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To cite this article: Alex C. Garn & Andreas Stenling (2024) University students’ daily motivation regulation: within- and between-level relations to academic functioning, Educational Psychology, 44:2, 227-246, DOI: 10.1080/01443410.2024.2331754

To link to this article: https://doi.org/10.1080/01443410.2024.2331754

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University students’ daily motivation regulation: within- and between-level relations to academic functioning

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ABSTRACT
This study investigated daily motivation regulation as a multilevel mediator of undergraduate students’ intrinsic and extrinsic motivation and academic functioning. Undergraduate students (\(N = 124\)) completed measures on motivation, motivation regulation, and study time for 10 consecutive days leading up to a statistics exam. Bayesian multilevel mediation models were used to examine motivation regulation as a mediator between motivation and daily study time at the within-person level and exam performance at the between-person level. Within-person findings revealed motivation regulation mediated the relation between both intrinsic and extrinsic motivation and study time although the indirect effect was substantially stronger for extrinsic motivation. Between-person findings did not support mediation between intrinsic and extrinsic motivation and exam performance. Specifically, none of the motivation or motivation regulation factors predicted students’ exam performance. It appears that motivation regulation typically stems from extrinsic motivation and is more closely associated with process-oriented rather than product-oriented academic functioning.

ARTICLE HISTORY
Received 31 January 2023
Accepted 1 March 2024

KEYWORDS
Multilevel mediation; situational motivation; self-regulated learning

Introduction
Academic success in university settings requires students to self-regulate numerous aspects of their learning (Wolters, 2003; Zimmerman & Schunk, 2008). For example, balancing study time with other obligations (i.e. time management), reducing distractions during class time (i.e. environmental structuring), and determining effective ways to learn new content (i.e. strategy use) are self-regulation choices that university students make daily (Dörrenbächer & Perels, 2016). These types of self-regulation choices...
help explain and differentiate students’ academic success (Berkeley & Larsen, 2018; Chen et al., 2017; Perels et al., 2009). Simply stated, students who take an active role in monitoring and controlling their learning processes function more effectively than those taking a passive role. Despite the emphasis placed upon self-regulated learning in university settings, many university students lack sufficient self-regulation skills (Peverly et al., 2003). This study uses Schmitz and Wiese’s (2006) three-phase process model of self-regulated learning as a theoretical lens because of its comprehensive nature to explain self-regulated learning.

One area of self-regulated learning that is starting to receive greater attention is motivation regulation (Bäulke et al., 2021; Garn & Morin, 2021; Kim et al., 2018). Motivation regulation represents an aspect of self-regulated learning that occurs when students deliberately monitor and manage their motivation (Wolters, 2003, 2011). University students must often identify when to initiate, maintain, or change aspects of their motivation to optimise academic functioning (Schwinger & Otterpohl, 2017). While academic functioning can consist of numerous indicators, the quantity and quality of learning outcomes provides a general classification system (Schmitz & Wiese, 2006). Quantity of learning often focuses on the amount of study time that students engage in during a given learning state while quality of learning generally focuses on students’ performances and achievements.

It is important to note that motivation, the energy and direction of behaviour (Pintrich, 2003), and active regulation over it are considered related but distinct concepts (Sansone et al., 2019; Wolters, 1998). For example, a student may study for 2 h/d because she wants to get a good grade in a difficult class (i.e. motivation). However, she may implement strategies such as setting up self-challenges, tracking learning progress, and connecting topics to personal interests to make studying for the class easier and more enjoyable (i.e. motivation regulation). Boekaerts (1992, 1997) was one of the first scholars to recognise the importance of differentiating motivation and motivation regulation. She distinguished between subjective control and active control when making motivation and motivation regulation contrasts. Motivation relies on subjective control whereby a student’s beliefs influence her/his academic functioning whereas motivation regulation implies the use of active control whereby a student intentionally influences these beliefs.

Until recently, researchers have used an individual differences perspective to examine the interplay between trait-like motivation and motivation regulation (e.g. Kim et al., 2018; Schwinger & Otterpohl, 2017; Wolters, 1998). This approach conceptualises motivation and motivation regulation as stable characteristics, highlighting patterns in variability between students. On the other hand, implementing a daily intra-individual approach explores the relation between motivation and motivation regulation within students. In this approach, motivation and motivation regulation represent dynamic state-like factors that change within students across different learning situations or demands (Dirkx et al., 2019). Recently, Bäulke et al. (2021) compared state and trait aspects of motivation regulation in university students, demonstrating that state aspects explained two-to-three times more variation than trait aspects. In the following paragraphs, we synthesise previous research on motivation regulation addressing gaps in the current literature and explore potential within-student sequences that connect motivation regulation, motivation, and academic functioning.
**Exploring motivation regulation as a process**

