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Playful study design and flow: the role of psychological needs and teachers' autonomy support in a weekly diary study

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Abstract

Playful Study Design (PSD) is a proactive, cognitive-behavioral strategy through which students redesign academic tasks to make them more enjoyable and challenging. Although PSD is theoretically linked to improved engagement and learning outcomes, its underlying mechanisms and contextual predictors remain underexplored. To fill this gap, this study integrates Self-Determination Theory and Study Demands-Resources Theory, investigating basic need satisfaction (autonomy, relatedness, competence) as a mediating mechanism and perceived autonomy support as a predictor for PSD and the flow experience. The study involved first-year undergraduate students who responded to one general and six weekly surveys, yielding weekly observations. Multilevel Structural Equation Modeling (MSEM) was used to analyze within-person relationships among PSD, need satisfaction, and flow, as well as cross-level effects of perceived teacher autonomy support. Weekly PSD was directly and positively related to the experience of flow. This relationship was mediated by the satisfaction of the needs for autonomy and competence, but not by the need for relatedness. Furthermore, teacher autonomy support predicted both PSD and study-related flow. Also, PSD mediated the relation between teacher autonomy support and flow. In conclusion, PSD is a proactive behavioral strategy that connects to enhanced flow by satisfying basic psychological needs. Teachers play a crucial role in fostering these effects through autonomy-supportive behaviors, helping students transform their study experiences into more engaging and immersive activities.

Keywords Flow · Need satisfaction · Playful study design · Self-determination theory · Study demands–resources theory

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1 Introduction

Being a student in the digital era offers clear advantages, such as immediate access to information and flexible learning opportunities, but also poses significant challenges. Among these, constant exposure to distractions such as social media and online entertainment can undermine concentration and academic performance (Flanigan et al., 2023; Romero et al., 2025). In this context, identifying strategies that enhance deep focus and make learning more engaging is increasingly important. Flow represents a mental state of deep absorption and focused engagement in an activity (Csikszentmihalyi, 2020). In educational settings, study-related flow refers to a short-term peak experience characterized by absorption, enjoyment, and intrinsic motivation during learning activities (Bakker et al., 2017). Understanding the antecedents and conditions that foster flow is essential, given its positive effects on learning, skill development, and academic performance (Asakawa, 2004; Mehta & Vyas, 2022). According to the self-determination model of flow (Bakker & Van Woerkom, 2017), individuals can proactively bring about their own flow by using self-determination strategies (i.e., self-leadership, job crafting, playful work design, and strengths use) to satisfy their basic needs for autonomy, competence, and relatedness, which then facilitates flow. This model is a domain-specific extension of Self-Determination theory (SDT; Deci & Ryan, 2000) that applies its principles to explain the emergence of flow experiences.

Previous research has identified both contextual factors (e.g., characteristics of the learning environment) and individual differences (e.g., personal resources) as predictors of flow (Asakawa, 2004; Demerouti et al., 2012; Mesurado et al., 2016). However, less attention has been paid to students' proactive behaviors, through which they actively shape their learning experiences (Bakker & Van Woerkom, 2017). According to the Study Demands–Resources (SD-R) theory (Bakker & Mostert, 2024), students may engage in self-initiated strategies to optimize motivation and well-being. Such strategies are often more aligned with personal preferences and may therefore be particularly effective (Siu et al., 2014). In this vein, playful study design (PSD) has recently emerged as a promising approach in educational contexts (Wang et al., 2023). PSD refers to a cognitive-behavioral strategy through which students intentionally redesign their study tasks to make them more enjoyable or challenging. For example, students may use humor or creative associations to memorize material (designing for fun) or set personal challenges to improve performance (designing for competition).

SDT (Deci & Ryan, 2000) posits that the satisfaction of basic psychological needs (autonomy, competence, and relatedness) facilitates optimal functioning. Accordingly, we argue that during weeks when students engage more in PSD, they are more likely to experience study-related flow. PSD may enhance flow by supporting need satisfaction, as playful elements such as challenge and creativity can foster competence and autonomy, while, in some contexts, also supporting relatedness. Prior research in organizational settings has shown that playful work design promotes need satisfaction and flow (Bakker et al., 2023; Scharp et al., 2022), but this relationship remains underexplored in educational settings.

In addition, we examine teacher autonomy support as a contextual factor that may facilitate both PSD and flow. Teacher autonomy support refers to a motivating style

through which teachers nurture students' inner motivational resources by offering meaningful choices, acknowledging students' perspectives and feelings, providing explanatory rationales for learning activities, and relying on informational rather than controlling language (Reeve, 2006). These autonomy-supportive practices are identifiable instructional behaviors that can be strengthened through training and have been consistently associated with greater need satisfaction and engagement among students (Howard et al., 2025; Mammadov & Schroeder, 2023; Su & Reeve, 2011). Emerging evidence from work settings suggests that supportive environments can strengthen the relationship between playful design and flow (Stefan et al., 2025), highlighting the importance of considering both individual and contextual factors. From an SD-R perspective (Bakker & Mostert, 2024), teacher autonomy support may function as a contextual study resource that provides students with the perceived choice, volition, and flexibility needed to proactively shape their learning activities. By allowing students greater latitude in how they approach and organize their study tasks, autonomy-supportive teaching may create favorable conditions for PSD, as students have greater freedom to introduce personally meaningful elements of fun or self-imposed challenge into their learning. Thus, teacher autonomy support may provide the behavioral latitude that enable students to initiate and enact PSD. Some of the pressing unanswered questions regarding playful design in the educational context are as follows: (1) To what extent does weekly playful study design predict study-related flow, and is this relationship mediated by the satisfaction of the basic psychological needs for autonomy, competence, and relatedness? (2) Does perceived teacher autonomy support predict students' weekly flow experiences, mediated by their engagement in playful study design?

This study answers these research questions and contributes to the literature in three ways. First, it extends research on playful design to the educational domain by providing empirical evidence that PSD is associated with study-related flow. Second, it identifies psychological need satisfaction as a mediating mechanism, explaining how proactive study strategies translate into greater immersion and absorption. Third, it adopts a multilevel perspective by examining teacher autonomy support as a contextual resource that predicts both PSD and flow. In doing so, the study responds to recent calls to integrate individual and environmental factors in flow research (Yan & Donaldson, 2023) and highlights the role of teacher autonomy support in shaping students' proactive engagement and optimal learning experiences.

