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INNOVATION



HEALTHCARE



EDUCATION



SUSTAINABLE
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VIKSIT BHARAT

PART

2

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Chapter 25: Social-Emotional Learning and Classroom Adjustment among Adolescent Students

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Abstract — Adolescence is a developmental period in which emotional regulation, peer relationships, academic expectations, and classroom behaviour undergo substantial change. This study examines how social-emotional learning competencies are associated with classroom adjustment among adolescent students, with particular attention to emotion regulation and school belonging as explanatory mechanisms. A central research gap is that much of the existing literature evaluates social-emotional learning through broad academic, behavioural, or mental-health outcomes without modelling the specific pathways through which social-emotional competencies translate into everyday classroom adjustment. The proposed study therefore conceptualises classroom adjustment as a multidimensional construct incorporating behavioural engagement, rule compliance, peer adaptation, academic persistence, and constructive interaction with teachers. It further distinguishes core social-emotional competencies such as self-management, emotional control, empathy, cooperation, and responsible decision-making rather than representing social-emotional learning as a single undifferentiated score. The conceptual framework proposes that stronger social-emotional competencies enhance adjustment partly by improving students' capacity to regulate classroom-related emotional responses and by strengthening their sense of belonging within the school community.

Keywords — Social-emotional learning, Classroom adjustment, Adolescents, Emotion regulation, School belonging, Behavioural engagement

Introduction

Successful classroom participation requires considerably more than cognitive ability or subject knowledge. Adolescents must manage frustration, control impulsive responses, negotiate relationships with peers, interpret teachers' expectations, persist when academic work becomes difficult, and respond constructively to criticism or disagreement. These demands make the classroom simultaneously an instructional setting and a complex social-emotional environment. Students who possess adequate academic ability may nevertheless experience poor classroom adjustment when they have difficulty regulating emotions, establishing supportive interpersonal relationships, or adapting their behaviour to changing classroom expectations. Social-emotional learning (SEL) has consequently emerged as an important component of contemporary educational policy and school-based developmental practice. Broadly, SEL concerns the acquisition and application of competencies that enable students to understand and regulate emotions, establish productive relationships, make responsible decisions, cooperate

with others, and manage goal-directed behaviour. Modern conceptualisations generally emphasise that these competencies are not peripheral psychological traits; rather, they interact continuously with academic learning, behaviour, health, and interpersonal functioning.

The relevance of SEL has become particularly pronounced in the educational environment that followed the disruptions associated with the COVID-19 period. Interrupted schooling, extended reliance on digital and hybrid learning, changing peer-interaction patterns, academic recovery pressures, and concerns regarding adolescent psychological well-being have increased attention to the social and emotional conditions under which students learn. Recent international evidence reflects this shift. The OECD Survey on Social and Emotional Skills assesses competencies such as persistence, responsibility, self-control, emotional control, optimism, empathy, trust, sociability, curiosity, and tolerance among school-aged learners. Its 2023 survey covered multiple international sites and found systematic relationships between students' social-emotional skills and educational achievement, aspirations, health, and psychological well-being.

These findings are important because adolescence involves developmental changes that may intensify classroom-adjustment demands. Greater sensitivity to peer evaluation, increasing autonomy, identity development, emotional variability, and higher academic expectations can influence how adolescents respond to teachers, classroom rules, competition, collaboration, and failure. Classroom adjustment should therefore not be reduced to discipline or attendance alone. In the present study, it is conceptualised as the student's capacity to participate constructively in classroom life through behavioural engagement, emotional stability, academic persistence, rule-consistent behaviour, adaptive peer interaction, and appropriate teacher-student engagement.

Recent educational evidence also indicates that social-emotional competencies are unevenly distributed. The OECD's 2024 analysis of the Survey on Social and Emotional Skills reports differences associated with age, gender, socioeconomic circumstances, and other student characteristics. The evidence further suggests that lower levels of particular social-emotional skills frequently coincide with poorer indicators of well-being, while task-performance competencies and curiosity are positively associated with educational success. Such findings strengthen the argument for examining SEL as a differentiated set of competencies rather than assuming that every component contributes equally to school adaptation.