Researchers investigating self-regulated learning have just started to scratch the surface on developing greater understanding about motivation regulation. Little is currently known about how university students monitor and control their motivation highs and lows from a within-person perspective (Miele & Scholer, 2018). Wolters (1998, 1999, 2003) has been at the forefront studying motivation regulation within self-regulated learning frameworks. One basic premise of Wolters’ work on motivation regulation is that students who actively monitor, control, and reflect upon their motivation increase likelihood for learning and academic success (Wolters, 2003). While there are several different regulation strategies students can implement (Schwinger & Otterphol, 2017; Wolters & Benzon, 2013), the overarching aim is to manage and exert control over motivation to address obstacles and advance academic success (Boekaerts & Corno, 2005). Kim et al. (2018) highlight the importance of examining students’ overall levels of motivation regulation, especially as it relates to diverse aspects of academic functioning.

Students’ overall motivation regulation may be especially salient when students are able to report it within the context of a course and its specific demands (Eckerlein et al., 2019; Pintrich & Zusho, 2007; Schmitz, 2006). For example, students may have greater awareness about motivation regulation when being asked to report it in the context of a challenging assignment, learning novel content, or preparing for a difficult exam (Schwinger & Stiensmeier-Pelster, 2012). Asking students to report motivation regulation without academic context may diminish cues that stimulate recall. This study adapts Schmitz and Wiese’s (2006) three-phase process model of self-regulated learning as a theoretical lens because it underscores the importance of contextual factors when considering self-regulation (see Figure 1). Specifically, we test a process model of motivational regulation that includes three phases: pre-action, action, and post-action. The pre-action phase starts with students’ situational motivation, which acts as the initial trigger in the self-regulation sequence (Klug et al., 2011). Schmitz and Wiese (2006) differentiate between intrinsic and extrinsic motivation based on the underlying energy of one’s actions. Intrinsic motivation occurs when students are driven by the inherent rewards offered by completing the academic task (e.g. challenge, interest, and pleasure). Extrinsic motivation occurs when students are driven by the external rewards offered by completing the academic task (e.g. grade, recognition, and status).

The action phase represents the next step of the process model, activating states of motivation regulation within students. Specifically, students begin to actively monitor and control their motivation to calibrate it to the situational demands of the academic task they are trying to complete. This might include making initial assessments about

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**Figure 1.** Application of Schmitz and Wiese (2006) three-phase process model of self-regulated learning.
the adequacy and level of control over situational motivation, detecting and solving salient motivational barriers, and/or identifying strategies to boost motivation (Boekaerts & Corno, 2005; Garn & Morin, 2021; Wolters & Benzon, 2013). Importantly, motivation regulation actions occur within the context of the situational demands or relevant learning states (Schmitz & Perels, 2011). This leads to the post-action phase. The post-action phase relates to aspects of learning outcomes such as situational learning outcome quantity (e.g. study time), quality (e.g. academic performance), and affect (e.g. enjoyment).

Understanding of the interplay between motivation, self-regulated learning (Schmitz & Wiese, 2006) including motivation regulation (Wolters, 2003), and academic functioning has been an important topic of discussion in educational research. The sequencing of motivation and motivation regulation remains an unresolved. To date, researchers taking an individual differences approach to motivation and motivation regulation (i.e. stable traits) generally situate motivation as an outcome of motivation regulation (e.g. Schwinger et al., 2009; Wolters, 1999). The general rationale for this sequence resides in the assumption that students’ use of motivation regulation aims to influence their motivation. Cross-sectional studies in both university and secondary students demonstrate small-to-moderate positive correlations between motivation regulation strategies or global motivation regulation and motivation constructs such as achievement goals (Kim et al., 2018; Wolters, 1998; Wolters & Benzon, 2013), interest and value (Wolters & Benzon, 2013), and self-efficacy (Kim et al., 2018). However, the most common motivation construct examined in motivation regulation studies is effort (Schwinger et al., 2009, 2012; Smit et al., 2017; Wolters, 1999). There is currently limited research exploring students’ motivation regulation in relation to their intrinsic motivation and extrinsic motivation.

Schwinger et al. (2009) investigated a potential mediation sequence using a cross-sectional design exploring motivation operationalised as effort regulation as a mediator between motivation regulation and grade point average (GPA) controlling for intelligence in German students in grades 11 and 12. Findings supported the proposed mediation model, which focused on motivation and motivation regulation from a trait perspective and in general, not within a specific academic context or situation. Schwinger and Stiensmeier-Pelster (2012) conducted a follow-up study with German students in grade 12 that employed a three-wave longitudinal design in an advanced mathematics course during the two weeks leading up to an exam. The proposed sequence focused on exam-specific motivation regulation strategies at time one (T1; two-weeks before exam) predicting changes in exam preparation effort (T2; 2–4 d before exam), in turn predicting exam performance (T3) controlling for previous mathematics grade. Again, findings supported the proposed sequential model.

