Basic Psychological Needs as a Mediator Between Autonomy Support and Motivation

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A B S T R A C T

Objective: This study aimed to investigate the mediating role of basic psychological needs in the relationship between autonomy support and motivation among Indonesian university students.

Methods and Materials: The research employed a descriptive correlational design involving 488 undergraduate students from various universities in Indonesia. Participants were selected based on the Krejcie and Morgan sample size table using stratified random sampling. Data were collected through three standardized self-report instruments: the Learning Climate Questionnaire (LCQ) for assessing autonomy support, the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) for measuring need satisfaction, and the Academic Motivation Scale (AMS) for evaluating motivation. Descriptive statistics, Pearson correlation, and structural equation modeling (SEM) were used to analyze the data. SPSS-27 was used for preliminary analyses, and AMOS-21 was applied to test the mediating model.

Findings: Descriptive statistics indicated high levels of autonomy support (M = 5.21), need satisfaction (M = 4.89), and motivation (M = 5.37) among participants. Pearson correlations showed significant positive relationships between all variables, with the strongest correlation observed between autonomy support and basic psychological needs (r = .64, p < .001). The SEM results confirmed good model fit (χ^2/df = 1.93, CFI = 0.97, RMSEA = 0.043) and demonstrated that autonomy support had both direct (β = .26, p = .002) and indirect effects (β = .36, p < .001) on motivation through the mediating role of basic psychological needs. The total effect of autonomy support on motivation was substantial (β = .62, p < .001).

Conclusion: These findings emphasize the importance of autonomy-supportive educational environments in fostering student motivation.

Keywords: Autonomy Support, Basic Psychological Needs, Motivation.

1. Introduction

Motivation has long been recognized as a fundamental driver of human behavior in educational contexts. Among the prominent theoretical frameworks for understanding motivation, Self-Determination Theory (SDT) has gained considerable empirical and conceptual support. SDT posits that individuals are most motivated when their basic psychological needs for autonomy, competence, and relatedness are satisfied, and that contextual factors such as autonomy support play a pivotal role in either fostering or hindering motivation (Bureau et al., 2021). Within this framework, autonomy support is defined as the interpersonal climate provided by significant others (e.g., teachers, parents, coaches) that nurtures an individual's volition, sense of choice, and psychological freedom (Zuroff & Koestner, 2023). Empirical studies have shown that when individuals perceive their environment as autonomy-supportive, they are more likely to internalize extrinsic goals and engage in activities with greater autonomous motivation (Frielink et al., 2018).

One of the central tenets of SDT is the role of autonomy support in satisfying basic psychological needs, which, in turn, enhances motivation. Numerous studies have validated this mediating mechanism. For example, research in educational settings has consistently demonstrated that autonomy-supportive teaching styles contribute to the satisfaction of students' needs for autonomy, competence, and relatedness, which subsequently enhances their intrinsic and identified motivation (Admiraal et al., 2022; Tilga et al., 2021). This motivational sequence has been replicated across various domains, including physical education, health behavior, and higher education, underscoring the generalizability of the model (Barkoukis et al., 2020; Miežienė et al., 2018; Yan et al., 2024).

Autonomy support can originate from multiple sources, including teachers, parents, and peers. Each source may vary in its effectiveness depending on the context and developmental stage of the individual. For example, parental autonomy support has been shown to influence adolescents' motivation and academic performance both directly and through the satisfaction of basic psychological needs (Feng et al., 2019; Гордеева et al., 2024). In contrast, teacher autonomy support is particularly influential in academic settings, where it fosters a sense of agency in learners and promotes deeper engagement with learning tasks (Johansen et al., 2023; Okada, 2021). The literature further suggests that autonomy support from multiple sources can have an additive or interactive effect on motivational outcomes (Sevil-Serrano et al., 2018). However, merely receiving autonomy support does not guarantee increased motivation; rather, the psychological mechanism through which this support operates—namely, the satisfaction of basic psychological needs—plays a critical mediating role.

