



Teacher Autonomy Support and Learning Engagement in Flipped Classroom Method: The Mediating Roles of Intrinsic Motivation and Self-Regulated Learning

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Abstract

As the adoption of flipped classroom methods (FCM) continues to grow in higher education, understanding the factors that promote students' learning engagement is crucial. While teachers' autonomy support (TAS) is widely recognized to enhance it, the underlying mechanism remains largely unexplored within the context. Based on Self-Determination Theory (SDT) and Constructivist Learning Theory, the study examined the mediating effects of students' intrinsic motivation (IM) and self-regulated learning (SRL) between TAS and learning engagement in a cross-sectional research design. Data were collected from 360 university students across six Indian states, and mediation analysis was incorporated. The findings disclosed that TAS positively impacts the learning engagement of the students directly and indirectly by fostering IM and SRL. It supports the propositions of the two theories. It suggests that autonomy-supportive pedagogical practices fashion psychologically empowering learning environments that, in turn, encourage learners to actively participate, thus creating effective student-centered flipped classroom environments. Educators should bring about conducive environments for effective pedagogy employment by offering choices, explaining rationales behind given tasks, and acknowledging student perspectives to nurture their motivation and self-regulated learning.

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INTRODUCTION

Teaching and learning styles have evolved significantly in recent years in many classrooms in Higher education, reflecting the transition from traditional, instructor-focused instruction methods to contemporary, student-centered instruction methods (Afzal et al., 2023). This mainly took place as the demands of new-age education, such as student-teacher interaction, involvement, etc., were not met by traditional lectures and have thus become out of date. In this transition, the central challenges are learner-related barriers such as resistance, anxiety, difficulty navigating new models, and low motivation (Karabulut-Ilgü et al., 2018; Lee & Choi, 2019). Numerous university classrooms struggle to sustain student engagement and involvement when transitioning to or adopting new

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pedagogical methods (Akçayır & Akçayır, 2018; Vinson et al., 2010).

This challenge matters because learning engagement is closely linked to students' concentration, persistence, motivation, and academic achievement (Xu et al., 2023). Learning engagement refers to students' cognitive and emotional involvement in accomplishing learning tasks (Astin, 1984; Schunk & Mullen, 2012), and higher engagement is associated with better academic performance and course completion (Kuh, 2009). Conversely, disengaged students are less likely to show interest, persist, or internalize the value of learning (Reeve et al., 2004). Thus, it is evident that low engagement is not a minor classroom challenge, but points to a deeper problem in how learning environments are organized. Teacher autonomy support (TAS) is one factor that may address this challenge (Jang et al., 2010; Ma, 2021; Miao & Ma, 2022; Reeve et al., 2004; Yang et al., 2022). Based on Self-Determination Theory (SDT), supporting students' needs for autonomy, relatedness, and competence can enhance their motivation and engagement. TAS refers to the opportunities and choices teachers provide for students to participate actively in learning and regulate their learning activities (Basri, 2023; Okada, 2023; Pineda et al., 2025; Reeve et al., 2004). Previous studies have associated TAS with engagement, creativity, motivation, and need satisfaction, although contradictory evidence has also been reported (Hospel & Galand, 2016; Núñez & León, 2015; Okada, 2023; Yilmaz & Yilmaz, 2023).

Flipped Classroom Method (FCM), introduced by Bergmann and Sams in 2012, has emerged as a pedagogical response to the limitations of lecture-dominated classrooms (Baig & Yadegaridehkordi, 2023). In FCM, students study learning materials before class and use class time for comprehension, problem-solving, discussion, and peer instruction (Agirman & Ercoskun, 2022; Baker, 2016; Bishop & Verleger, 2013; Lage et al., 2000; Paryani & Jradi, 2019). Previous studies have reported positive effects of FCM on student engagement and academic outcomes (Agyeman & Aphane, 2024; Ayçiçek & Yelken, 2018; Bachisse & Mouline, 2022; Chakawodza et al., 2025; Chen et al., 2025; Dieu, 2024; Elmaadaway, 2018; Haetami et al., 2025; Khadawardi et al., 2025; Lo & Hew, 2021). However, evidence remains inconsistent, as engagement gains vary across implementations and depend on students' preparation, participation, and the scaffolding provided by teachers (Alonso et al., 2023; Jang & Kim, 2020; Silverajah et al., 2022). Thus, adopting FCM alone does not necessarily guarantee sustained learning engagement, highlighting the need to examine pedagogical factors that can support engagement within flipped learning environments.