2 Theoretical background

2.1 The relation between playful study design and study-related flow

Bakker and Van Woerkom (2017) argued that individuals can use proactive behavioral strategies (such as self-leadership, playful design, crafting, and strengths use) to stimulate the flow experience (a positive short-term state characterized by absorption, intrinsic motivation, and enjoyment; Bakker et al., 2017). Playful study design is "a self-determined and proactive behavioral strategy that creates more fun and challenge into the existing study tasks" (Wang et al., 2023, p.160). Following Scharp

et al. (2019), the PSD strategy consists of two distinct dimensions: one dimension is ludic play, which refers to the use of humor and entertainment and relates to people's pleasure and enjoyment (Barnett, 2007). The other dimension is agonistic play, characterized by goals and challenges that help a person grow (Caillois, 2001). Previous research related to PSD is scarce; only one study investigated the weekly relationship between PSD and study engagement, demonstrating how students can use PSD to improve their engagement and attain their study goals (Wang et al., 2023), also, another research showed that PSD predicts students' social integration, study engagement, and well-being, validating the measure (Costantini et al., 2025).

According to the self-determination model of flow (Bakker & Van Woerkom, 2017), PSD helps students improve their study experience without altering their tasks. Students can boost their motivation and interest by infusing study activities with fun or introducing challenges when tasks feel monotonous. For example, setting a personal goal to beat one's previous record for completing a reading assignment reflects the design of competition. Similarly, injecting humor into a group project or turning a study session into a themed challenge (e.g., "quiz show"- style) illustrates the design of fun. These playful strategies can help transform routine study tasks into more stimulating and rewarding experiences (Costantini et al., 2025). Some weeks may feel less motivating, especially when students must attend a course they do not enjoy, unlike other weeks (Bakker et al., 2015). In this situation, we argue that PSD may be a good strategy to improve enjoyment, motivation, and involvement in learning tasks to experience study-related flow. When students use PSD during learning episodes, they approach their study in a way that brings out the best in them. Consequently, they can better balance their skills with the challenges of studying and are more likely to achieve a state of flow.

Hypothesis 1 *Weekly playful study design is positively related to study-related flow.*

2.2 The relation between playful study design and basic psychological needs

Students' psychological needs for autonomy, competence, and relatedness are often shaped by their social environments – through support from academic staff, peers, and family members (e.g., Girelli et al., 2018; Okray, 2016; Shin & Johnson, 2021). Importantly, in the present study, PSD is treated as a naturally occurring, self-reported approach to studying rather than an experimentally induced strategy. Accordingly, we examine whether weekly variations in PSD are associated with flow experiences, potentially through psychological need satisfaction. Building on this idea, the present study explores PSD as a complementary strategy for promoting need satisfaction. Rather than relying solely on external support, we examine whether students can spark study-related flow by intentionally infusing fun and challenge into their daily academic routines. The self-determination model of flow (Bakker & Van Woerkom, 2017) suggests that proactive work behavior satisfies basic psychological needs and fosters flow. Until now, only a few studies have investigated the relationship between playful design, as proactive behavior, and psychological needs in a work context, and previous research found that designing tasks to be more competitive and more fun for others involved satisfies the needs for relatedness, autonomy, and competence at

a daily level (Bakker et al., 2023; Scharp et al., 2022). Like other proactive strategies (i.e., job crafting), we argue that PSD may make learning activities more challenging and create internal rewards (i.e., mastery, fun) that satisfy psychological needs for university students (Bakker et al., 2020).

From an SDT perspective (Deci & Ryan, 2000), the need for relatedness can be supported not only by the social environment but also by students' proactive engagement with their study activities. PSD may represent one such pathway, as students can incorporate social or interactional elements into their learning, thereby fostering feelings of connection. Previous empirical evidence from work contexts suggests that designing for fun is particularly associated with the satisfaction of the need for relatedness, whereas designing for competition is more strongly associated with the satisfaction of the need for competence (Scharp et al., 2022). Thus, we propose that playful study design may support relatedness only insofar as it involves social or interactional components (e.g., collaborative or shared learning activities), making this link context-dependent rather than universal, and making it more likely that students will enjoy their studies and satisfy their need for relatedness (Robert, 2017). In addition, by competing with themselves, given the learning tasks to be completed, individuals set goals, making the work activity more meaningful. In this way, university students make their own studies more engaging, prevent boredom, and satisfy their need for competence (Bakker et al., 2023). To satisfy the need for autonomy, it is not enough for people to have the freedom to decide what to do, how to do it, and when to do it; they must put their autonomy into practice by taking personal initiative. By making learning activities more playful by approaching learning tasks as a game in which they try to reach self-set targets, students may experience more volition and satisfy their need for autonomy (Bakker & Van Woerkom, 2017). Thus, through PSD, students generate appropriate resources that, in SDT terms, function like "nutrients" to satisfy their basic psychological needs. Therefore, we propose:

Hypothesis 2 *Weekly playful study design is positively related to the satisfaction of the basic psychological needs for (a) autonomy, (b) relatedness, and (c) competence.*

2.3 Basic psychological needs and study-related flow

According to Self-Determination Theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2020), the satisfaction of basic psychological needs supports optimal motivation and functioning. In educational contexts, need satisfaction has been consistently associated with engagement, persistence, and well-being (Reeve, 2006), providing a theoretical basis for examining its association with study-related flow. Although direct evidence among students remains limited (Lüking et al., 2023; Shernoff et al., 2014; Shim et al., 2022), existing research suggests that psychological need satisfaction may represent a relevant motivational correlate of flow in learning contexts.