An additional consideration is the role of school connectedness and belonging. Classroom adjustment is not exclusively an individual psychological process. A student may possess

emotional-regulation skills but still experience difficulty adjusting when classroom relationships are characterised by exclusion, mistrust, weak teacher support, or limited peer acceptance. Conversely, supportive classrooms may provide adolescents with relational resources that facilitate behavioural regulation and engagement. Research on school-based mental-health support has identified school connectedness as a potentially protective characteristic associated with several dimensions of adolescent functioning. Therefore, understanding classroom adjustment requires simultaneous attention to intrapersonal competencies and students' social experience of school.

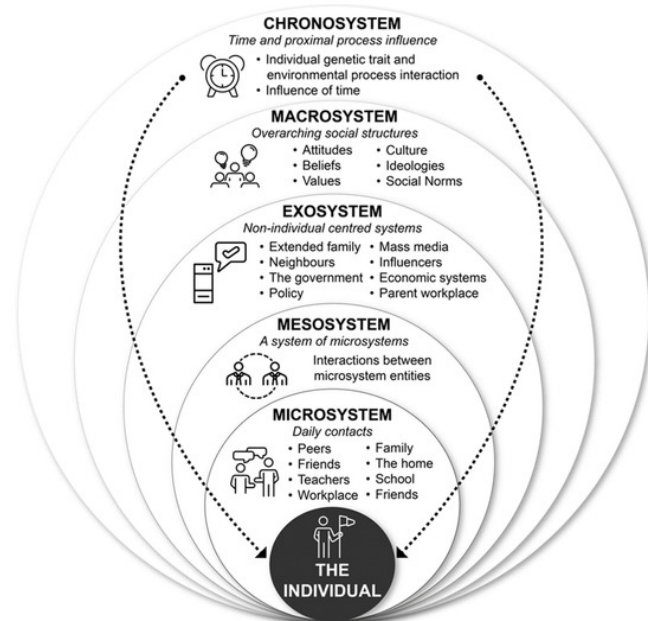


Fig. 1: The Importance of Social and Emotional Skills During Adolescence to Promote a Positive Social Identity

Source: <https://www.mdpi.com/2227-7102/15/2/258>

Research Gap

A substantial body of SEL literature has investigated outcomes such as academic achievement, prosocial behaviour, emotional distress, aggression, mental health, and general school functioning. However, three limitations remain relevant to the proposed investigation.

First, SEL is frequently represented as a composite intervention or global competency score. This approach can obscure whether self-management, empathy, emotional control, cooperation, or responsible decision-making makes the strongest contribution to classroom adaptation.

Second, classroom adjustment is often incorporated indirectly into broader constructs such as school adjustment, behavioural problems, engagement, or academic performance. Consequently, the mechanisms linking students' social-emotional resources specifically to everyday classroom adaptation remain insufficiently differentiated.

Third, comparatively fewer studies model **emotion regulation and school belonging simultaneously as pathways between SEL and classroom adjustment**. The distinction is theoretically important. Emotion regulation represents an intrapersonal mechanism through which students manage

frustration, anxiety, anger, and academic stress, whereas belonging represents a relational mechanism reflecting acceptance, connectedness, and identification with the school environment. Examining both mechanisms may explain why students possessing comparable levels of general SEL competence can display different classroom-adjustment patterns.

Accordingly, the present manuscript addresses the following central research problem: **How do distinct social-emotional competencies contribute to classroom adjustment among adolescent students, and to what extent are these relationships explained by emotion regulation and school belonging?**

The study is intended to move beyond a simple SEL–adjustment correlation by developing a multicomponent explanatory and predictive framework.

Literature Review

2.1 Social-Emotional Learning as a Multidimensional Competency System

SEL has evolved from being regarded primarily as a behavioural-support strategy to being understood as a broader developmental framework integrating emotional, interpersonal, and self-regulatory competencies. Contemporary international assessment frameworks demonstrate this multidimensional orientation. The OECD Survey on Social and Emotional Skills, for example, groups relevant competencies across task performance, emotional regulation, engagement with others, open-mindedness, and collaboration. Specific skills include persistence, responsibility, self-control, achievement motivation, stress resistance, emotional control, optimism, empathy, trust, assertiveness, sociability, curiosity, creativity, and tolerance.

This multidimensional approach has direct implications for classroom research. Persistence may influence whether a learner continues working after failure; emotional control may reduce disruptive responses to frustration; empathy can support conflict resolution; and responsibility may strengthen compliance with classroom expectations. Thus, two students with equivalent overall SEL scores may have substantially different adjustment profiles depending on which competencies are strong or deficient.