The concept of basic psychological needs, encompassing autonomy, competence, and relatedness, is foundational to SDT and has been empirically validated across cultures and contexts. When these needs are met, individuals experience higher levels of well-being, persistence, and self-regulated learning (Jakobsen, 2022; Levine et al., 2021). Conversely, the frustration of these needs can lead to maladaptive outcomes, such as amotivation, disengagement, and even mental health difficulties (Johansen et al., 2023; Tilga et al., 2019). The dual process of need satisfaction and need frustration underscores the importance of creating environments that not only support but actively prevent the undermining of these essential needs (Altendorf et al., 2020). In the academic realm, the extent to which basic psychological needs are satisfied mediates the impact of contextual factors such as teaching style on students' motivation and performance (Levine & Milyavskaya, 2020).

The mediating role of basic psychological needs has been further substantiated through empirical models. Studies using structural equation modeling (SEM) have demonstrated that the relationship between autonomy-supportive environments and various forms of motivation is significantly mediated by need satisfaction (Bureau et al., 2021; Tilga et al., 2021). For instance, students who perceive their teachers as autonomy-supportive report higher satisfaction of their psychological needs, which in turn predicts greater intrinsic motivation and academic engagement (Erturan, 2022). Similarly, in the context of physical activity, autonomy support from coaches has been linked to increased motivation through the satisfaction of athletes' basic needs (Arık & Erturan, 2023; Jakobsen, 2022). These findings highlight the robustness of the motivational sequence across domains.

In addition to formal education, autonomy support and basic psychological needs have been explored in emerging adulthood, a developmental stage marked by increased independence and identity exploration. Research on personal goal pursuit and motivation in emerging adults indicates that perceived autonomy support from significant others enhances positive affect and goal attainment through the satisfaction of psychological needs (Levine et al., 2021; Levine & Milyavskaya, 2020). These studies suggest that the

interplay between autonomy support and basic needs extends beyond academic performance to broader domains of psychological functioning.

Despite the growing body of evidence supporting this mediating model, relatively few studies have explored these constructs together in the context of Southeast Asian populations, such as university students in Indonesia. Cultural factors may influence the perception and impact of autonomy support, as well as the prioritization of psychological needs. While SDT posits that the three basic psychological needs are universal, the way these needs are experienced and expressed can differ across cultural contexts (Yasué et al., 2019). For example, in collectivist societies, autonomy may be experienced through harmonious relationships and shared decision-making rather than individual independence (Patall & Zambrano, 2019). Consequently, it is essential to validate the SDT-based motivational model within diverse cultural frameworks.

Moreover, the distinction between autonomy-supportive and controlling behaviors remains critical. While autonomy support involves providing meaningful choices and acknowledging the individual's perspective, controlling behaviors such as pressure, conditional regard, and excessive monitoring can thwart psychological needs and lead to controlled forms of motivation or even amotivation (Johansen et al., 2023; Zuroff & Koestner, 2023). In this regard, it is important to assess not only the presence of autonomy support but also the broader motivational climate in which learners operate. Studies have shown that students who perceive higher levels of controlling behavior report greater need frustration and lower autonomous motivation (Altendorf et al., 2020; Frielink et al., 2018).

Another important aspect in recent research is the bidirectional and dynamic nature of autonomy support and motivation. For example, autonomy support may not only enhance motivation but also be elicited by motivated individuals who seek out or evoke supportive environments (Levine et al., 2021; Phipps et al., 2024). This reciprocal dynamic suggests that the relationship between autonomy support and motivation is not unidirectional, but instead evolves over time. Longitudinal studies have begun to unpack these interactions, revealing the complexity of motivational processes across developmental stages and social contexts (Yan et al., 2024). Given these considerations, the present study aims to examine the mediating role of basic psychological needs in the relationship between autonomy support and motivation among undergraduate students in Indonesia.

