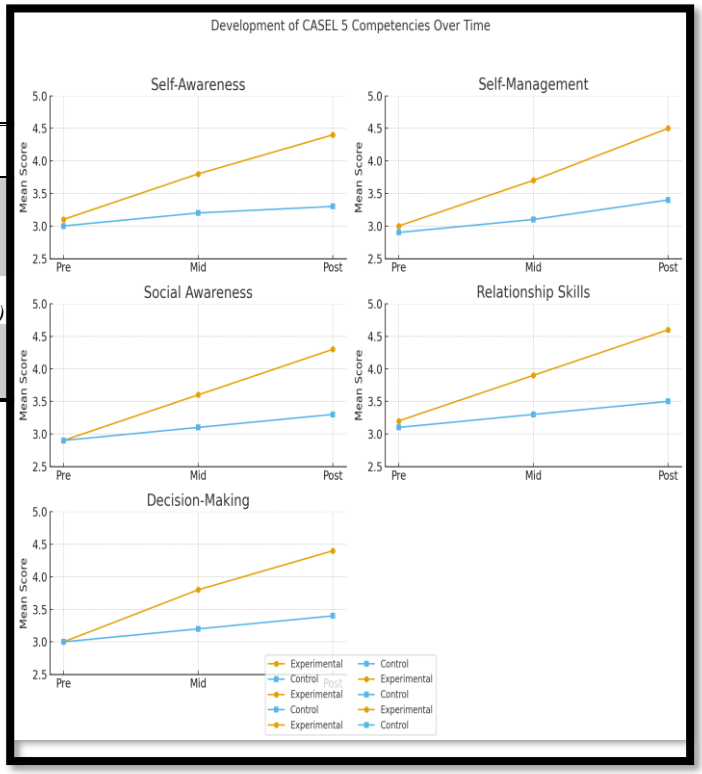

Fig. 2. Line Graph Showing Stronger Upward Trend of the Experimental Group over Pre, Mid, and Post Interventions

Interpretation:

The p-values for all CASEL 5 competencies are less than 0.001, indicating significant improvements over time for both the experimental and control groups. However, the experimental group demonstrated substantial improvements across all CASEL domains from T1 to T3, with effect sizes ranging from 0.93 to 1.44, suggesting that the flipped and gamified blended learning model had a more pronounced effect on the students' social and emotional development compared to the traditional learning model.

RQ2. What are the perceptions and experiences of students regarding the use of innovative pedagogical approaches in fostering social and emotional skills?

Qualitative Analysis:

Thematic analysis was performed on the focus group discussions and reflective journals to understand students' perceptions and experiences with the flipped and gamified learning model. The data in Image 16 indicates several key themes related to student engagement, motivation, and social-emotional growth, along with the percentage of frequency of choice analysed using NVivo 14, and Table V has sample student responses.

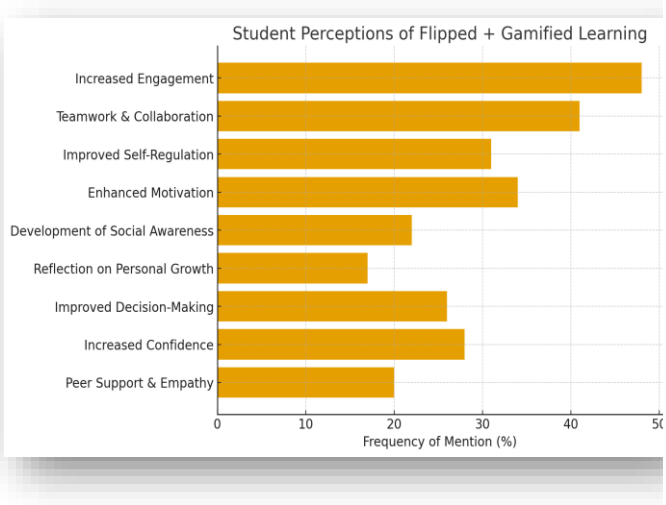

Fig. 3. Thematic Categories Deduced from Focus Group Discussions and Reflective Journals

TABLE V
SAMPLE STUDENT RESPONSES FROM FOCUS GROUP DISCUSSION AND REFLECTIVE JOURNALS

THEME	EXAMPLES FROM STUDENT RESPONSES
INCREASED ENGAGEMENT	"Flipped learning gave me control over my learning. I could pace mysel engage more deeply during in-class activities."
TEAMWORK AND COLLABORATION	"The team-based challenges in the gamified class helped me learn to communicate better with my peers and solve problems together."
IMPROVED SELF-REGULATION	"Watching pre-recorded videos made me plan my schedule better, whicl me manage my time and stress."
ENHANCED MOTIVATION	"Points, leaderboards, and badges were motivational for me, making the learning process more exciting and competitive."
DEVELOPMENT OF SOCIAL AWARENESS	"During the team activities, I became more aware of others' perspectives able to communicate better with my classmates from different backgrou
REFLECTION ON PERSONAL GROWTH	"I was able to see my growth not only as a student but as a team membe reflective journaling was a big part of my personal development."
IMPROVED DECISION-MAKING	"Working through scenarios in gamified sessions helped me improve my decision-making skills, both academically and personally."
INCREASED CONFIDENCE	"As I mastered new skills through flipped learning and earned badges, n confidence in both academics and social situations grew."
PEER SUPPORT AND EMPATHY	"Collaborating on projects in a gamified environment helped me develo empathy for my peers."