Although these studies provided initial support for the proposed sequence of trait-like motivation regulation, motivation, and academic function, it is important to understand limitations of their results. Cross-sectional studies do not provide meaningful information on the sequencing of constructs (Cole & Maxwell, 2003). Collecting data at one time makes it impossible to establish a time sequence, which assumes that motivation regulation occurs before motivation, and motivation occurs before academic functioning. Therefore, Schwinger et al. (2009) did not provide evidence of an actual
sequence. Rather, Schwinger et al. created a starting point for this type of research. Schwinger and Stiensmeier-Pelster (2012) addressed some of these concerns by using a three-wave study that established a time sequence. Specifically, Schwinger and Stiensmeier-Pelster (2012) measured motivation regulation before motivation, and motivation before academic functioning. However, they did not examine alternative sequences.

Unlike Schwinger et al., Smit et al. (2017) proposed a sequence of motivation beliefs including perceived value and competence, different motivation regulation strategies as mediators, with learning pleasure/interest and effort as outcomes. The sample consisted of secondary students and the research design was cross-sectional. Findings generally supported partially mediated relations. Once again, the use of a cross-sectional design prevented a true understanding of the sequence. Furthermore, the lack of motivation and motivation regulation context as well as not measuring academic performance outcomes were also limiting. Taken together, studies that focus on trait motivation, motivation regulation, and academic success to date provide limited understanding about sequencing of these factors. Exploring this sequencing issue from a state-level within-person approach could enhance motivation regulation research.

Garn and Morin (2021) shed some light on the sequence between motivation and motivation regulation in university students using a within-person approach. Specifically, they examined the interplay between motivation regulation and autonomous motivation states in one class over the course of a semester using seven waves of data. Findings supported the sequence for states of autonomous motivation predicting future states of motivation regulation, controlling for previous levels, but not motivation regulation predicting future states of autonomous motivation controlling for previous states. Garn and Morin (2021) did not explore extrinsic motivation nor did they investigate a sequence that fully integrated academic functioning.

**This study**

Therefore, the purpose of this study is to investigate a process model of university students’ motivation regulation within the context of learning statistical concepts. Specifically, we test two mediation models based on the self-regulated learning process model developed by Schmitz and Wiese (2006). The first mediation model occurs fully at the within-person level, examining motivation regulation as a mediator between intrinsic/extrinsic motivation and self-reported study time (see Figure 2). We hypothesised that students’ motivation regulation mediates the relations between intrinsic and extrinsic motivation and study time (Garn & Morin, 2021). The second mediation model examines the same initial sequence of intrinsic/extrinsic motivation predicting motivation regulation with exam performance as the outcome at the between-person level (Eckerlein et al., 2019; see Figure 3). We hypothesised that students’ motivation regulation mediates the relations between intrinsic and extrinsic motivation and exam performance. This study addresses numerous gaps in the motivation regulation literature. First, both intrinsic motivation and extrinsic motivation are included as precursors to motivation regulation. Despite the prominence of
distinguishing between intrinsic and extrinsic motivation, it is currently unclear what type of motivation plays a more prominent role in activating motivation regulation. Second, we test mediation models that includes within- and between-person academic functioning outcomes. One of the major aims of motivation regulation is to facilitate students’ willingness to engage in work that promotes learning and achievement (Wolters, 2011). Yet, a paucity of evidence exists concerning motivation regulation as an antecedent to the amount of time students spend studying outside of class each day. Similarly, motivation regulation should help explain variation in students’ academic achievement such as exam performance (Grunschel et al., 2016; Wolters, 2003).

This study also adapts Schmitz and Wiese’s (2006) process model of self-regulated learning specifically to motivation regulation (see Figure 1). This model provides a simple yet powerful framework to investigate motivation regulation sequences. Emphasis is placed on short-term states of motivation regulation, which has been shown to explain greater amounts of variability compared to stable traits (Baulke et al., 2021; Garn & Morin, 2021). We follow the recommendation of Schmitz and Wiese (2006) by operationalising a state as a one-day unit. Specifically, we explore 10 days leading up to a statistics examination. Mathematics in general (Schwinger & Stiensmeier-Pelster, 2012) and more specifically statistics (Valle et al., 2021) often generate motivational barriers. Thus, we determined that this type of content would likely create contextual characteristics that prioritise students’ use of motivation regulation. The practical rationale of this study centres on developing greater understanding about how students experience and actively control day-to-day motivation sequences that help explain study time behaviours and exam performance.

Methods

Participants

Participants were undergraduate students (N = 124, Mage = 20.60, SD = 1.41) from a large university in the Southeastern United States (see Table S1 in the Supplemental material). These were students enrolled in a large course focused on health-related testing and measurement. Approximately 75% of the students were female while the racial representation was White (67%), Black (21%), Asian/Asian-American (5%), Hispanic (5%), and Multi-Racial (2%). Most students (80%) were classified at the junior academic rank. A small percentage (15%) of students reported being the first generation of their family to attend university. GPAs ranged from 2.68 to 4.14 on a scale of 0–4.30 (M = 3.49, SD = 0.35). Students needed at least a 2.50 GPA to enrol in the course.