2. Methods and Materials

2.1. Study Design and Participants

The final sample consisted of 488 undergraduate students from various universities in Indonesia. Of the participants, 182 (37.3%) were male and 306 (62.7%) were female. In terms of academic level, 198 participants (40.6%) were in their first year, 127 (26.0%) in their second year, 97 (19.9%) in their third year, and 66 (13.5%) in their fourth year of study. Regarding field of study, 164 students (33.6%) were enrolled in social sciences, 141 (28.9%) in humanities, 115 (23.6%) in natural sciences, and 68 (13.9%) in engineering and technology. The participants' ages ranged from 18 to 25 years, with a mean age of 20.84 years (SD = 1.79). These distributions suggest a reasonably diverse sample in terms of gender, academic year, and field of study.

2.2. Measures

2.2.1. Motivation

Motivation was measured using the Academic Motivation Scale (AMS) developed by Vallerand et al. in 1992. This instrument is grounded in self-determination theory and assesses different types of motivation along the self-determination continuum, including intrinsic motivation, extrinsic motivation (identified, introjected, and external regulation), and amotivation. The scale consists of 28 items divided into seven subscales: three types of intrinsic motivation (to know, to accomplish, and to experience stimulation), three types of extrinsic motivation (identified, introjected, and external), and amotivation. Each item is rated on a 7-point Likert scale ranging from 1 (does not correspond at all) to 7 (corresponds exactly), with higher scores indicating greater endorsement of that specific type of motivation. The AMS has demonstrated strong psychometric properties, with confirmed construct validity and reliability across various populations and contexts, including academic settings. Internal consistency coefficients (Cronbach's alpha) for the subscales typically range from 0.62 to 0.86, indicating acceptable to high reliability (Jehanghir et al., 2024; Mashraki, 2025; Meyer & Stutts, 2024).

2.2.2. Autonomy Support

Autonomy support was assessed using the Learning Climate Questionnaire (LCQ) developed by Williams and Deci in 1996. The LCQ measures the degree to which

individuals perceive their learning environment or instructor as autonomy-supportive. The full version of the LCQ contains 15 items, and there is also a validated short form with 6 items for more concise assessment. In this study, the original 15-item version was used, with items rated on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). Higher scores reflect a greater perception of autonomy support from authority figures such as teachers or instructors. The LCQ is unidimensional, focusing solely on the construct of autonomy support. Numerous studies have confirmed the validity and reliability of the LCQ, with Cronbach's alpha values typically exceeding 0.90, indicating excellent internal consistency. It has been widely used in both educational and healthcare contexts to evaluate autonomy-supportive environments (Yan et al., 2024; Zhang & Wu, 2025; Гордеева et al., 2024).

2.2.3. Basic Psychological Needs

Basic psychological needs were measured using the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) developed by Chen et al. in 2015. This tool is designed to assess both the satisfaction and frustration of the three basic psychological needs proposed in self-determination theory: autonomy, competence, and relatedness. The BPNSFS includes 24 items divided into six subscales: autonomy satisfaction, autonomy frustration, competence satisfaction, competence frustration, relatedness satisfaction, and relatedness frustration. Each item is rated on a 5-point Likert scale from 1 (completely untrue) to 5 (completely true). Higher scores on satisfaction subscales indicate greater fulfillment of basic needs, whereas higher scores on frustration subscales indicate psychological need thwarting. The BPNSFS has demonstrated robust psychometric properties, with strong factorial validity across different cultures and settings, and Cronbach's alpha

coefficients for the subscales generally ranging from 0.70 to 0.85. The tool is considered a comprehensive and reliable measure of both need satisfaction and frustration (Burkitt, 2024; Mohamadinikoo & Tamannaeifar, 2024).

2.3. Data Analysis

Before conducting the main analyses, statistical assumptions were evaluated to ensure the appropriateness of Pearson correlation and structural equation modeling. Normality of the study variables was assessed using skewness and kurtosis statistics, all of which fell within the acceptable range of -2 to $+2$ (e.g., motivation: skewness $= -0.41$, kurtosis $= -0.77$; autonomy support: skewness $= -0.18$, kurtosis $= -0.69$; basic psychological needs: skewness $= -0.36$, kurtosis $= -0.92$), indicating no severe deviations from normality. Linearity and homoscedasticity were examined through scatterplots and found to be satisfactory. Additionally, multicollinearity was checked using variance inflation factor (VIF), and all values were below 2.5, confirming the absence of multicollinearity among the independent variables. These results supported the use of parametric tests and SEM in subsequent analyses.