However, the three psychological needs may differ in their conceptual proximity to flow. Satisfaction of the need for competence, which reflects feeling effective and capable of mastering challenging activities (Deci & Ryan, 2000; Ryan & Deci, 2020), is conceptually aligned with the challenge–skill balance central to flow (Fullagar et al., 2018). Similarly, satisfaction of the need for autonomy reflects a sense of

volition and ownership over one's actions, which may support intrinsic engagement and sustained involvement in study activities. In contrast, satisfaction of the need for relatedness primarily concerns feeling connected to, cared for, and significant to others (Ryan & Deci, 2020), making its association with an intrapersonal experiential state such as flow less theoretically direct. Accordingly, we adopt a more exploratory perspective regarding need for relatedness, recognizing that its association with flow may depend on the social context in which studying occurs. Overall, we propose that psychological need satisfaction is associated with study-related flow, while acknowledging that the strength and nature of this association may differ across the three needs.

Hypothesis 3 *Weekly satisfaction of the need for (a) autonomy, (b) relatedness, and (c) competence is positively related to study-related flow.*

2.4 From playful study design to flow through basic psychological needs

Based on SDT and previous research, we will investigate the role of each psychological need as a mediator between PSD and flow in study activities. Students engaging in competition or enjoyable activities during their studies, such as designing fun or competitive activities, can foster their *autonomy* by setting personal goals, taking charge of their direction, and maintaining focus. When students design their study tasks to be more competitive, they aim to make them more challenging by incorporating play, reframing work activities as puzzles, or setting personal goals during tasks (Scharp et al., 2019). Recent weekly research indicated that students who employed the PSD strategy improved their study engagement and were more likely to achieve their study goals by actively creating opportunities to feel competent (Wang et al., 202). Therefore, proactive behaviors, such as PSD, fulfill the *need for competence*. Students, like employees, can also foster experiences of connection by creating enjoyable or competitive situations. This behavior encourages light-hearted interactions with others and ensures that activities remain fun for everyone involved, including colleagues (Scharp et al., 2019). Thus, the *need for relatedness* can be satisfied through proactive study-related strategies, such as PSD.

From an SDT perspective, the satisfaction of these basic psychological needs contributes to optimal motivation and functioning (Ryan & Deci, 2020), which may, in turn, be associated with optimal experiential states such as flow. Thus, rather than assuming a direct link between relatedness and flow, we propose that PSD may support flow by fostering psychological need satisfaction and, consequently, optimal functioning. Encouraging students to design study strategies that incorporate fun and competition may foster greater autonomy in setting their own learning rhythm and methods, thereby increasing the likelihood of experiencing study-related flow. In the context of PSD, incorporating competition involves students setting personal challenges rather than competing with others. This self-directed form of competition satisfies their need for challenge and mastery, thereby facilitating the experience of study-related flow (Costantini et al., 2025). On the other hand, designing learning tasks to be more fun involves PSD's more socially oriented dimension, and students satisfy the need for relatedness, which leads to study-related flow. Based on the SDT

of flow (Bakker & Van Woerkom, 2017), the present study tests that needs satisfaction is an important personal resource that can transform positive behaviours into favourable study outcomes.

Hypothesis 4 *The relationship between weekly playful study design and flow is mediated by the weekly satisfaction of the needs for (a) autonomy, (b) relatedness, and (c) competence.*

2.5 Teacher autonomy support as contextual support for playful study design and study-related flow

In our research, we aim to address the existing gap in the literature concerning the relationship between teacher autonomy support and study-related flow. Since university students often experience flow due to situational factors rather than personal traits, it is thought that teachers influence these flow experiences (Ljubin-Golub et al., 2020). Following Williams and Deci (1996), teacher autonomy support refers to students' perceptions of how their teacher makes them feel confident in their abilities, and understood, listened to, and accepted. In an educational context, teacher autonomy support could be relevant to study-related flow because "even optimal challenges will not engender intrinsic motivation or flow unless people experience themselves as autonomous in carrying them out" (Deci & Ryan, 2000; p. 261). Ljubin-Golub and colleagues (2020) found that teachers' autonomy support was associated with increased flow experience during learning, aligning with previous research highlighting the role of situational factors in academic flow (Bakker et al., 2011; Rijavec et al., 2017). Based on the SD-R theory (Bakker & Mostert, 2024), which offers a framework for understanding student well-being generated by study resources and demands, we argue that students are part of the educational system and are influenced by their teachers. Drawing on organizational research on supportive leadership and its empowering effects on employees, teacher autonomy support may similarly foster student well-being and performance (Bakker, 2022). Teacher autonomy support may be associated with study-related flow by fostering autonomous and intrinsically motivated engagement with study activities (Deci & Ryan, 2000). This multi-level effect of teacher autonomy support is expected to be relevant for the student flow experience. Thus, if students perceive that their teacher promotes their sense of volition and provides autonomy-supportive structures, they will be more absorbed in their learning activities, have more intrinsic motivation and enjoyment, and feel confident and accepted in the study context (Simon & Salanga, 2021).

Hypothesis 5 *Teacher autonomy support is positively related to weekly study-related flow.*

According to SDT (Deci & Ryan, 2000; Ryan & Deci, 2020), autonomy-supportive environments create a fertile ground for students to engage in self-initiated, intrinsically motivated behaviors, such as PSD. For a creative approach to learning that relies on humor and playful challenge to yield benefits, students must feel free to customize and personalize their learning experience without the teacher imposing limitations

on their autonomy (Reeve, 2006). For instance, a student trying to make study tasks more fun may flourish in an environment where the teacher encourages creativity and independence, but may feel stifled or disengaged if their teacher enforces rigid structures or discourages non-traditional approaches. Autonomy-supportive environments signal that it is *safe* and *valued* to personalize one's learning experience (Jeno et al., 2018; Patall et al., 2018). For example, when a student experiences autonomy support from teachers (e.g., acknowledging the student's initiative and allowing flexibility in how tasks are approached), the PSD may be strengthened, and the student transforms revision into a self-generated quiz game. Thus, teacher autonomy support functions as a key contextual amplifier of the motivational benefits of PSD.

Additionally, teachers' autonomy support is an important contextual resource to help students deal with complex and uncertain situations more effectively (Ryan & Deci, 2020). Likewise, we believe that university students who receive greater teacher autonomy support can design their weekly study tasks more competitively or enjoyably.