Within FCM settings, TAS may influence learning engagement through intrinsic motivation (IM) and self-regulated learning (SRL) (Gopez & Guintu, 2025; Yang et al., 2022). Specific to flipped learning contexts, professor support for autonomy has also been associated with student accomplishment through learning engagement (Yoon et al., 2020). Intrinsic motivation (IM) represents an important motivational mechanism that encourages students to engage in learning activities with personal interest and internal satisfaction (Belady, 2022). Autonomy support can foster students' perceived competence and autonomy, thereby supporting IM (Niemiec & Ryan, 2009; Núñez & León, 2016; Young, 2005). Similarly, TAS has been associated with SRL, which enables students to regulate their learning activities and sustain engagement (Miao & Ma, 2022, 2023; Vansteenkiste et al. 2012). Empirical studies have reported positive relationships between TAS and IM (Germani & Palombi, 2022; Torbergesen et al., 2023) and between TAS and SRL (Bai & Gu, 2022; Romanyshyn & Freiuk, 2024), including within flipped learning contexts. These findings suggest that learning engagement may be influenced not only directly by TAS but also through motivational and self-regulatory mechanisms.

The study is grounded in Self-Determination Theory (SDT) and Constructivist Learning Theory (CLT). SDT explains how TAS may enhance students' autonomy, competence, and relatedness, thereby fostering IM and SRL (Deci & Ryan, 2000). CLT provides a pedagogical foundation for FCM by emphasizing active, participatory, and socially mediated learning through pre-class preparation and in-class discussion and problem-solving (Vygotsky, 1978). Together, these perspectives provide a theoretical basis for examining IM and SRL as mechanisms linking TAS with learning engagement.

Although previous studies have established positive relationships between TAS, IM, SRL, and learning engagement, these variables have largely been examined through independent or direct-effect models rather than a sequential mediation framework. Miao & Ma (2023) examined mediation involving self-efficacy and SRL, but empirical evidence on the sequential roles of IM and SRL in linking TAS to learning engagement remains limited. In addition, research specifically examining these

relationships within FCM in higher education is still limited (Azhar & Rashid, 2025; Sandhu et al., 2019). Therefore, further investigation is needed to clarify how motivational and self-regulatory mechanisms jointly explain the relationship between TAS and learning engagement in flipped classroom settings.

The primary objective is to examine the association between TAS and LE in FCM settings in higher education. Further, by drawing on SDT and CLT, the study seeks to ascertain the mediating roles of IM and SRL in this association.

Hypothesis 1: TAS is significantly related to learning engagement

Hypothesis 2: TAS is significantly related to intrinsic motivation

Hypothesis 3: TAS is significantly related to self-regulated learning

Hypothesis 4: Intrinsic motivation is significantly related to learning engagement

Hypothesis 5: Self-regulated learning is significantly related to learning engagement

Hypothesis 6: Intrinsic motivation is significantly related to self-regulated learning

Hypothesis 7: Intrinsic motivation and self-regulated learning mediate the relationship between TAS and learning engagement

The findings of the study will contribute to existing literature on FCM by throwing light on the evidence of dual mediating roles of IM and SRL between TAS and LE, offering theoretical and practical implications for educators, institutions and policymakers seeking to optimize student-centered pedagogical approaches.

METHOD

Sample and Area

A cross-sectional exploratory research design with a quantitative method that included serial mediation analysis was undertaken in November and December of 2025. This design was chosen as it enables examining numerous direct and indirect relationships among variables. Before beginning data collection, approval was obtained from the Ethical committee of the corresponding authors' institution, GlobalNxt University, Kuala Lumpur, Malaysia. As samples, 360 students from six higher education institutions in six Indian states participated, i.e., West Bengal (n=80, 22%), Odissa (n=64, 18%), Jharkhand (n=60, 17%), Chhattisgarh (n=56, 16%), Assam (n=52, 14%) and Uttar Pradesh (n=48, 13%) via a non-probability convenience sampling technique. The use of Google Forms allowed the investigators to reach such a geographically dispersed population, passed on through faculty and institutional contacts. Here, the participation was purely based on students' access to the link and their willingness to participate. Thus, the samples were inherently self-selected and not randomly drawn. This sampling technique aided in meeting the time constraint and limited resources. Department of Education accounted for 14.8% of the subjects taken by the students, followed by Management (16.9%), English (17.7%), Engineering (16.2%), Information and Technology (13.2%), Administration (13.9%), and "other" disciplines (7.3%). An electronic informed consent form to confirm their voluntary participation was received. Participants were required to be enrolled full-time at a university or a college and pursue either undergraduate or postgraduate studies. The 360 participants' average age was 23 years, with 216 females and 144 males.