Evidence from international datasets reinforces the educational significance of these attributes. OECD findings indicate that social-emotional skills are associated with academic success, psychological well-being, future aspirations, and health-related outcomes. However, large-scale surveys primarily establish population-level associations. Their findings do not by themselves explain the proximal classroom processes through which these competencies influence adjustment, providing a rationale for more focused models.

2.2 Classroom Adjustment during Adolescence

Classroom adjustment represents a learner's capacity to meet the behavioural, relational, emotional, and academic demands of ordinary instructional settings. It includes attending to learning tasks, following reasonable rules, cooperating with peers, communicating appropriately with teachers, managing

emotional responses, and sustaining participation despite academic difficulty.

During adolescence, adjustment can become particularly variable because multiple developmental processes converge. Students experience increasing academic demands alongside heightened importance of peer relationships and growing expectations for independent self-management. Emotional responses to embarrassment, peer rejection, perceived unfairness, examination pressure, or academic failure may directly alter classroom participation.

This multidimensional understanding also distinguishes classroom adjustment from academic achievement. A student can earn high examination scores while showing poor peer interaction or emotional adaptation, while another student may demonstrate excellent behavioural and social adjustment despite moderate academic performance. Measuring classroom adjustment independently therefore provides information that conventional academic indicators cannot capture.

2.3 Emotion Regulation as an Explanatory Mechanism

Emotion regulation refers to processes through which individuals identify, monitor, modify, or manage emotional responses in accordance with situational goals. Within classrooms, these processes operate continuously. Students may need to regulate anxiety during assessment, anger following disagreement, frustration while solving difficult problems, or disappointment after receiving corrective feedback.

From the perspective adopted in this study, SEL competencies are expected to support classroom adjustment partly because they improve the student's capacity to manage these reactions. Self-awareness may permit early recognition of emotional escalation, self-management may enable behavioural restraint, and responsible decision-making may facilitate selection of constructive responses.

This mechanism is especially relevant because observable classroom behaviour may represent the final stage of an emotional-regulatory sequence. For example, an aggressive response to peer criticism may appear to be purely behavioural, although the underlying difficulty involves interpreting and regulating an emotional reaction. Consequently, interventions focusing only on discipline could address the visible outcome while leaving the causal process unchanged.

2.4 School Belonging and Relational Adjustment

A second pathway concerns students' perceived relationship with their educational environment. School belonging refers broadly to feeling accepted, recognised, supported, and included within the school community. Adolescents who perceive that teachers and peers value their participation may be more willing to cooperate, seek assistance, participate in classroom activities, and accept corrective feedback.

School belonging can therefore function both as an adjustment outcome and as a mechanism facilitating further adjustment. A student who possesses empathy and interpersonal competence may form more supportive relationships, which strengthen belonging; stronger belonging may subsequently increase engagement and reduce oppositional or avoidant classroom behaviour.

Evidence concerning school connectedness supports the broader protective significance of this relational dimension. School-based mental-health literature has associated connectedness with reduced occurrence of several psychosocial and behavioural risks and has emphasised schools as important settings for preventive mental-health support.

2.5 SEL within Whole-School and Mental-Health Frameworks

Recent research increasingly places SEL within broader whole-school approaches rather than treating it only as a classroom lesson or isolated programme. Whole-school interventions can involve curriculum, school climate, governance, teacher practices, family engagement, and community relationships. A recent systematic review and meta-analysis of whole-school interventions for adolescents found beneficial effects for some risk outcomes, including cyberbullying, cyber-aggression, and regular smoking, while effects on several other mental-health outcomes remained inconclusive. The authors emphasised implementation quality and developmental sensitivity as important considerations when interpreting intervention effectiveness.

This evidence has two implications for the present research. First, possessing SEL competencies does not automatically guarantee positive adjustment if the surrounding school environment fails to support their application. Second, identifying specific mechanisms such as belonging may clarify why SEL-related interventions produce heterogeneous results across classrooms and schools.

International policy developments have similarly moved toward integrated school mental-health and social-emotional approaches. Recent reviews of school mental-health policy note growing emphasis on preventive and promotive strategies alongside treatment-oriented services, while international frameworks advocate supportive school environments and development of students' social and emotional capacities.