Hypothesis 6 *Teacher autonomy support is positively related to weekly playful study design.*

Teachers can also provide a validating context that enhances the likelihood that students' playful strategies translate into flow. Also, in autonomy-supportive environments (where teachers acknowledge students' improvement and mastery, encourage effort, listen to new ideas, and respond to comments and questions), university students who make their weekly learning tasks more fun or competitive will experience enhanced flow (Liu et al., 2023). Such an environment may provide the behavioral latitude students need to proactively shape their study tasks according to their preferences and interests, thereby facilitating PSD. For instance, when students have greater flexibility in how they organize and approach their learning, they may be more inclined to introduce elements of fun, creativity, or self-imposed challenge into otherwise routine study activities. Thus, autonomy-supportive teachers provide choice, acknowledge students' perspectives, minimize controlling pressure, and encourage initiative, thereby making playful modifications feel legitimate rather than distracting, risky, or noncompliant (Deci & Ryan, 2000; Ryan & Deci, 2020). In such contexts, playful study design is more likely to lead to deep concentration and intrinsic enjoyment because students can align study tasks with their interests, preferred strategies, and optimal level of challenge.

Hypothesis 7 *Playful study design mediates the relationship between autonomy support from teachers and study-related flow.*

3 Method

3.1 Participants and procedure

This study was conducted in accordance with the American Psychological Association's ethical guidelines, and all procedures complied with the ethical standards of the 1964 Helsinki Declaration and its subsequent amendments. Our study posed minimal risk to participants (Whicher & Wu, 2015), ensuring no influence or deception during the process. We did not target vulnerable individuals, such as children or those with diminished autonomy. Participants were recruited among a cohort of first-year psychology students at a large public university in Romania. The students signed up voluntarily for a weekly diary study, provided informed consent, and were aware of their right to withdraw at any time without repercussions to their progress within the discipline. To incentivize participation and prevent dropout, students who completed all measurements were offered bonus points on one of the evaluations in their introductory research methods course. To prevent pressure to participate, alternative means of obtaining equivalent credit were provided.

Measures of teacher autonomy support and demographic information were collected in an initial general questionnaire. This was followed by six weekly surveys measuring playful study design, psychological need satisfaction, and study flow. The weekly questionnaires were administered every Friday during the second part of the day, allowing students to reflect on and report their study experiences over the respective week. Participant retention across the study was satisfactory. Of the 151 students who initially signed up and completed the general questionnaire, 135 responded in week 1 (10.6% dropout), 130 in week 2 (13.9% dropout), 126 in week 3 (16.6% dropout), and 112 in weeks 5 and 6 (25.8% dropout). For the final sample, we retained 105 participants ($N_{L2} = 105$) who completed the general questionnaire and at least three of the weekly surveys. This yielded a final sample of five-hundred and sixty-nine weekly responses ($N_{L1} = 569$). Attrition across the study appeared gradual rather than systematic. Consistent with this observation, Little's Missing Completely at Random (MCAR) test (Little, 1988) was non-significant, $\chi^2(430) = 435.60$, $p = .415$, indicating that missingness was consistent with the MCAR assumption. Consequently, missing data were handled using Maximum Likelihood estimation with robust standard errors (MLR). A large majority of students were female (86.7%) with a mean age of 20.5 years ($SD = 5.04$).

3.2 Measures

Teacher autonomy support was measured using six items from the Learning Climate Questionnaire (LCQ; Williams & Deci, 1996), following the short version used by Simon and Salanga (2021). An example item is, "My teacher listens to how I would like to do things". Participants could respond to each statement using a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The scale had good internal consistency ($\alpha = 0.86$).

Weekly playful study design was measured using 12 items developed by Costantini et al. (2025) for the university context. The items capturing the two dimensions

of PSD were adapted to the weekly design of the study: designing fun (e.g., "This week, I looked for ways to make my study tasks more fun for everyone involved"); designing competition ("This week, I tried to make my study a series of exciting challenges"). The students responded to the statements on a 7-point scale ranging from 1 (*totally disagree)* to 7 (*totally agree)*. To ensure that the weekly version retains the originally proposed factor structure, we conducted Multilevel Confirmatory Factor Analyses (MCFA). The MCFA showed that the weekly measure had the originally proposed factor structure with very good fit to the data ($\chi^2[51] = 209.46$, $p < .001$; *CFI* = 0.93; *TLI* = 0.90; *RMSEA* = 0.07, $SRMR_{Within} = 0.05$). Cronbach's α values across the six weeks ranged from 0.87 to 0.91.

Weekly psychological need satisfaction was assessed with one item for autonomy ("This week, I felt free to do my studies the way I think it could best be done"), relatedness ("This week, I felt part of a group"), and competence ("This week, I felt competent in tasks related to my studies"). The items were adapted from the Work-related Basic Need Satisfaction Scale of Van den Broeck and colleagues (2010) and reformulated to refer to weekly study experiences. Responses were given on a 7-point scale (1 = *totally disagree*, 7 = *totally agree)*. The choice of single-item measures was motivated by the repeated-measures nature of the weekly diary design and the need to minimize participant burden. More broadly, previous research has supported the use of single-item measures when constructs are sufficiently well-defined and repeated assessments require brief measurement instruments (Fisher et al., 2016; Nagy, 2002; Spörrle et al., 2014; Allen et al., 2022). Recent research has also demonstrated the feasibility of assessing basic psychological need satisfaction using carefully selected single items (Martela & Ryan, 2024). Accordingly, the use of these single-item measures should be considered a pragmatic measurement choice aimed at reducing participant burden across repeated weekly assessments.

Weekly study flow was measured with the thirteen-item Study-Related Flow Inventory (WOLF-S) scale (Bakker et al., 2017) adapted for weekly measurement. The items captured three dimensions of flow: absorption (e.g., "This week, when I learned, I forgot everything else around me"), enjoyment (e.g., "This week, my studying gave me a good feeling"), and intrinsic motivation (e.g., "This week, I studied because I enjoyed it"). Responses were given on a 7-point scale ranging from 1 (*never*) to 7 (*always*). We also implemented MCFA in the case of this measurement to test whether the weekly adaptation retains the original factor structure of the concept. The results show a good fit to the data ($\chi 2[59] = 281.29$, $p < .001$; *CFI* = 0.94; *TLI* = 0.93; *RMSEA* = 0.08; $SRMR_{Within} = 0.05$), indicating that the weekly measure retains the original structure of the concept. The scale also demonstrated excellent reliability across the weekly measures (α = 0.92–0.94).