Instruments Used

The following scales were adopted as a whole, and the contents were not altered. Nevertheless, construct validity was assessed using Confirmatory Factor Analysis (CFA) as recommended by the literature (Chakraborty et al., 2021). Also, the instruments' validation was carried out using both EFA and CFA, the established scale validation procedures. Before adaptation, the scales were retested using a few samples from India to check the reliability quotients.

Teacher Autonomy Support (TAS)- Bai and Gu (2022) developed the Perceived TAS scale with five items, which were adopted from the scale developed by Jang et al. (2010). It aimed at eliciting students' perception of how their teacher provided autonomy support in their pedagogical behaviors, which is the independent variable here. The scale was unidimensional and was gauged on a 5-point Likert scale. Before being adopted here, the internal consistency coefficient (α) was re-examined in the Indian context and found to be $\alpha=0.774$.

Learning Engagement (LE)- Online Student Engagement scale by Dixon (2015) was employed to elicit the dependent variable. It consists of 19 items across four dimensions such as skill, participation, emotional and performance engagement. Like the scale used for the independent variable, a five-point Likert format ranging from 1 to 5 that drew their behaviors, thoughts and feelings towards that subject, was in place. The investigators re-examined the internal consistency coefficient (α) in the Indian context and found it to be $\alpha=0.919$.

Intrinsic Motivation (IM)- Heindl et al. (2020) developed the Extended Short Scale for measuring Intrinsic Motivation. Well-grounded in self-determination theory, the scale captures the student's intrinsic motivation experiences through 15 items and five dimensions. The responses were again collected on a five-point Likert format, like the previous two constructs. The investigators re-examined the internal consistency coefficient (α) in the Indian context and found it to be $\alpha=0.929$.

Self-Regulated Learning (SRL)- Academic Self-Regulated Learning Questionnaire (ASLQ) by Nambiar et al. (2022) was developed to gauge academic SRL among higher education students. It comprises 36 items across three dimensions, reflecting the cyclical character of SRL. Unlike the above three measures, this was rated on a 4-point Likert scale from strongly agree to strongly disagree. Though it was validated on college students in India, the investigators re-examined the internal consistency coefficient (α) and found it to be $\alpha=0.959$.

Statistical Analysis

After determining each of the instruments' reliability scores, the investigators assessed the various mediation-related hypotheses. The analyses were carried out using Hayes (2018) PROCESS macro (Model 6) for the Statistical Package for the Social Sciences (SPSS). In order to determine the connection between the variables, descriptive statistics were computed, and the Pearson correlation coefficient was investigated. Stepwise linear regression and multivariate regression analysis techniques were used to look at the associations between the variables prior to the mediation analysis. The Bootstrap approach was employed to observe the indirect effects for the mediation model developed in accordance with the findings (Figure 1). It is determined that mediations, direct effects, and indirect effects are significant if the result does not include a zero (Gürbüz, 2019). Additionally, the reliability and consistency of the results were supported by the validation of the mediation model using Structural Equation Modelling (SEM) in AMOS version 23. Figure 1 presents the research flowchart, outlining the study design, participant selection, instruments, theoretical framework, and statistical analysis procedures.