A sample size of 50–100 is required for estimating fixed between-person level effects in multilevel structural equation models (cf. Hox & McNeish, 2020). Thus, our between-person level sample size of 124 was deemed sufficient. Sample size recommendations for 1-1-1 within-subject mediation models with Bayesian estimation are scarce. However, based on the available literature (e.g. Edwards & Konold, 2022), we deemed the within-person level sample size (n = 965) to be sufficient.
Measures

Students’ motivation was assessed with four items adapted from Academic Self-Regulation Questionnaire (Ryan & Connell, 1989). There were two items pertaining to intrinsic motivation and extrinsic motivation (i.e. external regulation), respectively. Intrinsic items were, ‘Today, I studied for [name of class] because I find the topics interesting’; ‘Today, I studied for [name of class] because I find the topics challenging’. Extrinsic motivation items were, ‘Today, I studied for [name of class] because I want to do well on the next test’; ‘Today, I studied for [name of class] because I want to get a good grade’. Items were answered on a 5-point scale ranging from (1) strongly disagree to (5) strongly agree.

Motivation regulation was measured with three items from a previous diary study on self-regulated learning published by Schmitz and Wiese (2006). The three items were, ‘Today I purposefully tried to motivate myself to learn [name of class] topics’; ‘Today I was able to study for [name of class] even when I didn’t want to’; and ‘Today I tried to reduce distractions so studying for [name of class] would be easier’. Items were answered on a five-point scale ranging from (1) strongly disagree to (5) strongly agree.

We examined structural validity and cross-level invariance of the daily motivation measures using multilevel confirmatory factor analysis (CFA). A measurement model with three latent factors (intrinsic motivation, two items; extrinsic motivation, two items; and motivation regulation, three items) at the within- and between-person levels showed excellent model fit. Tests of cross-level invariance provided support for weak metric isomorphism, which suggest that the interpretation of the latent factors is similar across levels. The multilevel CFA and cross-level invariance tests are presented in detail in the Supplemental material.

Academic functioning was measured in multiple ways. Study time was measured with the following item from Schmitz and Wiese (2006), ‘How much time did you spend studying [name of class] today?’ and asked to report the number of hours and minutes. We created a daily studying score in minutes for each student. The primary instructor of the course provided one researcher with students’ exam performance scores representing percentage of correct answers. The format of the exam included multiple choice, true/false, and short answer questions.

Finally, we included students’ gender, grade level, age, and race as control variables. Students also reported if they were the first generation in their family to attend university. Cumulative GPAs from all previous semesters at the university were gathered from records provided by an academic official within the department offering the course.

Procedures

Approval to conduct this study was received from the university institutional review board where the data collection took place. The primary researcher first discussed the study with the primary instructor of the course. A recruiting script that described study procedures was sent to all 201 students enrolled in the course via email using the web-based learning management system associated with the course. This email was
sent out the week before the study started. Students received an electronic link each day, for 10 consecutive days, leading up to the statistics exam (day 11). On day 1, students received the first link to an online questionnaire with the measures reported above and questions related to demographics. The day 1 questionnaire was set up so that students gave informed consent before answering any questions. Students were asked to fill out each questionnaire only after they had completed studying/homework for the course for that day. Electronic links were sent to students at 9:00 am, closing at 11:59 pm each day. An incentive programme was set up whereby students received 1 extra-credit point each time they completed the questionnaire (total course points = 650). The primary instructor shared exam scores with one researcher approximately one week after it was completed. GPA information was obtained for students who completed the study.

Data analysis

Mplus version 8.6, Los Angeles, USA (Muthén & Muthén, 1998–2017) was used to estimate Bayesian multilevel mediation models. First, we calculated intraclass correlation coefficients (ICC(1)) for the repeated measures to examine the degree of variance attributable to the between-and within-person levels. A larger ICC(1) indicates more between-person variance whereas a smaller ICC(1) indicates more within-person variance. Item-level reliability of the multi-item scales (motivation regulation, intrinsic motivation, and extrinsic motivation) was calculated using the formula $\alpha = \frac{\sigma^2_{\text{occasion level}}}{\sigma^2_{\text{occasion level}} + (\sigma^2_{\text{item}}/P)}$, where $\sigma^2_{\text{occasion level}}$ is the level 2 variance, $\sigma^2_{\text{item}}$ is the level 1 variance, and P is the number of items in the scale (Nezlek, 2017). Given that there is no reason to expect high internal consistency for study time ratings and that with a single item it is impossible to distinguish the true score and error score for the within-person component without further assumptions or external information (Yang et al., 2022), we did not compute Cronbach’s alpha for study time. Instead, we calculated ICC(2) as an indicator of reliability that reflects the proportion of observed variance in the aggregated study time ratings attributable to true differences between persons (Lüdtke & Trautwein, 2007). We used these guidelines for evaluating reliability: 0.00–0.10, virtually no reliability; 0.11–0.40, slight; 0.41–0.60, fair; 0.61–0.80, moderate; 0.81–1.0, substantial. Note, however, that these are guidelines, not golden rules, and were developed for trait scales. Somewhat more relaxed standards can be applied for scales with fewer items administered frequently (e.g. as in daily diary studies; Nezlek, 2017).