3.3 Statistical approach

We tested the proposed model using Multilevel Structural Equation Modeling (MSEM; Preacher et al., 2011) with Maximum Likelihood Estimation and Robust Standard Errors in *MPlus* version 8 (Muthén & Muthén, 1998–2017). This approach allows us to investigate within-person (L1) processes (i.e., weekly intra-personal variation in playful study design is related to weekly intra-personal variation in need

satisfaction and study flow) in the context of between-person (L2) differences (i.e., students' perceptions of their teachers' autonomy support). We used latent centering available in Mplus to separate the within-person and between-person variance in the weekly measures (Preacher et al., 2011). Given the limited number of L2 observations, we used latent centering for variance decomposition but relied on manifest indicators rather than a fully latent (doubly latent; Preacher et al., 2011) measurement specification for all constructs.

We compared three successive models. The first model specified each weekly measure at both levels to separate the within-person and between-person variability and establish baseline variance in the outcome. The second model introduced all hypothesized direct and indirect effects at the within-person level, while still specifying the between-person variance for each variable. The third model expanded to include teacher autonomy support at L2 and its hypothesized relationships with PSD and flow at the student level, as well as the indirect path from autonomy support to flow through PSD. After each step, we calculated pseudo-R^2 values to gauge incremental variance explained by adding parameters to the model (Snijders & Bosker, 1999). To test the improvement in model fit, we used Bayesian Information Criteria (BIC) and calculated the Satorra-Bentler scaled chi-square difference based on the log-likelihoods (Satorra & Bentler, 2010). For the indirect effects, 95% Wald symmetric confidence intervals were calculated, which is the appropriate method in Mplus for multilevel models (Muthén & Muthén, 1998–2017).

3.4 Robustness checks

Given the theoretical and statistical complexity of the model, we have implemented a series of robustness checks. First, to account for the inflated risk of Type I error arising from multiple simultaneous tests, the Benjamini-Hochberg (BH) false discovery rate (FDR) procedure was applied to all structural path coefficients. This procedure controls the expected proportion of false discoveries among all rejected hypotheses, offering greater statistical power while maintaining acceptable error control in the context of multiple correlated tests (Benjamini & Hochberg, 1995). P-values for all structural paths ($m = 10$ at L1, $m = 4$ at L2) were ranked in ascending order, and each was evaluated against its BH critical value of $(k/m) \times 0.05$. Paths with $q < 0.05$ were considered statistically significant. Effects were interpreted as statistically significant only if they remained significant after this correction.

To assess the plausibility of the hypothesized direction of effects, we tested a reversed-path model in which study-related flow was specified as the predictor of PSD, inverting all hypothesized paths. This model showed a substantially worse fit compared to the theoretically hypothesized model, with both AIC and BIC values increasing relative to the original specification ($\Delta BIC = 23.01$). The scaled chi-squared comparison further confirmed a worse-fitting model with the same number of parameters ($\Delta\chi^2 = -14.24$, $\Delta df = 0$), indicating that reversing the path direction meaningfully reduces model fit. Although effects were also statistically significant in the reversed model, this is not surprising given the contemporaneous nature of the weekly measurements. Taken together, the fit comparisons support the theoretically hypothesized ordering of effects.

Finally, given that the weekly measures included all variables in a single questionnaire, this can raise the risk of common method bias. Following Kock (2017), we conducted a full collinearity test based on variance inflation factors (VIFs). All VIFs ranged from 1.12 to 1.41 (below the recommended threshold of 3.3), indicating that common method bias is not a concern for the weekly measures in this study.

4 Results

Table 1 presents multilevel correlations, means, and standard deviations for each study variable. Separating the variance of the weekly measures showed that approximately half of the variability in playful study design (ICC = 0.59) and in study flow (ICC = 0.56) resides at the intra-individual level. This indicates that students' use of playful study strategies and their experience of flow fluctuate meaningfully from week to week within the same person, rather than being entirely stable personal traits. Such within-person variability underscores the dynamic nature of these constructs and supports the use of a weekly diary design to capture temporal changes in students' motivational and experiential states. The *ICC* values for need satisfaction were as follows: need for autonomy (*ICC* = 0.31), relatedness (*ICC* = 0.49), and competence (*ICC* = 0.40). Since 30% to 70% of the variance in the weekly measures is attributable to within-person fluctuations, multilevel analysis is warranted to account for the nested structure of the data (Snijders & Bosker, 1999).

Table 2 reports the results of the MSEM for each successive model. A significant chi-squared difference between models, alongside a progressive decrease in BIC values, indicates that model fit significantly improved with each added parameter to the model.

In support of H1, the weekly playful study design showed a significant positive relationship with study-related flow (b = 0.53, SE = 0.06, p <.001, q < 0.001). As further postulated in H2, playful study design also had significant weekly positive associations with the satisfaction of the needs for autonomy (H2a, b = 0.54, SE = 0.08, p <.001, q < 0.001), relatedness (H2b, b = 0.51, SE = 0.09, p <.001, q < 0.001), and competence (H2c, b = 0.68, SE = 0.08, p <.001, q < 0.001). When it comes to the relationships between the mediators and outcome, as predicted in H3, we observed

Table 1 Multilevel correlations and descriptive statistics

	Mean (SD)	ICC	1	2	3	4	5	6
1. L1 Flow	4.07 (1.09)	0.56	-	0.65***	0.36**	0.35**	0.49***	0.54***
2. L1 Playful study design	4.51 (1.01)	0.59	0.56***	-	0.26*	0.43***	0.23*	0.43***
3. L1 Autonomy	5.31 (1.25)	0.31	0.32***	0.32***	-	0.31**	0.57***	0.32**
4. L1 Relatedness	5.5 (1.42)	0.49	0.15**	0.31***	0.20***	-	0.22	0.28**
5. L1 Competence	5.08 (1.33)	0.40	0.37***	0.42***	0.36***	0.29***	-	0.28**
6. L2 Autonomy support	5.69 (0.72)							-