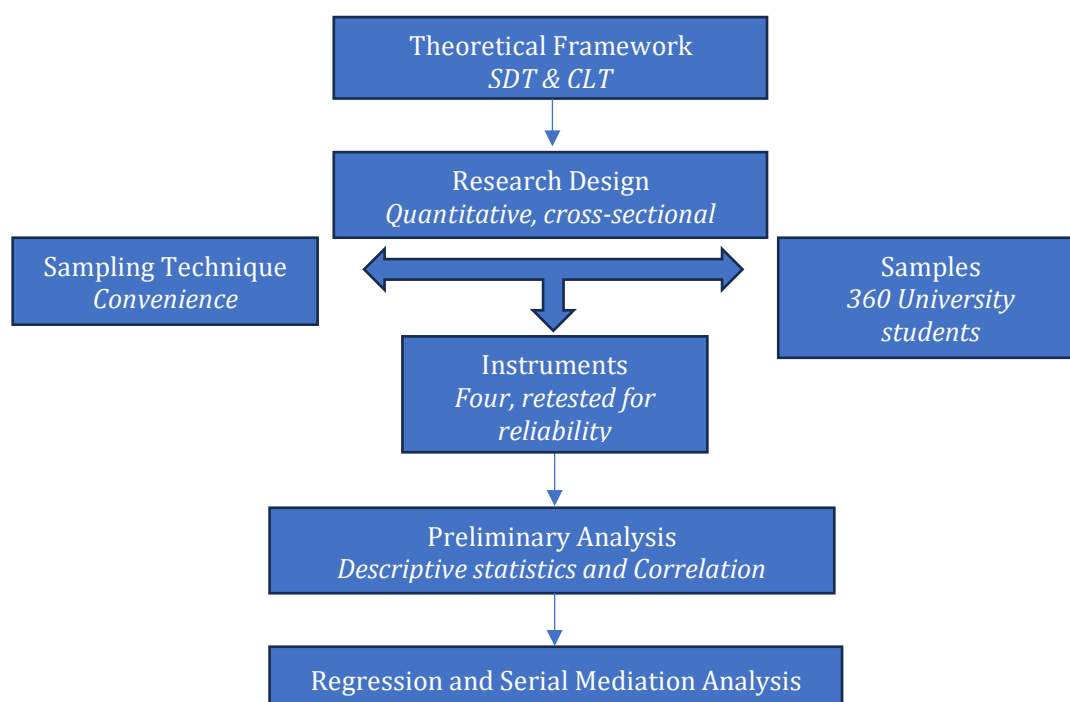


Figure 1. Research Flowchart

All relevant statistical assumptions were explicitly tested and found to be satisfactory. Analytical models are three: (1) Parallel mediation model such as (a) $TAS \rightarrow IM \rightarrow LE$, and (b) $TAS \rightarrow SRL \rightarrow LE$, while controlling for the direct effect of TAS on LE. (2) A serial mediation model where IM and SRL mediate the $TAS \rightarrow LE$ relationship in a sequential causal chain, i.e. $TAS \rightarrow IM \rightarrow SRL \rightarrow LE$. (3) A full conceptual model incorporating both parallel and serial pathways was tested to compare model fit and determine the relative contribution of each indirect effect. The visual representation is shown in Figure 2.

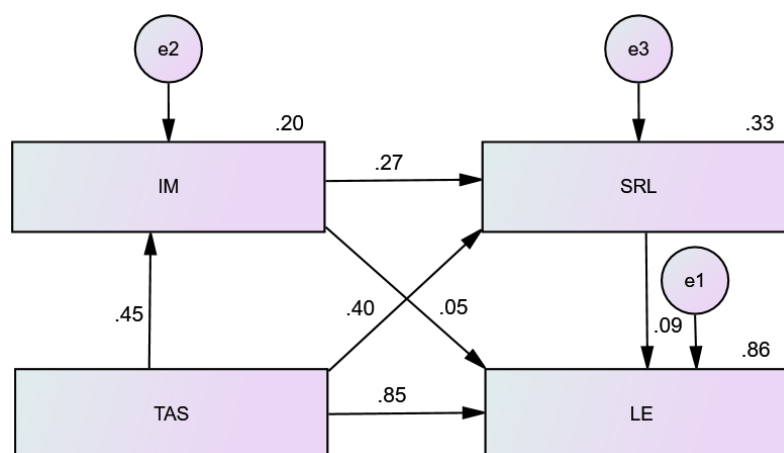


Figure 2. Diagram Showing Associations between TAS and LE for the Sample of 360 Students

RESULTS AND DISCUSSION

Results

This section displays the empirical findings obtained following the statistical analyses. It includes results of descriptive statistics, correlation, regression and serial mediation testing, along with a figure displaying the association.

The baseline characteristics of participants across the four variables

The distributional characteristic of the study variables according to gender across the four variables is summarized in Table 1.