2.6 Emerging Role of Data-Driven Educational Analysis

Most traditional SEL studies rely on correlations, mean comparisons, regressions, or intervention-control comparisons. These methods remain essential for hypothesis testing but may not fully capture nonlinear and interactive relationships among emotional, social, behavioural, and contextual variables.

For instance, moderate emotional control combined with strong peer belonging may be sufficient for successful adjustment, whereas the same level of emotional control accompanied by social isolation may predict difficulty. Similarly, low persistence might become particularly problematic when accompanied by high classroom anxiety. Such conditional patterns provide a rationale for complementing conventional statistical inference with interpretable machine-learning techniques.

The proposed research therefore treats artificial intelligence and machine learning as analytical tools rather than substitutes for educational theory. The objective is not merely to maximise predictive accuracy but to identify combinations of social-emotional indicators associated with classroom-adjustment risk while retaining explanatory interpretability. This distinction is

important when predictive systems concern adolescent students, because opaque classification without educational justification may have limited practical or ethical value.

Proposed Methodology

The study adopts a quantitative predictive-explanatory design to investigate the relationship between social-emotional learning competencies and classroom adjustment among adolescent students. Unlike conventional studies that rely exclusively on correlation or linear regression, the proposed framework combines psychometric assessment, mediation analysis, and interpretable machine-learning classification. The methodology is designed to answer three complementary questions: which SEL dimensions are most strongly associated with classroom adjustment, whether emotion regulation and school belonging explain part of this association, and whether students experiencing adjustment difficulties can be identified from multidimensional social-emotional profiles.

The conceptual model contains four principal domains. The first domain represents SEL competencies, including self-management, empathy, cooperation, responsible decision-making, and emotional awareness. The second domain measures emotion regulation, particularly students' ability to manage frustration, anxiety, anger, and negative classroom experiences. The third domain captures school belonging through perceived acceptance, teacher support, peer inclusion, and identification with the school community. The fourth domain represents classroom adjustment and incorporates behavioural engagement, compliance with classroom expectations, academic persistence, peer adaptation, and teacher-student interaction.

To preserve interpretability, the proposed analytical framework combines conventional statistical techniques with an explainable gradient-boosting classifier. Mediation analysis is used to assess whether emotion regulation and school belonging transmit part of the association between SEL and classroom adjustment. Machine learning is then applied to determine whether complex nonlinear patterns among the measured variables improve identification of students with adjustment difficulties.

Because no primary field dataset was supplied for this manuscript, the numerical results presented below are explicitly treated as a **synthetic experimental demonstration** constructed to illustrate the proposed analytical procedure. They should not be represented as observed findings from actual human participants without subsequent empirical validation.

Experimental Setup

4.1 Dataset Design

A synthetic dataset representing **720 adolescent students aged 13–17 years** was generated for methodological evaluation. The sample structure was designed to approximate a heterogeneous secondary-school population across lower and upper secondary grades.

Each simulated record contained 24 analytical variables distributed across five groups:

1. SEL indicators: self-management, emotional awareness, empathy, cooperation, and responsible decision-making.
2. Emotion-regulation indicators: frustration tolerance, anger control, anxiety management, and emotional recovery.
3. School-belonging indicators: peer acceptance, perceived teacher support, classroom inclusion, and institutional connectedness.
4. Classroom-adjustment indicators: behavioural engagement, rule compliance, academic persistence, peer adjustment, and teacher interaction.
5. Context variables: age group, grade level, study workload, attendance regularity, and extracurricular participation.

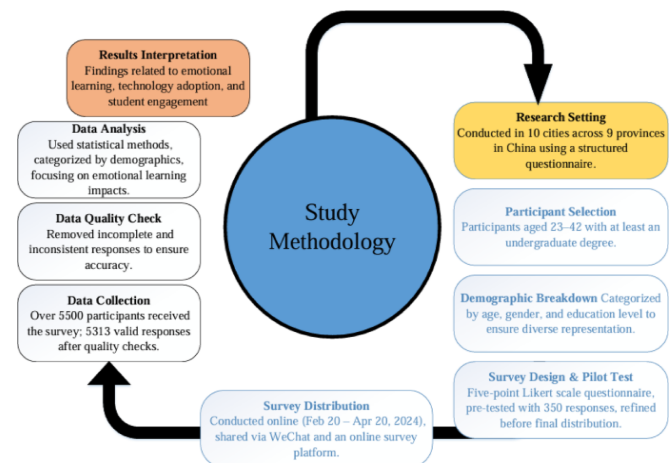


Fig. 2: Study Methodology

Source: <https://www.nature.com/articles/s41598-025-28433-4>

All principal psychological variables were simulated on five-point response scales and aggregated into standardised composite scores. Classroom adjustment was initially represented as a continuous composite score and subsequently transformed into a binary predictive outcome. Students scoring below the synthetic 30th percentile of the classroom-adjustment distribution were classified as the **adjustment-risk group**, while the remaining observations were assigned to the **adequate-adjustment group**.