*** p <.001; ** p <.01; *p <.05; L1 – weekly measures, L2 – general measures; N_{L1} = 569; N_{L2} = 105; Within-person correlations are displayed under the main diagonal, and between-person correlations are displayed above the main diagonal

Table 2 Multilevel results: direct effects, variance decomposition, model fit and effect sizes

	Model 1	Model 2	Model 3
Level 1			
Intercept	4.05(0.09)***	4.05(0.09)***	1.89(0.05)***
a1: PSD -> Autonomy		0.56(0.08)***	0.54(0.08)***
a2: PSD -> Relatedness		0.51(0.09)***	0.51(0.09)***
a3: PSD -> Competence		0.70(0.08)***	0.68(0.08)***
b1: Autonomy -> Flow		0.10(0.03)*	0.10(0.03)**
b2: Relatedness -> Flow		−0.05(0.03)	−0.05(0.03)
b3: Competence -> Flow		0.10(0.04)**	0.11(0.04)**
c: PSD -> Flow		0.54(0.06)***	0.53(0.06)***
Level 2			
ab: Autonomy support -> PSD			0.41(0.13)**
bb: PSD -> Flow			0.48(0.11)***
cb: Autonomy support -> Flow			0.36(0.09)***
Variance components			
L1 variance (flow)	0.52(0.05)***	0.34(0.03)***	0.34(0.03)***
L2 variance (flow)	0.67(0.12)***	0.53(0.11)***	0.32(0.06)***
ΔBIC		−411.77	−47.36
Parameters	15	22	25
$\Delta\chi^2$ (df)		276.64(7)***	66.29(3)***
Δ Pseudo R^2		0.27(26.8%)	0.25(24.5%)

L1 = weekly; L2 = general; PSD = Playful Study Design; ***- p<.001; ** - p<.01; * - p<.05; Main outcome - *weekly flow;* All effects are unstandardized; Robust standard errors of estimates are displayed in the parentheses

that satisfaction of the need for autonomy (H3a, b = 0.10, SE = 0.03, p =.001, q = 0.002), and competence (H3c, b = 0.11, SE = 0.04, p =.003, q = 0.004) significantly predicted study-related flow. However, satisfaction of the need for relatedness (H3b, b = −0.05, SE = 0.03, p =.124, q = 0.124) was not significantly related to study flow. These results align with the findings regarding the indirect effects, which offered partial support for H4. The weekly relationship between playful study design and study-related flow was partially mediated by satisfaction of the need for autonomy (H4a; b = 0.05, SE = 0.02, p =.002, q = 0.003; 95% CI [0.02; 0.08]) and competence (H4c; b = 0.07, SE = 0.03, p =.004, q = 0.005; 95% CI [0.02; 0.12]), but not by relatedness (H4b; b = −0.03, SE = 0.02, p =.114, q = 0.124; 95% CI [−0.06; 0.006]) (Table 3; Fig. 1).

Finally, the results supported all hypotheses regarding the L2 effects of teacher autonomy support. Students who perceived that their teachers were more autonomy-supportive experienced more flow overall across the six weeks (H5; b = 0.36, SE = 0.09, p <.001, q < 0.001) and were more likely to introduce playful design into their studies (H6; b = 0.41, SE = 0.13, p =.002, q = 0.003). Beyond the within-person association between the two, playful study design also showed a between-person

Table 3 Indirect effects

Predictor	Mediator	b	SE	*p*	95% CI	
					Lower	Upper
Level 1						
PSD	Autonomy	0.05	0.02	0.002	0.020	0.084
PSD	Relatedness	−0.03	0.02	0.114	−0.058	0.006
PSD	Competence	0.07	0.03	0.004	0.024	0.122
Level 2						
Autonomy Support	PSD	0.20	0.08	0.017	0.035	0.362

Outcome: Study Flow. PSD = Playful Study Design. Estimates are unstandardized. *CI* – 95% confidence intervals

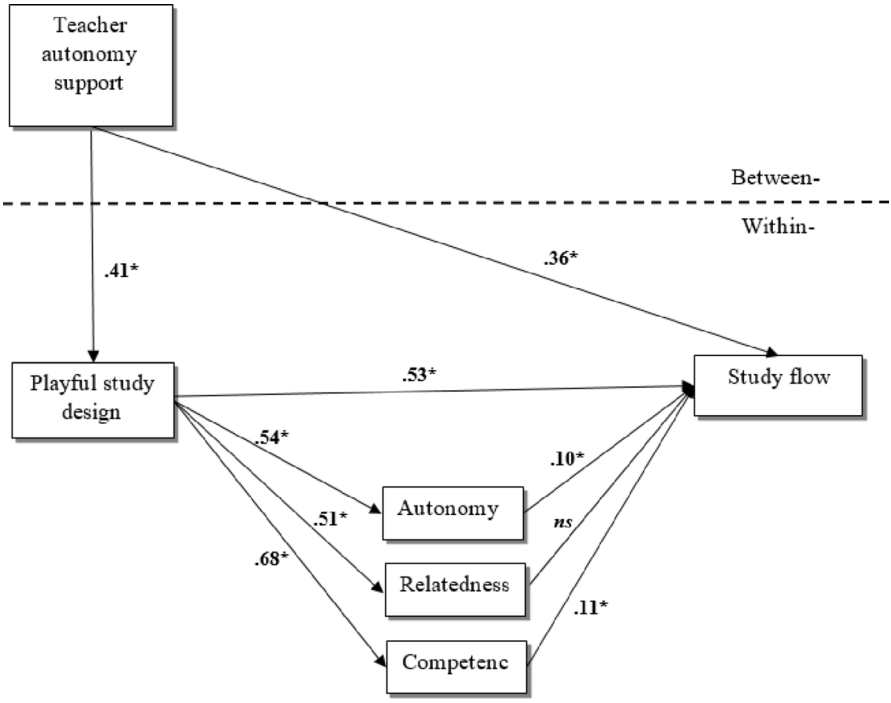


Fig. 1 Weekly relationships between playful study design and flow, mediated by need satisfaction. Teacher autonomy support as contextual antecedent for playful study design and study flow

association with study flow (b = 0.48, SE = 0.11, p <.001, q < 0.001). Finally, the data showed a significant and positive indirect effect from teacher autonomy support to study flow, mediated by playful study design (H7; b = 0.20, SE = 0.08, p =.017, q = 0.017, 95% *CI* [0.04; 0.36]), indicating that students who were taught by more autonomy supportive professors had overall more frequently relied on playful strategies in learning and this reflected in more experiences of flow while studying.