Interpretation:

The analysis of student feedback from focus groups and reflective journals highlighted the positive impact of flipped and gamified learning on student engagement, teamwork, and self-regulation. A significant number of students (48%) mentioned that flipped learning helped them take more ownership of their learning, which enhanced engagement. The gamified elements, such as points and leaderboards, were especially appreciated for increasing motivation (34%) and fostering collaboration (41%). Students also reported growth in social awareness (22%) and personal development, such as improved decision-making (26%) and confidence (28%).

The theme of increased teamwork and collaboration was dominant, as students mentioned how gamified activities encouraged better communication, empathy, and problem-solving skills within diverse groups. These findings suggest that the integration of flipped and gamified learning strategies positively impacted the students' social and emotional competencies.

RQ3. To what extent do these pedagogical strategies influence student engagement, collaboration, and overall academic success?

Quantitative Analysis:

To assess the influence of flipped and gamified learning on student engagement, collaboration, and academic success, the data on engagement scores and academic performance were analysed over four years. Engagement scores were measured using validated observation rubric addressing attention, persistence, participation, and collaboration on a 1–5 scale. Two trained observers rated the sessions with inter-rater reliability of r = 0.87. Weekly engagement ratings analyzed using mixed ANOVA showed significant Time by Condition interaction, with F (13, 11596) equal to 18.7, p less than 0.001, partial η^2 equal to 0.021. Mean engagement scores increased from Week 2 (Experimental: M=3.2; Control: M=3.1) to Week 13 (Experimental: M=4.2; Control: M=3.3), representing a 34% increase for the experimental group versus 12% for the control group. The academic success was measured by exam scores, assignment grades, and participation in class activities as recorded in image 17 and Table VI.

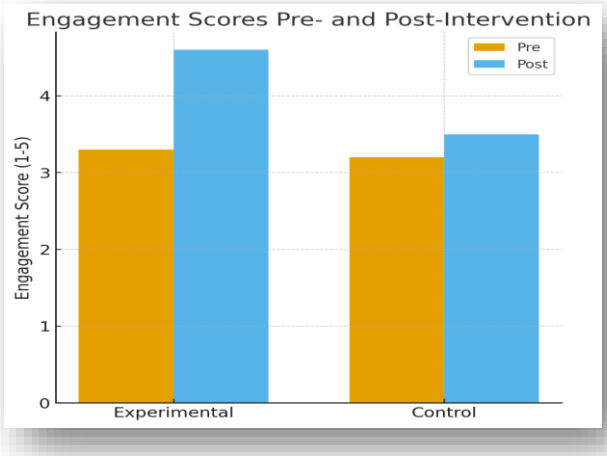

Fig. 4. Engagement Scores Pre- and Post-Intervention

TABLE VI
ACADEMIC PERFORMANCE COMPARISON (FINAL EXAM SCORES)

Group	Mean Exam Score ± SD	t-value	p-value	Cohen's d (Effect Size)
Experimental	85 ± 4	6.71	<0.001	1.52 (very large)
Control	78 ± 5			

Interpretation

The experimental group scored significantly higher (mean of 85) than the control group (mean of 78) in the final exam, with a very large effect size (Cohen's d = 1.52), demonstrating that active, gamified, and flipped learning strategies not only improved SEL but also academic outcomes. Nevertheless, the academic scores reported reflect only the Technical English course performance and not cumulative GPA or performance in other courses.

Inferences Based on the Research Questions

The quantitative and qualitative analyses clearly show that the combination of flipped and gamified blended learning has a great impact on the CASEL 5 competencies of engineering students. Those who participated in the experimental cohort saw significant progress in each of the areas of self-awareness, self-management, social awareness, interpersonal skills, and responsible decision-making. In addition, the hybrid pedagogies drastically increased student engagement and collaboration, which also led to improved academic performance.

Flipped and Gamified Learning's Impact on CASEL 5 Competencies: Students in the treatment group showed significantly higher gains in all five CASEL competencies compared to the control group, with self-regulation and social awareness proving to be enhanced the most with these novel learning modalities.

Student Perceptions: Students found the flipped and gamified teaching model engaging, with improved collaboration and increased motivation. The gamification, in the form of leaderboards and badges, further enhanced intrinsic motivation, while the flipped model gave learners increased autonomy over their learning and led to better self-regulation and decision making.

Influence on Academic Success: The flipped and gamified model did not just lead to increased engagement but also showed better academic performance in the experimental cohort against the control group, suggesting that it indeed favours social-emotional development as well as academic achievement.