Table 1. Preliminary Analysis of Demographic Characteristics ($M \pm SD$) by t-test ($N=360$)

Variables	Male (n=144)	Female (n=216)	t
TAS	12.06±4.18	11.91±4.38	0.310
LE	47.67±14.20	46.88±14.69	0.508
IM	41.13±11.37	42.21±12.91	0.816
SRL	89.06±27.64	81.53±27.16	2.559**

Note. Teacher Autonomy Support (TAS), Learning Engagement (LE), Intrinsic Motivation (IM), and Self-Regulated Learning (SRL)

Table 1 displays the demographic characteristics of male ($n = 144$) and female ($n = 216$) participants across the four variables: Independent- Teacher Autonomy Support (TAS), Dependent- Learning Engagement (LE), Mediating 1- Intrinsic Motivation (IM), and Mediating 2- Self-Regulated Learning (SRL). A significant gender difference was observed only in Self-Regulated Learning, with males ($M = 89.06$, $SD = 27.64$) scoring significantly higher than females ($M = 81.53$, $SD = 27.16$), $t(358) = 2.559$, $p < .01$. This implied that males tend to possess more SRL than females. However, with regards to TAS, both genders displayed a nearly identical score but remained statistically insignificant ($t = 0.310$, $p > .05$). Nonetheless, no significant gender differences were found in Learning Engagement ($t = 0.508$, $p > .05$) and Intrinsic Motivation ($t = 0.816$, $p > .05$). This suggests that although males demonstrated higher SRL, both genders showed similar levels of TAS, IM and LE.

Correlation Analysis

The strength of the relationships among the study variables was examined using correlation analysis and is displayed in Table 2. This provides preliminary evidence of existing associations.

Table 2. Intercorrelations ($N = 360$)

Variables	M±SD	TAS	LE	IM
TAS	11.97±4.30	-		
LE	47.19±14.48	0.927**	-	
IM	41.78±12.31	0.447**	0.505**	-
SRL	84.54±27.56	0.518**	0.562**	0.449**

Note. ** $p < 0.01$.

Table 2 presented above displays the intercorrelations among the variables based on the 360 samples. The numerous significant values yielded confirm the correlations identified in previous studies. The results suggest that all variables are positively and significantly correlated at the $p < 0.01$ level. To be specific, TAS showed a positive correlation with LE ($r = 0.927$), IM ($r = 0.447$), and SRL ($r = 0.518$). This simply translates to individuals reporting greater exposure to TAS tend to have higher levels of IM, SRL and LE. Further, LE was also positively correlated with IM ($r = 0.505$) and SRL ($r = 0.562$). This implies that the greater the levels of IM and SRL, the greater the levels of LE. Furthermore, SRL demonstrates a strong positive correlation with IM ($r = 0.449$), indicating that higher SRL is linked with higher IM, and vice versa. Overall, these findings suggest that all four variables, i.e., Teacher Autonomy Support, Learning Engagement, Intrinsic Motivation, and Self-Regulated Learning, are positively correlated with one another and tend to increase simultaneously. They also demonstrate that the antecedent TAS positively influences both the mediators and the dependent variable. Thus, *Hypothesis 1- Hypothesis 6 are all accepted*.

Testing for Mediation Effects

The effects of independent and mediating variables on the dependent variable were assessed via regression analysis, and Table 3 displays the extent to which the variation in the dependent variable is attributable to the predictor variables.

Table 3. Regression Analysis of Variable Relationships in the Mediation Model ($N=360$)

Model 1	B	Std. Error	R	R ²	F	β	t	Sig.
TAS	1.2810	.1354	.4472	.2000	89.4957	.4472	9.4602	.000
Dependent Variable: IM								
Model 2								
TAS	2.5427	.3111	.5724	.3276	86.9821	.3966	8.1732	.000
IM	.6086	.1086				.2719	5.6041	.000
Dependent Variable: SRL								
Model 3								
TAS	2.8376	.0770				.8423	36.8342	.000
IM	.1063	.0257	.9352	.8745	827.1289	.0904	4.1277	.000
SRL	.0448	.0120				.0854	3.7284	.000
Dependent Variable: LE								

Table 3 exhibits the results of the regression analysis. In Model 1, TAS significantly predicted IM ($\beta = .4472$, $t = 9.4602$, $p < .001$), explaining 20.00% of the variance in IM. This suggests that students who perceived greater levels of TAS were significantly more likely to develop greater IM, confirming the first pathway of the serial mediation chain.