The predictors included in the model accounted for a meaningful proportion of variance in weekly flow incrementally across model steps. The introduction of within-person predictors in Model 2 explained an additional 27% of variance beyond

that explained by the intercept-only Model 1. The subsequent inclusion of between-person predictors in Model 3 accounted for an additional 25% of variance. These incremental pseudo R^2 estimates indicate that both the within- and between-person components of the theoretical model contributed strongly and independently to the explanation of variability in flow. Beyond the overall variance explained, the individual coefficients can be interpreted directly in scale-point increments (given that all constructs were assessed on a unified seven-point scale). The associations involving PSD were the strongest, relatively. A one-point weekly increase in PSD corresponded to roughly a half- to two-thirds-point increase in need satisfaction (b = 0.51–0.68) and about a half-point increase in study-related flow (b = 0.53). The need satisfaction – flow paths and the indirect effects were the weakest, reflecting small shifts on the response scale (b = 0.07–0.11). The between-person effects of teacher autonomy support fell in between, showing moderate associations with both PSD (b = 0.41) and flow (b = 0.36).

5 Discussion

This study examined the relationship between students' engagement in playful study design (PSD) and weekly study-related flow, as well as the mechanisms underlying this association. Across six weekly measurement occasions, the findings consistently support the view that proactive, student-initiated strategies are a meaningful pathway to optimal learning experiences. PSD was associated with flow both directly and indirectly, through the satisfaction of the needs for autonomy and competence, but not relatedness. Beyond within-person dynamics, the broader learning context mattered: students who perceived greater teacher autonomy support engaged more in PSD and experienced higher levels of flow overall, with PSD functioning as the mechanism through which autonomy support translated into optimal study experiences.

Previous studies have shown that a playful approach to studies was positively related to weekly study engagement and goal attainment (Wang et al., 2023), and predicted students' social integration (Costantini et al., 2025). Recent literature has also highlighted the importance of play in improving motivational, behavioral, and cognitive student outcomes (Xiao & Hew, 2024). Our study extends this line of investigation by providing evidence that students' weekly use of PSD is positively associated with their weekly experiences of study-related flow.

By investigating the satisfaction of basic psychological needs as a mediating mechanism, we provide a theoretically grounded explanation of how proactively introducing play into study activities can contribute to greater immersion and concentration in learning. Based on the self-determination model of flow (Bakker & Van Woerkom, 2017), PSD reflects students' playful inclinations in shaping their learning experiences and is associated with psychological need satisfaction and study-related flow. Our findings extend previous empirical evidence collected in work settings, which indicated a connection between playful work design and basic need satisfaction on the one hand (Bakker et al., 2023; Scharp et al., 2022), and need satisfaction and the flow state on the other hand (Bakker & Van Woerkom, 2017; Shim et al., 2022).

Interestingly, PSD was positively associated with the need for relatedness, yet this need did not significantly predict study-related flow. The absence of a significant association between the need for relatedness and study flow may be understood in light of the differing temporal and conceptual proximity of the basic psychological needs to flow experiences. Study flow is typically conceptualised as a short-term experiential state characterised by intense task absorption, a perceived balance between challenge and skill, and a strong sense of volitional engagement (Bakker et al., 2017). These features align closely with the needs for competence and autonomy, which are inherently task-specific and situational (Bakker & Van Woerkom, 2017). In contrast, the need for relatedness reflects a sense of belonging and interpersonal connection that is often constructed over longer periods and across interactions. As such, relatedness may function as a more distal or contextual resource, which supports general well-being and engagement but is less directly implicated in momentary experiences of flow within individual study episodes.

Our findings also showed that students who perceived their teachers as more autonomy supportive (by offering meaningful choices, encouraging independent thinking, and minimizing pressure), were more likely to experience flow during their weekly academic activities. When teachers allow students to choose their own learning strategies or project formats, students may experience a greater sense of ownership, which may be associated with higher intrinsic motivation and greater focus. These results align with earlier research emphasizing the importance of situational factors in experiencing academic flow (Ljubin-Golub et al., 2020; Rijavec et al., 2017; Simon & Salanga, 2021). Importantly, as predicted, this relationship between teacher autonomy support and flow was mediated by PSD. In other words, the positive association between teacher autonomy support and flow was facilitated by the use of PSD. From an SD-R perspective (Bakker & Mostert, 2024), teacher autonomy support is a contextual study resource that is positively associated with adaptive forms of study-related flow. Such support provides students with psychological latitude and encouragement, which may stimulate the proactive use of additional resources. In this vein, PSD can be understood as resource-generating behavior, through which students actively enrich their study activities (e.g., by introducing challenge, variety, or structure), and acts as a proximal mechanism linking teacher autonomy support to study-related flow. By redesigning their study tasks in more engaging ways (e.g., turning revision into a game, setting self-imposed challenges), students may optimize the balance between study demands and available resources, thereby increasing the likelihood of experiencing flow. Through this mechanism, autonomy support may be translated into higher levels of study-related flow via students' active use of PSD. These findings indicate that environmental resources, as conceptualized in SD-R theory (Bakker & Mostert, 2024), such as teacher autonomy support, play a vital role in enabling students to translate proactive individual strategies (like PSD) into meaningful flow experiences. In doing so, this study contributes to the growing body of multilevel research in education by highlighting how top-down contextual factors (e.g., autonomy-supportive teaching) predict bottom-up student behaviors (e.g., playful learning strategies), which, in turn, are linked to study-related flow. (Bakker et al., 2023).