The first mediation model was a 1-1-1 within-subject mediation model (Bolger & Laurenceau, 2013) where all variables were at the within level. Variables were group mean centred prior to estimating the model. In addition to estimating the product of the X-to-M and M-to-Y coefficients ($ab$), this model also includes a covariance of between-subjects differences in the X-to-M and M-to-Y relations, which is important for correct estimation of the indirect effect. This covariance reflects a type of co-mod-eration indicating the extent to which moderation in the X-to-M link covaries with the moderation of the M-to-Y link.
The second model was a 1-1-2 mediation model (Preacher et al., 2010) where the independent variables and mediator were at the within level, whereas the dependent variable was at the between level. Latent mean centering (Asparouhov & Muthén, 2019) was used for the within-level variables, whereas continuous between-level predictors (i.e., age, GPA score) were grand-mean centered. With latent mean centering, the within-level variable is decomposed into a latent between and within part, which can be viewed as an implicit group mean centering of the within-level variable. Thus, latent mean centering provides a clear separation of the within- and between-level effects (Asparouhov & Muthén, 2019).

Two Markov chain Monte Carlo chains and 100,000 iterations were used to estimate the posterior distributions of the parameters. The first 50,000 iterations were discarded as burn-in. We assessed chain convergence with the potential scale reduction factor (PSRF) where a low (e.g., < 1.05) and stable PSRF was considered evidence of chain convergence. Model fit of the 1-1-2 mediation model was evaluated using the posterior predictive p (PPP) value and its accompanying 95% confidence interval. A PPP value below .05 is considered a poor-fitting model, whereas a PPP value of .50 with a 95% confidence interval centring on zero indicates an excellent model fit. Parameter estimates were evaluated using 95% credibility intervals (CrI). If the interval did not include zero, it was considered a credible parameter estimate (Zyphur & Oswald, 2015).

In both models, we report explained variance ($R^2$) as an indicator of effect size. In the 1-1-1 mediation model, which include random effects, this refers to the within-level $R^2$ values averaged across clusters (Schuurman et al., 2016). We included day (1–10) as a within-level predictor to account for time effects (Wang & Maxwell, 2015). In all analyses, we relied on the default noninformative prior specification in Mplus. All available data were included in the analyses. Missing observations are treated as unknown values to be estimated; the estimates will therefore be adjusted for missingness (Enders, 2010).

Results

Descriptive statistics and preliminary analyses

Descriptive statistics are shown in Table 1. A total of 22.2% of the daily surveys were missing across the 10 days. The average number of days with responses was 7.78 (SD = 1.71, range 5–10), which indicates a relatively high response rate. Survey completion rate was not related to demographic characteristics (students’ gender, grade level, age, race, generation, and GPA) or students’ average levels of the main study variables (i.e., extrinsic motivation, intrinsic motivation, motivation regulation, study time, and exam score). We also performed Little’s MCAR test (Little, 1988) as an omnibus evaluation of the missingness and it was not statistically significant, $\chi^2 = 2062.46$, $p = .633$. Based on the analysis of individual predictors and the omnibus evaluation of the missingness, we assumed that the data were missing at random. Motivation regulation, intrinsic motivation, extrinsic motivation, and study time increased across the 10 days approaching the exam. The ICC(1) values for the repeatedly assessed motivation variables and study time indicated that a larger part of the variance was at the within-person level compared to the between-person level (see Table 2). Item-level
reliability \((\alpha)\) ranged from 0.613 to 0.815, which is acceptable given the study design. Reliability (ICC(2)) of the aggregated study time ratings was 0.601. Exam score was only weakly correlated to the motivation variables at the between level, whereas the motivation variables and study time displayed moderate to strong correlations at both the between- and within-level.

### 1-1-1 Within-person mediation model

In the first mediation model, we examined the direct and indirect links between daily intrinsic motivation, extrinsic motivation, motivation regulation, and study time. The results are shown in Figure 2 and this model focuses on within-person level relations, that is, how deviations from individuals’ mean scores over time are related.