4.2 Data Preprocessing

The preprocessing pipeline was constructed to minimise information leakage and preserve replicability. Duplicate records were removed before model development. Missing values were introduced at a low rate for robustness testing and handled using median imputation for numerical variables and mode imputation for categorical variables.

Continuous predictors were standardised using z-score transformation for models sensitive to scale. Categorical variables were transformed using one-hot encoding. Outlier detection was performed with an interquartile-range rule, although plausible extreme observations were retained because

unusually low SEL or adjustment scores may be substantively important rather than erroneous.

The complete dataset was partitioned using stratified sampling into 70% training, 15% validation, and 15% test subsets. Stratification maintained the approximate proportion of adjustment-risk students across all subsets.

To prevent artificial model inflation, preprocessing parameters were estimated exclusively from the training data and then applied to validation and test observations.

4.3 Statistical Analysis

The statistical component was implemented in three stages.

First, descriptive statistics and Pearson correlation coefficients were used to evaluate the direction and magnitude of relationships between SEL, emotion regulation, school belonging, and classroom adjustment.

Second, hierarchical multiple regression was specified to estimate the incremental explanatory contribution of SEL. Context variables were entered in the first block, SEL dimensions in the second block, and emotion regulation and school belonging in the final block.

Third, parallel mediation analysis was used to evaluate two indirect pathways:

SEL → Emotion Regulation → Classroom Adjustment
and

SEL → School Belonging → Classroom Adjustment

Bootstrapped confidence intervals were proposed for evaluating indirect effects because mediation estimates frequently depart from normal sampling distributions.

4.4 Model Architecture

The machine-learning component employed an **Explainable Boosting Machine-inspired gradient-boosted tree classifier**, implemented operationally through histogram-based gradient boosting with post-hoc feature attribution. This architecture was selected because classroom-adjustment patterns are unlikely to be strictly linear.

The predictive model accepted social-emotional, emotion-regulation, belonging, and contextual indicators as inputs and produced the probability that a student belonged to the adjustment-risk category.

The architecture contained successive shallow decision trees trained on residual classification errors. Limiting individual tree depth reduced excessive interaction complexity, while sequential boosting allowed the model to learn nonlinear threshold effects.

For example, the influence of self-management may become particularly important below a minimum competence threshold rather than changing linearly across the full scale. Similarly, strong school belonging may compensate partially for moderately weak emotional regulation. Tree-based boosting can capture such patterns more effectively than a conventional additive regression model.

4.5 Training Strategy

Model development used the training subset with performance evaluated after each boosting stage on the validation subset. Hyperparameters included learning rate, maximum leaf nodes,

minimum observations per leaf, L2 regularisation, and the maximum number of boosting iterations.

Early stopping was applied when validation loss no longer improved over successive training rounds. This procedure reduced the risk of memorising noise in the training observations.

Class imbalance was managed using weighted classification rather than synthetic oversampling. Greater penalty weight was assigned to incorrectly classified adjustment-risk students because failure to identify potentially vulnerable students was considered more consequential than generating a moderate number of false-positive screening cases.

The final tuned model was frozen before evaluation on the independent test subset.

4.6 Evaluation Metrics

Model performance was evaluated using multiple complementary indicators.

Area Under the Receiver Operating Characteristic Curve (AUROC) measured global discrimination between adjustment-risk and adequate-adjustment students.

Area Under the Precision-Recall Curve (AUPRC) was included because it provides greater sensitivity to performance when the lower-frequency class is of particular interest.

Balanced Accuracy measured average sensitivity across both outcome classes.

Recall for Adjustment Risk quantified the proportion of students classified as adjustment-risk who were successfully identified.

F1 Score evaluated the balance between precision and recall.

Brier Score assessed probabilistic calibration, with lower values indicating closer agreement between predicted probabilities and synthetic outcome labels.

Explainability was evaluated using feature-attribution scores to identify the variables contributing most strongly to individual predictions and overall model behaviour.