5.1 Theoretical contributions

Our results consolidate the self-determination model of flow (Bakker & Van Woerkom, 2017) and provide new evidence for the relationship between PSD as a bottom-up proactive strategy and flow in the academic context, through the satisfaction of psychological needs. Moreover, our findings were consistent with multilevel SD-R theory (Bakker & Mostert, 2024), showing that the multi-level effect of teacher autonomy support is relevant for students' experience of study-related flow. Thus, students who perceive their teacher as promoting their sense of volition and providing autonomy-supportive structures are more absorbed in learning activities, have more intrinsic motivation and enjoyment, and feel confident and accepted in the study context. Also, these findings offer a theoretical contribution by advancing the application of SD-R theory (Bakker & Mostert, 2024) to the study of flow in educational contexts. Specifically, the environmental resources, such as teacher autonomy support, play a crucial role in facilitating the translation of students' proactive, self-initiated strategies (e.g., PSD) into optimal experiential states. In this way, the study contributes to emerging multilevel perspectives on student engagement by demonstrating how top-down contextual resources (e.g., autonomy-supportive teaching) are linked to bottom-up behavioral processes (e.g., playful study design) in the development of study-related flow experiences (Bakker et al., 2023).

5.2 Practical implications

Our research on PSD reveals several advantageous applications for an autonomous learning environment to enhance a student's study flow. First, universities might consider implementing PSD training programs that encourage students to proactively redesign their study tasks or learning activities to make them more enjoyable and challenging (cf. Costantini et al., 2025). These adjustments can help increase study-related flow directly and indirectly through the satisfaction of basic psychological needs (autonomy and competence). Second, teachers may support a learning climate that acknowledges students' improvement and mastery, encourages effort, listens to new ideas, and responds to comments and questions. By fostering an environment where PSD is utilized, students can engage with it to make their learning process more enjoyable and challenging, promoting concentration and intrinsic enjoyment of learning tasks.

5.3 Limitations

The most important limitation is posed by the study design, which, although it is strong in some respects (e.g., multiple weekly measurements that allow within-person and between-person inferences and better ecological validity), cannot support strong causal inferences or completely unidirectional interpretations. Although the present study assumes that psychological need satisfaction precedes study-related flow, it is important to acknowledge that alternative directional relationships are theoretically plausible. For instance, experiencing flow, characterized by deep task involvement and a sense of mastery, may subsequently enhance perceptions of auton-

omy and competence. We have grounded the directionality of our model in the self-determination model of flow (Bakker & Van Woerkom, 2017), which conceptualizes need satisfaction as an antecedent of optimal functioning and experiential states, and made sure to test for reversed causality to support this direction. However, future studies should employ a robust experimental design to better establish causation. For example, students could be trained in PSD techniques specifically designed to promote flow, and their outcomes could be compared with those of a control group to assess the unique effects of a PSD intervention on study-related flow (cf. Costantini et al., 2025). Experimental designs could also explore the effect of combining an individual-level intervention (to help students integrate PSD into learning tasks) with an organizational-level intervention (to instruct teachers to provide more autonomous support for students) on flow.

Importantly, the present study may not have been optimally suited to capture the role of relatedness. Our weekly measurement approach aggregates experiences across multiple study episodes and may therefore obscure the situational and interaction-based nature of relatedness. As such, the absence of an effect should not be interpreted as evidence for the irrelevance of relatedness, but rather as an indication that its role may depend on temporal resolution and context. Future research could address this by examining relatedness at shorter time scales (e.g., daily or experience-sampling designs) or in learning contexts with greater social interaction, thereby allowing a more precise test of its role in facilitating flow.

Another limitation of this study is the reliance on self-report measures. To mitigate this, we followed Podsakoff et al.'s (2012) recommendation and informed participants that there are no correct or incorrect answers. We sought to reduce common-method bias by using validated measures and ensuring construct validity through appropriate reliability coefficients; however, shared method variance in self-report diary data cannot be fully ruled out.

The generalisability of the present findings is limited by the specificity of the sample, which consisted of first-year psychology students from a single Romanian university and was predominantly female. While this gender distribution reflects the typical composition of psychology programs, future research should examine whether the observed associations replicate across more diverse academic disciplines and institutional contexts, and in more gender-balanced samples. Also, the use of academic incentives may have introduced systematic biases, such as increased compliance, selective participation, or socially desirable responding; however, such practices are common in longitudinal educational research to support retention, and our within-person analytical approach partially mitigates concerns related to stable individual differences.

Given another proactive strategy students use, like study crafting (Sabri et al., 2025), future research may focus on understanding their relative contributions and potential combined effects in driving positive learning outcomes. Future investigations that do not focus solely on one strategy but also examine their interactions and potential compounding effects would provide a more comprehensive picture of bottom-up strategies, as SD-R theory (Bakker & Mostert, 2024) theoretically proposes.

Finally, the analytical technique applied in this study has two minor limitations that need to be considered. Due to constraints in L2 sample size and, relatedly, sta-

tistical power, we could not estimate a model with a fully latent specification of all measures and had to rely on manifest variables. Additionally, standardized effect estimates are not yet available for the latent-centering multilevel specification used here. Therefore, the interpretation of effect sizes is based on the incremental variance explained by adding parameters to the model in a stepwise fashion, and on non-standardized coefficients interpreted as point-increases on the response scales.

5.4 Conclusions

Given the frequent and intense interactions between learning activities and various online distractions vying for students' attention, there is a pressing need for interventions that promote proactive strategies to help students enhance their concentration and study flow. Our findings indicate that weekly PSD is positively associated with study-related flow, both directly and indirectly through psychological need satisfaction. Also, teachers' autonomy support predicts PSD and study-related flow. Our findings offer practical guidance for combining student-focused interventions that encourage playful study strategies (like PSD) with teacher-focused approaches that foster autonomy-supportive environments, helping students feel confident, heard, and understood.

Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Competing interests The authors have no relevant financial or non-financial interests to disclose.

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