First, daily intrinsic \((b = 0.199, 95\% \text{ CrI} [0.107, 0.289])\) and extrinsic \((b = 0.683, 95\% \text{ CrI} [0.609, 0.758])\) motivation were both positively related daily motivation regulation, with a stronger relation between extrinsic motivation and motivation regulation. Motivation regulation was, in turn, positively related to study time \((b = 18.467, 95\% \text{ CrI} [13.548, 23.505])\). Neither intrinsic \((b = 0.229, 95\% \text{ CrI} [−4.023, 4.479])\) or extrinsic \((b = 3.513, 95\% \text{ CrI} [−1.179, 8.207])\) motivation had a credible direct relation with study time.
Intrinsic ($ab = 4.554$, 95% CrI $[1.744, 7.869]$) and extrinsic ($ab = 12.625$, 95% CrI $[8.664, 17.045]$) motivation had indirect effects on study time through motivation regulation. The model accounted for 59.8% of the variance in motivation regulation and 38.2% of the variance in study time. Note that these $R^2$ values are within-level $R^2$ averaged across clusters. To summarise, daily intrinsic motivation and extrinsic motivation had indirect effects on daily study time through daily motivation regulation. Higher than usual intrinsic and extrinsic motivation was related to higher than usual motivation regulation, which in turn was related to higher than usual study time.

1-1-2 Mediation model

In second mediation model, we examined the direct and indirect links between average intrinsic motivation, average extrinsic motivation, and average motivation regulation across the 10 days leading up the exam and exam score. The results are summarised in Figure 3 (and Table S2 in the Supplemental material), and we were primarily interested in the between-level relations. The PPP value was .086 with a 95% confidence interval ranging from $-9.343$ to $50.777$, which indicates an acceptable model fit. Average intrinsic ($b = 0.202$, 95% CrI $[0.059, 0.346]$) and extrinsic ($b = 0.519$, 95% CrI $[0.315, 0.712]$) motivation were both positively related to average motivation regulation. However, extrinsic motivation was more strongly related with motivation regulation than intrinsic motivation. The relation between motivation regulation and exam score was weak and the 95% CrI included zero ($b = -0.026$, 95% CrI $[-0.089, 0.039]$). Intrinsic motivation ($b = -0.038$, 95% CrI $[-0.070, -0.003]$) was negatively related to exam scores, whereas the relation between extrinsic motivation and exam score was weak and the 95% CrI included zero ($b = 0.019$, 95% CrI $[-0.035, 0.073]$). The model accounted for 59.0% of the variance in motivation regulation at the within-person level. At the between-person level the model accounted for 47.9% of the variance in motivation regulation and 47.0% of the variance in exam scores.

![Figure 2. Results of 1-1-1 multilevel mediation model of motivation, motivation regulation, and academic functioning. Note. Unstandardised estimates are reported. 95% CrIs are presented in brackets; intervals that do not include zero indicate a statistically significant effect. W: within-person level; IM: intrinsic motivation; EM: extrinsic motivation; MR: motivation regulation.](image)
The indirect effects of average intrinsic motivation ($ab = -0.004$, 95% CrI $[-0.021, 0.008]$) and extrinsic motivation ($ab = -0.013$, 95% CrI $[-0.049, 0.020]$) on exam score through average motivation regulation were weak and the 95% CrIs included zero, thus indicating that the average motivation regulation did not mediate the relations between average intrinsic and extrinsic motivation and exam score.

**Discussion**

Adapting Schmitz and Wiese’s (2006) three-phase process model of self-regulated learning, we tested two mediation models to extend understanding about how university students’ daily motivation regulation functions within the context of preparing for a statistics exam. Specifically, we investigated a proposed sequence initiated by students’ intrinsic motivation and extrinsic motivation (i.e. pre-action phase), mediated by motivation regulation (i.e. action-phase), ending with academic functioning (i.e. post-action phase; see Figure 1). The first mediation model examined within-person effects on daily study time while the second mediation model focused on between-person effects on exam performance. In the following discussion, we first situate preliminary findings into the motivation regulation literature and then address implications of the within-person and between-person mediation models.
Although much of the research on motivation regulation to date concentrates on between-person relations with different aspects of students’ motivation and academic functioning (Kim et al., 2018; Schwinger et al., 2009; Wolters & Benzon, 2013), evidence highlighting the benefits of taking a within-person, situational approach is accumulating (Bäulke et al., 2021; Eckerlein et al., 2019; Garn & Morin, 2021). Similar to these recent studies, our findings demonstrated that a majority of the variability occurred at the within-person level compared to the between-person level. Along the same lines, the salience of motivation regulation increased in the 2 d prior to the statistics exam. Therefore, treating motivation regulation as a dynamic state appears to capture how students typically use motivation regulation during specific academic pursuits. This also reinforces the importance of exploring dynamic aspects of learning process in educational research (Schmitz, 2006). Furthermore, initial findings likely provide insights about why the fully within-person mediation model produced robust results while the between-person mediation model yielded weak results in this study.