Looking at Model 2, both TAS and IM remained significant predictors of SRL with $\beta = .3966$, $t = 8.1732$, $p < .001$ and $\beta = .2719$, $t = 5.6041$, $p < .001$, respectively. A noteworthy finding is that, upon introduction of IM as a predictor, the TAS's effect on SRL was reduced, which is suggestive of IM partially mediating the relationship between TAS and SRL, which again is consistent with SDT's internalization process.

In Model 3, LE was regressed on TAS, IM, and SRL. TAS showed a strong positive effect on LE ($\beta = .8423$, $t = 36.8342$, $p < .001$), IM also significantly predicted LE ($\beta = .0904$, $t = 4.1277$, $p < .001$), as did SRL ($\beta = .0854$, $t = 3.7284$, $p < .001$). This model showed a very high explanatory power, indicating that 87.45% of the variance in LE was explained by the combined effects of TAS, IM and SRL. This may be due to the theoretical closeness and overlapping nature of the four variables within the study's framework, as TAS is a direct antecedent of both mediators. Another noteworthy finding is that TAS retains the strongest effect on LE, though the model introduced both mediator variables, suggesting only partial mediation.

The analytical explanation of these findings is a multiple mediation framework in which IM and SRL act as mediating mechanisms in the relationship between TAS and LE. Specifically, TAS not only directly influences engagement but also exerts indirect effects through IM and SRL. Because the effect of TAS on LE is still considerably high even when the two mediators are added, put differently, TAS has both a direct impact on LE and an indirect impact through IM and SRL. Thus, *Hypothesis 7 was accepted*, i.e., IM and SRL mediate the relationship between TAS and LE.

Mediation Analysis

Table 4 presents the total, direct, and indirect effects of teacher autonomy support on learning engagement, including the parallel indirect pathways through intrinsic motivation and self-regulated learning and the serial pathway through intrinsic motivation and self-regulated learning.

Table 4. Total, Direct and Indirect Effects through Mediation Effect ($N=360$)

Path	Effect Size	Bootstrap SE	Bootstrap (95% CI)
Total	3.1227	.0668	[2.9914, 3.2541]
Direct	2.8376	.0770	[2.6861, 2.9891]
Total indirect effect	0.2851	.0583	[.1788, .4076]
Indirect effects1 (TAS→IM→LE)	0.1361	.0389	[.0645, .2194]
Indirect effects2 (TAS→SRL→LE)	0.1140	.0411	[.0437, .2049]
Indirect effects3 (TAS→IM→SRL→LE)	0.0350	.0128	[.0129, .0627]

It was conducted by utilizing the Bootstrap (model 6) technique to assess the total, direct, total indirect and indirect effects of TAS on LE. The results were all significant (95% CI did not include 0). The total effect of TAS on LE was statistically significant (effect = 3.1227, 95% CI [2.9914, 3.2541]), indicating that higher levels of perceived TAS were associated with higher levels of LE. The direct effect of TAS on LE also remained significant after including the mediators (effect size = 2.8376, 95% CI [2.6861, 2.9891]). This drop in the size from the total effect suggests the presence of mediators, while the continued significance of the direct path indicates partial mediation.

As for the indirect effect, the overall indirect effect of TAS on LE in the complete model was significant at .2851, with a 95% confidence interval. This confirmed that the association between TAS and LE is transmitted in part through the hypothesized mediating variables. In particular, (1) TAS → IM → LE had a significant indirect effect (effect = .1361, 95% CI [.0645, .2194]); (2). TAS → SRL → LE had a significant indirect effect (effect = .1140, 95% CI [.0437, .2049]); and (3). TAS → IM → SRL → LE had a significant indirect effect (effect = .0350, 95% CI [.0129, .0627]).

Overall, these findings support a partial multiple mediation model in which IM and SRL function as both independent and sequential mediators in the relationship between TAS and LE. The results suggest that the independent variable impacts the dependent variable not only directly but also indirectly by fostering students' intrinsic motivation and strengthening their self-regulated learning. However, since the study relies only on self-reported Likert-type scales across the four constructs, it is important to bear in mind before interpreting the results that no post-hoc statistical tests were conducted to examine common method variance.