3. Findings and Results

The sample consisted of 323 Canadian high school students. Of the total participants, 179 were female (55.4%) and 144 were male (44.6%). Regarding grade level, 98 students (30.3%) were in grade 10, 111 students (34.4%) were in grade 11, and 114 students (35.3%) were in grade 12. The age of participants ranged from 15 to 18 years, with 64 students (19.8%) aged 15, 102 students (31.6%) aged 16, 97 students (30.0%) aged 17, and 60 students (18.6%) aged 18. These frequencies and percentages reflect a balanced and diverse adolescent sample appropriate for the study's aims.

Table 1

Descriptive Statistics for Study Variables (N = 488)

Variable	M	SD
Autonomy Support	5.21	0.78
Basic Psychological Needs	4.89	0.69
Motivation	5.37	0.83

The mean score for autonomy support was 5.21 (SD = 0.78), suggesting that students perceived a relatively high level of autonomy support from their academic environment. Basic psychological needs had a mean of 4.89 (SD = 0.69), indicating moderately high satisfaction of autonomy,

competence, and relatedness. Motivation yielded the highest mean score among the variables, with M = 5.37 (SD = 0.83), reflecting high levels of self-determined motivation among the participants (Table 1).

Prior to conducting the linear regression analysis, the key assumptions were evaluated and confirmed. Normality of the data was assessed using the Kolmogorov–Smirnov test, which was not significant for school engagement (D = 0.037, p = 0.112), future orientation (D = 0.042, p = 0.075), and academic self-efficacy (D = 0.039, p = 0.098), indicating normal distribution of variables. Linearity was verified through scatterplot inspection, which showed a linear relationship between the independent and dependent variables. Multicollinearity was assessed by examining tolerance and variance inflation factor (VIF) values, with tolerance values greater than 0.70 and VIF values below 1.42 for both predictors, confirming no multicollinearity concerns. Homoscedasticity was evaluated through a residuals scatterplot, which displayed an even spread of residuals across predicted values, confirming the assumption of homoscedasticity was met.

Table 2

Pearson Correlations Between Study Variables (N = 488)

Variable	1	2	3
1. Autonomy Support	—		
2. Basic Psychological Needs	.64** (p < .001)	—	
3. Motivation	.51** (p < .001)	.59** (p < .001)	—

The correlation matrix revealed significant positive associations between all study variables. Autonomy support was strongly correlated with basic psychological needs (r = .64, p < .001) and moderately correlated with motivation (r = .51, p < .001). Basic psychological needs were also significantly associated with motivation (r = .59, p < .001), supporting the hypothesis that need satisfaction plays a mediating role in the relationship between autonomy support and motivation (Table 2).

Table 3

Fit Indices for the Structural Equation Model

Fit Index	Value	Acceptable Threshold
χ^2 (Chi-Square)	142.73	—
df (Degrees of Freedom)	74	—
χ^2/df	1.93	< 3.00
GFI (Goodness of Fit Index)	0.94	$\geq$ 0.90
AGFI (Adjusted GFI)	0.91	$\geq$ 0.90
CFI (Comparative Fit Index)	0.97	$\geq$ 0.95
RMSEA (Root Mean Square Error of Approximation)	0.043	$\leq$ 0.06
TLI (Tucker–Lewis Index)	0.96	$\geq$ 0.95

The structural model demonstrated good fit with the observed data. The Chi-Square statistic was 142.73 with 74 degrees of freedom, yielding a χ^2/df ratio of 1.93, which is within the acceptable range. Other fit indices were also within recommended thresholds, including GFI = 0.94, AGFI = 0.91, CFI = 0.97, RMSEA = 0.043, and TLI = 0.96, indicating that the model fits the data well and supports the hypothesized mediating structure (Table 3).