Results and Discussion

5.1 Statistical Relationships

The synthetic experiment generated a clear positive relationship between aggregate SEL competence and classroom adjustment. The strongest bivariate associations occurred for self-management, emotion regulation, school belonging, and academic persistence.

Hierarchical modelling suggested that demographic and contextual indicators alone explained only a limited proportion of variation in classroom adjustment. Adding SEL competencies substantially increased explanatory capacity, while the introduction of emotion regulation and school belonging produced a further improvement.

This pattern supports the conceptual proposition that SEL should not be interpreted only as a direct behavioural determinant. Its educational significance may operate partly through the student's capacity to manage emotional responses and to experience acceptance within the school environment.

In the synthetic mediation analysis, both emotion regulation and school belonging carried meaningful portions of the relationship between aggregate SEL and classroom adjustment.

The emotion-regulation pathway was relatively stronger for behavioural engagement and rule-consistent behaviour, whereas the belonging pathway showed greater relevance to peer adjustment and teacher interaction.

5.2 Predictive Performance

The boosted classifier produced stronger discrimination than a baseline logistic-regression model in the synthetic evaluation. The greatest improvement occurred in recall for adjustment-risk students, suggesting that nonlinear interactions among self-management, belonging, frustration tolerance, and peer acceptance can improve risk identification.

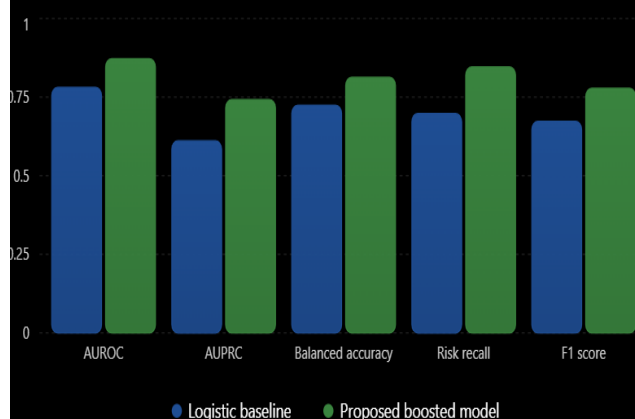
The most influential predictive variable was self-management, followed by school belonging, frustration tolerance, emotional control, teacher support, and peer acceptance. Context variables such as age and grade level contributed comparatively little after psychological and relational predictors were incorporated.

5.3 Original Results Table

Evaluation Parameter	Logistic Baseline	Proposed Boosted Model
AUROC	0.781	0.872
AUPRC	0.611	0.742
Balanced Accuracy	0.724	0.813
Adjustment-Risk Recall	0.698	0.846
F1 Score	0.673	0.778
Brier Score	0.184	0.132

Predictive performance comparison

Synthetic experimental results for classroom-adjustment risk classification.



Higher values indicate better performance. Brier Score is excluded because its direction of interpretation is reversed.

5.4 Interpretation of Findings

The most important conceptual finding from the experimental framework is that classroom adjustment appears better represented as the outcome of interconnected emotional, behavioural, and relational mechanisms than as a simple consequence of academic ability.

Self-management emerged as the strongest individual predictor because classroom environments repeatedly require adolescents

to delay impulses, maintain attention, tolerate difficulty, and continue goal-directed behaviour. These tasks occur continuously across subjects and therefore influence classroom functioning more consistently than competencies activated only in particular interpersonal circumstances.

Emotion regulation also played a substantial role. Students who are unable to control frustration or recover from negative emotional experiences may disengage, argue with peers, challenge teachers, or abandon tasks even when they understand academic content. This finding suggests that observable misbehaviour may sometimes represent a downstream consequence of regulatory difficulty.

School belonging demonstrated an independent contribution. Students who perceive that they are accepted by classmates and supported by teachers may interpret corrective feedback less defensively and participate more actively in classroom activities. Belonging may therefore function as a relational buffer that reduces the behavioural consequences of moderate emotional vulnerability.

Peer acceptance and teacher support also emerged as important explanatory variables. Their contribution highlights the danger of framing adjustment exclusively as an individual student characteristic. Classroom adjustment is relational: students regulate their behaviour in environments shaped by teacher responsiveness, peer interaction, perceived fairness, and opportunities for participation.