Discussion

As evident, TAS has a strong effect on LE and a significant indirect effect, indicating that a portion of the effect worked through both the mediators, i.e., IM and SRL. This pattern is in correspondence with SDT, which predicts that TAS bolsters students' sense of desire and ownership;

in addition, by providing students with internal drives, teachers can impact students' LE (Reeve et al., 2004). In the context of higher education, autonomy support has been strongly associated with autonomous motivation and basic psychological need satisfaction, with a smaller yet significant link to engagement (Núñez & León, 2016; Okada, 2023). Evidence from a meta-analysis confirmed that autonomy supportive pedagogical style of teaching impacts learners' motivation, engagement and effort in learning (Bureau et al., 2022; Reeve & Cheon, 2021). This will help students develop adaptive motivational patterns, better LE, and immersion in learning activities (Hall & Webb, 2014). Also, results show that SRL mediated the effect of TAS on LE; that is, students' SRL levels increased with teacher-directed assistance, which in turn promoted LE. This is similar to the findings of earlier investigations (Núñez & León, 2015). This is also in accordance with SDT, as students who get autonomy support are more likely to see the importance and worth of their education and develop a greater drive to learn on their own.

Specific to the FCM context, TAS is directly associated with the intrinsic motivation of the learners and perceived academic outcomes, and when employed with opportunities for collaboration, their study effort increases (Cheah & Sale, 2019; Galindo-Domínguez & Bezanilla, 2025; Khosravani et al., 2020; Li & Zeng, 2025). In the same vein, the findings align with existing literature as teacher autonomy support boosts students' intrinsic motivation and can increase their learning engagement in FCM (Alonso et al., 2023; Butzler, 2014). Further, in the FCM context, we witness intrinsic value, motivation and self-regulation significantly increase compared to conventional classroom pedagogies.

Nevertheless, contradicting findings exist that warrant caution in interpreting and reaching concluding remarks. The effects of TAS on LE may be context-varying and dependent on supplementary instructional conditions (Yilmaz & Yilmaz, 2023). For instance, Hospel and Galand (2016) concluded that autonomy support is necessary but not sufficient to bring about student engagement, as other supplementary aids such as involvement and structure are needed to strike a good balance. Also, students' lack of readiness, which is rooted in their familiarity with conventional learning methods, can limit the effect of autonomy support strategies, as they may not be equipped to respond to the higher learner autonomy that the FCM demands (Garcia-Ponce & Mora-Pablo, 2020).

LIMITATIONS

The survey completely relied on a self-reported data collection method that can introduce common method variance and bias, social desirability bias and measurement overlap (such as extremely high correlation between TAS and LE). We recommend future research to address this by undertaking mixed method approaches where qualitative methods are also used to triangulate findings. Also, as the participants hailed only from India, the results cannot be generalized globally and are limited to the specific geography and culture. The study can be replicated in different continents and nations to figure out the generalizability of the proposed mediating mechanisms. Next, the cross-sectional design provides results only for the data collection period, and the study should be repeated over time to yield more generalizable results. Longitudinal research studies that examine the stability of the role of the two mediators are recommended. Finally, other mediator variables that may potentially influence learning engagement are not explored. Future studies may explore additional mediating or moderating variables and extend the participant base to include schoolteachers and teacher educators to further validate and expand the findings.

CONCLUSION

The results extend our understanding of SDT in FCM settings by empirically confirming that autonomy support provided by teachers positively impacts students' engagement in learning through sequential mediation of IM and SRL, the psychological and behavioral pathways that remain largely unexplored in prior FCM investigations. With regards to existing literature, by stressing the crucial role educators play, the current study adds to the expanding corpus of work on TAS and LE in higher education settings. The findings throw light on autonomy-supportive teaching as a significant driver of student engagement, even within technology-mediated pedagogies and student-centered formats. As for implementing the findings in teaching strategies, educators should bring about

conducive environments for effective pedagogy employment. When using FCM, they should append autonomy-supportive strategies such as offering choices, explaining rationales behind given tasks, and acknowledging student perspectives to nurture their motivation. Further, flipped learning designs should highlight intrinsically engaging assignments to promote students' self-regulated learning and engagement.

AUTHOR CONTRIBUTIONS

SC contributed to the conceptualization, study design, development of the theoretical framework, and preparation of the manuscript. SaD and SuD were responsible for the literature review, instrument selection, data analysis, and critical revision of the manuscript. SS, BN, AP, and JSP contributed to data collection and validation.

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