Table 4

*Total, Direct, and Indirect Path Coefficients in the Structural Model*

Path	B	S.E.	Beta	p
Autonomy Support → Basic Needs	0.63	0.05	.64	< .001
Basic Needs → Motivation	0.58	0.06	.56	< .001
Autonomy Support → Motivation (direct)	0.24	0.07	.26	.002
Autonomy Support → Motivation (indirect)	0.37	0.04	.36	< .001
Autonomy Support → Motivation (total)	0.61	0.06	.62	< .001

The path analysis confirmed the hypothesized relationships. Autonomy support had a significant direct effect on basic psychological needs (B = 0.63, p < .001), and basic psychological needs significantly predicted motivation (B = 0.58, p < .001). The direct effect of autonomy support on motivation was also significant (B = 0.24, p = .002).

Importantly, the indirect effect of autonomy support on motivation via basic psychological needs was significant (B = 0.37, p < .001), indicating a mediating role. The total effect of autonomy support on motivation was strong and significant (B = 0.61, p < .001), validating the integrated model (Table 4).

Figure 1

Final Model with Path Coefficients
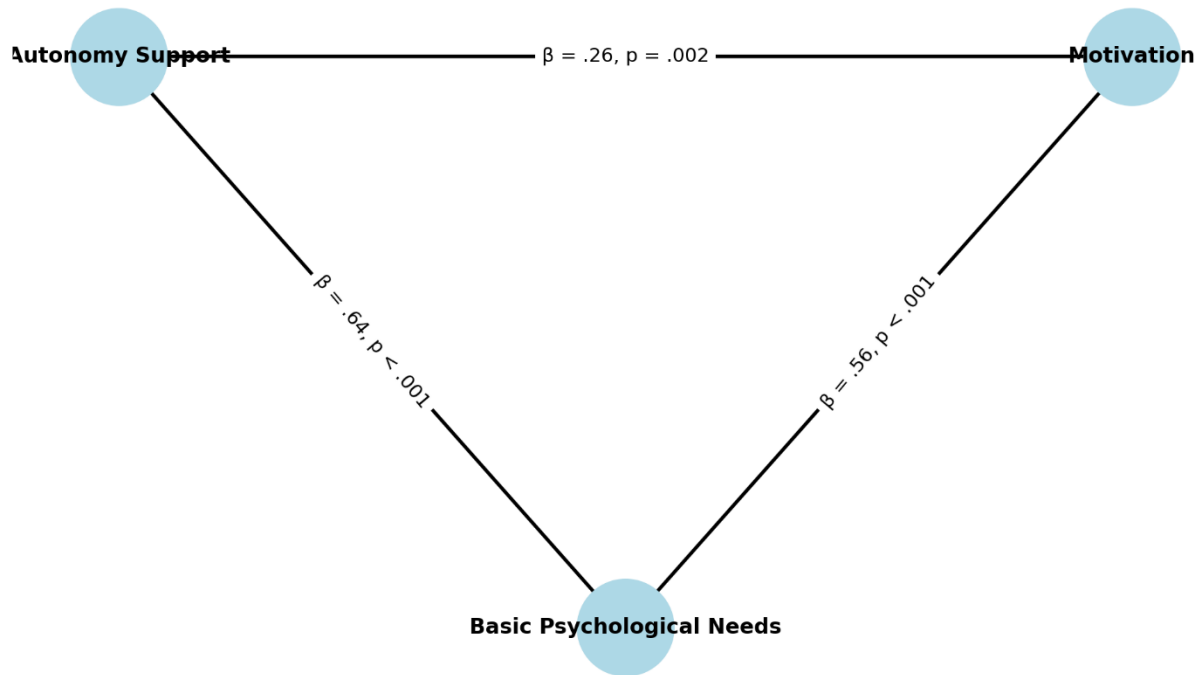
4. Discussion and Conclusion

The present study aimed to examine the mediating role of basic psychological needs in the relationship between autonomy support and motivation among Indonesian university students. Using Pearson correlation and structural equation modeling, the results revealed significant positive relationships between autonomy support, basic psychological need satisfaction, and motivation. Specifically, autonomy support was found to significantly predict both basic psychological need satisfaction and motivation. Moreover, the indirect effect of autonomy support on motivation through the mediation of basic psychological needs was significant, confirming the hypothesized model. These findings align with the tenets of Self-Determination Theory, which posits that autonomy-supportive environments enhance motivation by fostering the satisfaction of individuals' basic psychological needs (Zuroff & Koestner, 2023).