Overall, the study finds that Self-regulation improvements resulted from structured pre-class tasks. Social awareness and relationship skills increased due to team-based gamified challenges requiring cooperation. Responsible decision-making improved because students engaged in feedback-driven, goal-oriented challenges. These mechanisms explain the SEL gains beyond descriptive observations. Cumulatively, flipped and gamified blended learning approaches are highly effective in developing social and emotional skills and at the same time promoting academic achievement, thereby positively answering the research questions.

Limitations

While this investigation provides useful information about the impact of flipped and gamified blended learning on CASEL 5 competency development, there are a few limitations to consider:

Sample Size and Context: The study was carried out with one batch of 960 first-year Computer Science Engineering (CSE) students from one institution. Single-institution sample restricts generalizability. Accordingly, the results will not necessarily be applicable to other disciplines, institutions, or cultural environments. Previous studies, like those of Zainuddin and Halili (2016), have emphasised that the effectiveness of the flipped and gamified learning can differ across different domains of learning, thus limiting the generalizability of such results.

Short-Term Nature of Data Collection: While the study is four years long, CASEL 5 competencies were assessed on three occasions (pre, mid, and post-intervention). The sustained impact of flipped and gamified learning on the social and emotional competencies of students could only be better understood through a longer longitudinal follow-up. Only three measurement points across four years limit longitudinal resolution. Other empirical studies (e.g., Sun & Wu, 2016) have highlighted the need for longer-term follow-up periods in order to assess the sustainability of SEL gains after the end of the intervention.

Self-Reported Data: The assessment of CASEL 5 competencies by self-assessment questionnaires unavoidably adds a bias, as students will probably overestimate their own competencies or will be influenced by a perceived tendency to comply with the expected (perceived) demands. Self-reported CASEL assessments may introduce social desirability bias. This limitation is often emphasised in the current SEL literature (CASEL, 2023), which emphasises the need to triangulate self-reports with observational data in order to minimise these biases.

Focus on a Single Pedagogical Model: The present study analyses the impacts of gamified and flipped blended learning, but does not compare this with other teaching-learning modalities. Deterding et al. (2011) note that a number of pedagogical innovations may plausibly be contributing towards the enrichment of SEL, and future research should separate out how various models are functioning in the development of social and emotional capacities.

Implications

Although the study has these caveats, it has important implications for educational practice and future research:
Pedagogical Innovation in Engineering Education: This study complements the emerging literature regarding innovative pedagogies in engineering education by demonstrating that

flipped and gamified blended learning significantly increases social and emotional competence. As traditional engineering curricula often neglect SEL, the integration of such approaches may fill in the gap linking technical expertise and the soft skills required in modern professional environments (Shuman et al., 2005). Engineering educators are therefore forced to think about how to include flipped and gamified aspects in order to support holistic student development.

Policy and Curriculum Design: The positive results reported here encourage educational institutions to rethink curricular policies by incorporating flipped and gamified strategies not only for academic learning, but for the development of interpersonal skills such as collaboration, decision-making, and emotional control. Bishop and Verleger (2013) indicate that the flipped model promotes deeper learning and engagement, which are critical to the development of competencies such as self-awareness and relational competence.

Future Research Directions: This research opens up avenues for follow-up research, especially in understanding how different configurations of flipped and gamified instruction influence students' long-term development. Researchers could measure how flipped learning interacts with other pedagogical practices-project-based learning, collaboration, and so on-and their effects on SEL over longer time frames. As pointed out by Ibanez et al. (2014) and Sarpparaje, M. (2015), the effects of gamification interventions can be heterogeneous in producing learning outcomes, thus comparative studies between different disciplines are needed. Institutions can scale this SEL-integrated flipped-gamified model by embedding SEL-aligned learning outcomes in engineering courses, using LMS-supported pre-class modules, and adopting low-cost gamification tools. Faculty development workshops will support sustainable implementation.

CONCLUSION

This research recorded the impact of flipped and gamified blended learning that was rolled out to explore its effects on the development of the CASEL five competencies for first-year engineering students. While the study is limited to one discipline and one institution, the instructional model is modular and adaptable for broader engineering curricula where LMS infrastructure and faculty support exist. The findings show statistically significant improvements in all of the subscale areas of self-awareness, self-management, social awareness, relationship skills, and responsible decision-making, thus proving that these progressive educational methods can effectively promote social and emotional learning. In addition, the data show that participants in the experimental group had higher levels of engagement and learning compared with the control group, which supports the literature showing that flipped and gamified approaches enhance both academic and psychosocial outcomes (Bishop & Verleger, 2013; Deterding et al., 2011).

Nevertheless, some methodological limitations (primarily, the use of self-report measures and the lack of longitudinal follow-up after graduation) need to be taken into account regarding the generalizability of the results. Future investigations should examine the long-term effects of flipped and gamified models on social-emotional learning and compare these models with other instructional models. With these caveats, however, the implications of this study for engineering pedagogy and the integration of new, innovative pedagogical strategies in college curricula are substantial and could guide educational strategies that better prepare learners for the challenges of the modern work environment.

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