**Within-person relations**

The first mediation model examining within-person relations provided support for the three-phase process model of motivation regulation. In the pre-action to action sequence, both daily intrinsic motivation and extrinsic motivation predicted students’ motivation regulation, explaining almost 60% of the variance in motivation regulation at the within-person level. Our findings suggest that different types of daily motivation are prominent triggers of motivation regulation within students. It is interesting that extrinsic motivation was clearly a stronger predictor of motivation regulation compared to intrinsic motivation. This seems logical considering researchers describe motivation regulation as an active control mechanism used to monitor and address motivational impediments (Boekaerts, 1997; Wolters, 2003). Students who rely on extrinsic motivation may be more prone to motivational problems because they have not fully internalised the benefits and value of learning specific content such as statistics. Extrinsic motivation may also trigger students’ use of motivation regulation based on feelings of increased pressure to get a good grade on the exam and negative anticipated emotions associated with potentially failing to do so (Ryan & Deci, 2020).

The contextual nature of universities and learning statistics more specifically may also help explain the strong link between students’ extrinsic motivation and motivation regulation. From a general perspective, universities are high stakes, outcome-oriented settings where poor academic performance can drastically disrupt student progress (Goudas & Boylan, 2012). For example, students that do poorly in a class may be required to repeat it, placed on probationary status, and/or forced to switch their major area of study. The content area may also help explain the extrinsic motivation to motivation regulation sequence. University students report numerous motivational barriers to learning statistical concepts such as lack of knowledge and value for statistics coupled with poor previous performance (Onwuegbuzie & Wilson, 2003). These types of barriers may accentuate students’ use of extrinsic motivation and subsequent motivation regulation when studying statistics because of their desire to do activities that are more appealing.
On the other hand, students reporting intrinsic motivation tend to be highly engaged in the learning process (Ryan & Deci, 2020). Already highly motivated during the pre-action phase, these students may be less likely to perceive motivational problems, minimising the relevance of motivation regulation (Wolters & Benzon, 2013). In other words, intrinsically motivated students may view the need for control as unnecessary. Recently, Garn and Morin (2021) found that higher levels of state intrinsic motivation reduced future states of motivation regulation in university students, which diverge from our findings. Another possibility is that only certain aspects of motivation regulation remain pertinent for students with high intrinsic motivation. For example, intrinsically motivated students may focus on reducing distractions to maximise learning engagement whereas overcoming study apathy is not a relevant issue. What is clear from our findings is that intrinsic motivation and extrinsic motivation both contribute to motivation regulation at the within-person level.

In the action to post-action sequence of the first mediation model, students’ motivation regulation was a positive predictor of self-reported study time, accounting for over 35% of the variance. Thus, motivation regulation directly enhanced the amount of time students reported studying (i.e. academic functioning) as predicted by the three-phase process model of self-regulated learning (Schmitz & Wiese, 2006). A basic assumption of motivation regulation is that it functions as a mechanism to help promote better academic functioning (Schwinger et al., 2009; Wolters, 2003), which our findings supported at the within-person level. Bäulke et al. (2021) demonstrated that motivation regulation can reduce within-person reports of procrastination. Our findings add to their findings by showing that motivation regulation does not just prevent study avoidance, but also increases study behaviour. Spending more time studying seems especially valuable considering the numerous difficulties university students report about learning statistics (Onwuegbuzie & Wilson, 2003).

The overall within-person indirect relations supported mediation for both extrinsic motivation and intrinsic motivation sequences, supporting the three-phase process model of self-regulated learning (Schmitz & Wiese, 2006) that guided this study. It is important to note that neither intrinsic motivation nor extrinsic motivation directly influenced students’ study time. Our findings support the general sequence outlined by Smit et al. (2017), which situates motivation regulation as a proximal predictor and motivation an indirect predictor of academic functioning. However, unlike Smit et al. (2017) our findings demonstrate this sequence holds up in a time series research design focused on within-person relations. What remains unclear is if this holds up in a time-series research design examining between-person relations.

**Between-person relations**

The between-person mediation model did not produce the same robust results as the within-person mediation model. Evidence supported the initial pre-action phase to action phase; however, this was not the case for the action phase to post-action phase sequence. Specifically, both intrinsic motivation and extrinsic motivation were predictors of motivation regulation but motivation regulation was not a meaningful predictor of students’ exam performance. Findings across both mediation models
highlight the important role that extrinsic motivation plays in determining students’ use of motivation regulation, more so than intrinsic motivation. In other words, our findings show that extrinsic motivation explains greater within-person and between-person variability in motivation regulation compared to intrinsic motivation although both were meaningful antecedents. Again, this would seem to suggest that motivation regulation appears to be more salient when students rely on less adaptive forms of motivation (Ryan & Deci, 2020; Wolters, 2003).