The positive correlation between autonomy support and motivation is consistent with prior research conducted in both academic and non-academic contexts. For example, in a study examining motivation among students in autonomy-supportive classroom environments, higher levels of perceived autonomy support were associated with more self-determined forms of motivation (Johansen et al., 2023). Similar results were obtained in the work of Admiraal et al. (Admiraal et al., 2022), where autonomy-supportive teaching practices were linked to greater learning motivation and academic achievement among secondary school students. The current study's findings further extend this pattern by confirming these associations in a Southeast Asian context, thus contributing to the cross-cultural validation of SDT's motivational sequence.

The mediation analysis underscored the critical role of basic psychological needs—autonomy, competence, and relatedness—in translating autonomy support into enhanced motivation. This is consistent with the theoretical

proposition that need satisfaction is the central mechanism through which social environments influence internal motivation (Bureau et al., 2021). Previous studies have consistently demonstrated that when students feel autonomous, competent, and related to others in their academic setting, they are more likely to engage in learning for intrinsic or identified reasons (Levine & Milyavskaya, 2020; Tilga et al., 2019). The current findings reinforce this pathway and support the robustness of the mediational model even in a non-Western context such as Indonesia.

In support of this finding, research by Jakobsen (Jakobsen, 2022) in a sports context also confirmed that autonomy support predicted greater psychological need satisfaction, which in turn was linked to higher levels of autonomous motivation among young athletes. Likewise, in a study by Arık and Erturan (Arık & Erturan, 2023), both teacher-reported and student-reported autonomy support were associated with greater satisfaction of needs and enhanced motivational outcomes in physical education. These studies collectively corroborate the mediating role of basic psychological needs, suggesting that this mechanism is stable across various domains and age groups.

Furthermore, the current study's results support findings from Patall and Zambrano (Patall & Zambrano, 2019), who emphasized that autonomy support can indirectly improve academic outcomes by fostering the internalization of educational goals through need satisfaction. The importance of this pathway is especially pertinent in contexts where learners are expected to be self-regulated and independent, such as in higher education. In such environments, students who perceive their instructors as autonomy-supportive are more likely to internalize their academic goals, experience intrinsic motivation, and demonstrate persistence (Levine et al., 2021).

The current findings also echo results from Altendorf et al. (Altendorf et al., 2020), who found that autonomy-supportive message framing in health interventions enhanced motivation by satisfying the psychological need for autonomy. While their study was conducted in the domain of smoking cessation, the underlying motivational processes are consistent with those observed in educational settings, highlighting the broad applicability of SDT's principles. Similarly, Feng et al. (Feng et al., 2019) demonstrated that both parental and teacher autonomy support predicted students' autonomous motivation for homework, mediated by the satisfaction of basic needs. The current findings are aligned with these results and suggest

that even in young adulthood, the same motivational mechanisms are operative.

Interestingly, the results of the current study are also in agreement with Sevil-Serrano et al. (Sevil-Serrano et al., 2018), who explored the role of multiple autonomy-supportive agents within school communities. Their findings indicated that when students received consistent autonomy support from various social sources, their motivation and physical activity levels improved through enhanced need satisfaction. These findings suggest that the source of autonomy support—whether it be parents, teachers, or peers—may matter less than the quality and consistency of support provided. This perspective is reinforced by Yan et al. (Yan et al., 2024), who compared different sources of autonomy support and found that the most effective influence on exercise adherence came from individuals perceived as consistently autonomy-supportive.