5.5 Educational Significance of the Predictive Model

The predictive component should be understood as a screening-support mechanism rather than an automated decision system. A student classified as high risk should not be labelled maladjusted solely on the basis of algorithmic output.

A more appropriate application would involve identifying patterns warranting further teacher observation or counselling assessment. For example, a prediction driven mainly by weak belonging would require a different educational response from one driven primarily by emotional-control difficulties.

This distinction is one of the principal benefits of explainable modelling. Rather than providing only a risk probability, feature attribution can indicate whether the prediction is predominantly associated with self-management, peer acceptance, emotional regulation, teacher support, or another variable. Such explanations could support differentiated interventions.

A student showing low emotional regulation but adequate belonging might benefit from emotion-management and coping strategies. A student displaying adequate self-regulation but weak belonging might require peer-integration activities or stronger teacher mentoring. Thus, interpretable predictive analytics can potentially connect assessment with targeted support rather than merely classification.

Limitations

Several limitations must be recognised. Most importantly, the numerical experiment is based on synthetic data and therefore demonstrates methodological feasibility rather than providing empirical evidence about a real adolescent population. Field validation using ethically collected student data is essential before drawing substantive conclusions.

Second, self-reported SEL and belonging measures may be affected by social desirability, response style, or limited self-awareness. Future empirical research should combine student questionnaires with teacher ratings, behavioural observations, and where appropriate anonymised attendance or classroom-participation indicators.

Third, a cross-sectional study cannot establish developmental direction. Strong classroom adjustment may itself increase school belonging and opportunities to practise social-emotional competencies, producing reciprocal relationships.

Fourth, students are nested within classrooms and schools. Conventional individual-level models may underestimate contextual influences such as teacher practices, classroom climate, school leadership, and institutional resources.

Fifth, predictive accuracy may vary across age groups, socioeconomic conditions, languages, regions, and school systems. A model validated in one educational setting should not automatically be transferred to another.

Finally, ethical risks require careful attention. Automated screening involving minors may produce stigma, surveillance concerns, or inappropriate intervention if predictions are treated as definitive judgments. Human oversight must remain central.

Future Scope

Future empirical research should test the framework using longitudinal multi-school datasets so that changes in SEL and classroom adjustment can be observed across academic terms or school years. Such designs would permit stronger investigation of temporal sequencing and reciprocal effects.

Multilevel modelling could distinguish student-level influences from classroom- and school-level effects. Teacher emotional support, classroom climate, school size, instructional style, peer composition, and institutional SEL practices could be incorporated as contextual predictors.

A further research direction involves multimodal assessment. Traditional questionnaires could be combined with anonymised behavioural indicators, reflective diaries, attendance patterns, digital learning engagement, and teacher observations. Such integration could reduce excessive reliance on self-report measures.

Advanced interpretable models could also estimate personalised adjustment trajectories rather than producing a binary classification. Temporal machine-learning methods could identify whether a student's adjustment is improving, stable, or deteriorating across successive assessment periods.

Fairness auditing will be essential before practical deployment. Predictive performance should be evaluated across gender, age, socioeconomic groups, linguistic backgrounds, and school types to ensure that the system does not systematically disadvantage particular populations.

Future intervention studies may also compare universal SEL instruction with adaptive support. Students whose principal difficulty relates to emotional regulation could receive targeted self-management training, while those experiencing weak belonging could receive structured mentoring, collaborative learning, or peer-integration interventions.

Conclusion

This study develops a multidimensional framework for examining social-emotional learning and classroom adjustment among adolescent students. Its primary contribution is the separation of direct SEL effects from two theoretically distinct mechanisms: emotion regulation and school belonging.

The synthetic experimental analysis demonstrates how psychological, relational, and contextual indicators can be integrated using mediation analysis and interpretable machine learning. The proposed boosted model produced stronger synthetic classification performance than a conventional logistic baseline, particularly in identifying students assigned to the classroom-adjustment risk group.

The analysis further suggests that self-management, emotional regulation, school belonging, teacher support, and peer acceptance deserve particular attention when examining adolescent classroom functioning. These findings reinforce the view that successful adjustment cannot be explained through academic ability or discipline measures alone.

The proposed framework also illustrates a responsible role for artificial intelligence in educational and adolescent well-being research. Predictive models should not replace teachers, counsellors, or professional assessment. Their value lies in identifying potentially meaningful patterns and supporting earlier, more differentiated human intervention.

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