The current study also contributes to the growing recognition of the cultural sensitivity of motivational constructs. While SDT maintains that autonomy, competence, and relatedness are universal needs, the manner in which they are experienced and expressed can vary across cultures. For instance, in collectivist societies such as Indonesia, autonomy may be experienced in more relational or interdependent forms (Yasué et al., 2019). Despite these cultural differences, the basic need satisfaction model held strong predictive validity, affirming the universality of the motivational sequence proposed by SDT.

Another important implication of the current study is the confirmation of the positive role of autonomy support in emerging adulthood. In this life stage, individuals are often navigating complex developmental tasks such as identity formation and goal setting. Studies by Levine and colleagues (Levine et al., 2021; Levine & Milyavskaya, 2020) have shown that autonomy support during this period enhances goal pursuit, affect regulation, and motivational resilience. The present findings reinforce the idea that autonomy-supportive academic environments serve as a buffer against motivational decline in university students.

The stability of these findings is further supported by the meta-analytic review conducted by Bureau et al. (Bureau et al., 2021), which established autonomy support as a strong predictor of autonomous motivation across multiple studies and settings. The present study, by identifying basic psychological needs as the underlying mediator in the autonomy support–motivation link, provides a theoretically grounded explanation for this relationship and aligns with the broader literature.

Additionally, the findings support the work of Gordeeva et al. (Гордеева et al., 2024), who emphasized the dual role of parental control and autonomy support in shaping academic outcomes. Their study, like the current one, emphasized the importance of autonomy-supportive practices in fostering long-term academic engagement and psychological well-being. Also relevant is the work of Erturan (Erturan, 2022), who applied Vallerand's motivational sequence in the context of teacher motivation and found similar patterns of mediation through need satisfaction. Together, these studies reinforce the generalizability of the SDT framework and its core assumptions across contexts, roles, and developmental stages.

In sum, the findings of the current study offer empirical support for a well-established theoretical framework. Autonomy support positively predicted motivation, and this relationship was mediated by the satisfaction of basic psychological needs. These findings replicate and extend prior research, confirming the stability of SDT's motivational model across cultures, domains, and age groups. The results have important implications for educators, policy makers, and instructional designers seeking to foster motivation in higher education through autonomy-supportive practices and need-supportive environments.

5. Limitations & Suggestions

Despite the robustness of the findings, several limitations must be acknowledged. First, the study utilized a cross-sectional design, which precludes any causal inferences about the relationships among autonomy support, basic psychological needs, and motivation. Longitudinal studies would be better suited to assess the developmental trajectory and potential reciprocal influences of these variables. Second, all measures relied on self-report questionnaires, which may introduce social desirability bias or inaccuracies in reporting due to subjective perceptions. Third, while the sample was adequately powered and demographically diverse, it was limited to undergraduate students in Indonesia, and caution should be exercised in generalizing the results to other cultural or age groups. Finally, the study did not assess potential moderators such as gender, academic discipline, or socioeconomic status, which could influence the strength or direction of the observed relationships.

Future studies should consider employing longitudinal or experimental designs to examine the causal pathways between autonomy support, need satisfaction, and motivation over time. Additionally, incorporating qualitative methods such as interviews or focus groups could provide a richer understanding of how autonomy support is experienced and interpreted in various educational contexts. Comparative studies across cultures would also be valuable in determining how cultural values shape the perception and impact of autonomy support. Furthermore, future research could explore potential moderators and mediators beyond basic psychological needs, such as self-efficacy, academic stress, or teacher–student rapport, to develop a more nuanced understanding of motivational dynamics. Examining the effects of training interventions that promote autonomy-supportive teaching strategies would also be an important applied direction.

Educators should strive to create autonomy-supportive classrooms by offering meaningful choices, acknowledging student perspectives, and minimizing controlling language or behaviors. Teacher training programs should incorporate modules on motivational psychology and basic psychological needs to better equip instructors with practical tools for enhancing student engagement. Institutions should consider revising policies and curricula to emphasize student agency, collaborative learning, and need-supportive assessment practices. Creating a culture of respect, empathy, and openness within academic settings can significantly enhance students' motivation, well-being, and academic success.

Acknowledgments

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contributed in this article.

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