On the other hand, our findings diverge from the assumption that motivation regulation is an important predictor of exam performance (Eckerlein et al., 2019). Eckerlein et al. (2019) found that motivation regulation was a meaningful predictor of university students’ performance on a psychology examine, even after controlling for previous academic achievement. One possible explanation is contextual differences related to content between the two studies (Pintrich & Zusho, 2007). It seems plausible that the content focus of students’ academic pursuits may moderate the relation between motivation regulation and exam performance. University students may have greater difficulties using motivation regulation effectively when preparing for an exam focused on content outside of their comfort level, which is often the case with statistics (Onwuegbuzie & Wilson, 2003). In other words, the benefits of motivation regulation on exam performance may only pay off in certain circumstances with content playing an important role.

Another possible explanation is self-report bias. Students’ self-reported exam scores in the Eckerlein et al. (2019) study whereas we obtained exam scores from the course instructor. Many students might view reporting exam performance as a sensitive topic, with higher grades representing increased social desirability. Numerous studies have shown that student self-reports of academic performance consistently produce systematic inaccuracies (Duckworth & Yeager, 2015; Rosen et al., 2017). Specifically, lower achieving students often report higher academic performance scores than they actually achieve. Getting exam scores directly from the course instructor eliminated this potential bias in our study.

**Limitations and future research**

However, this study is not without limitations. First, although we investigated both intrinsic motivation and extrinsic motivation in line with the Schmitz and Wise (2006) process model, we did not explore different types of extrinsic motivation (Ryan & Deci, 2020). Specifically, extrinsic motivation focused on getting good grades, which represents a classic form of external regulation whereby students lack meaningful levels of internalisation. Exploring a broader spectrum of extrinsic motivation including self-determined forms such as identified regulation would enhance future research covering the pre-action phase to action phase sequence of the self-regulation process model (Schmitz & Wiese, 2006) as applied to motivation regulation. Second, we tested the mediating role of motivation regulation in relation to motivation and academic functioning at both the within- and between-person levels. Future research would benefit investigating motivation regulation as a moderator. It is plausible that high levels of motivation regulation may strengthen academic functioning for students with
low motivation. Third, we did not test different motivation regulation strategies that might be more effective at linking extrinsic or intrinsic motivation to academic functioning. Fourth, we relied on students’ self-reported study time as our within-person academic functioning outcome. This type of academic functioning outcome could be subject to social desirability bias. Future research should explore objectively measured within-person academic functioning outcomes via systematic observation techniques. Furthermore, longer periods of study time may not always reflect effective self-regulation. Investigating study time and learning strategies in future research would simultaneously address quantity and quality of studying. Fifth, we only assessed the study variables once per day, which precluded us from examining processes within days. Future studies could be designed to capture these motivational processes within days using multiple assessments each day and carefully consider the time lag between the measurement of the predictor, mediator, and outcome. Future studies could also examine motivational spill-over effects from 1 day to the next. Sixth, we did not explore the potential reciprocal effects between motivation and motivation regulation. Bidirectional relations between motivation and motivation regulation are plausible and should be investigated in future research. Finally, this sample was small and consisted of mostly White female students from one region within the United States. Our results may not universally generalise to other populations; therefore, future research should explore similar mediation models with students with more diverse demographic characteristics. Similarly, studying the potential moderating role of learning content would also enhance understanding about the process of motivation regulation.

Practical implications and conclusion

There are numerous practical implications associated with our results. Getting students to study outside of class can be a challenge. Findings showed that students who monitor and manage their motivation, whether from an intrinsic or extrinsic source, were more likely to engage in daily study behaviours. Therefore, it would be advantageous for teachers and academic professionals to assist students with learning how to use motivation regulation strategies effectively. Teaching motivation regulation skills could be integrated into course content by individual instructors or taught within academic skills classes. Providing students with motivation regulation resources could also occur during orientation sessions for incoming first year students or during academic support interventions with struggling students.

In conclusion, finding ways to improve student success is a major emphasis in university settings (Burke, 2019). Finding methods to increase student retention and graduate rates benefit students and universities in numerous ways. Many universities are becoming more responsive in how they support student success. Incorporating self-regulated learning skills including motivation regulation into strategic curriculum and retention-oriented support systems is one approach. Our findings demonstrate the value of investigating motivation regulation as a process within students. Thus, this study sets the stage for further development and application of the three-phase process model of self-regulated learning (Schmitz & Wiese, 2006) as it pertains to motivation regulation. It appears that motivation regulation is especially applicable
when university students focus on the outcome of learning situations such as getting a good exam grade rather than the challenge and/or pleasure of learning the material. Therefore, the development of motivation regulation interventions should target students in learning situations that stimulate high levels of extrinsic motivation. Finally, motivation regulation helps facilitate students’ engagement in study behaviours during exam preparation. Developing formal learning experiences that teach university students how to use motivation regulation skills effectively may potentially lay the groundwork for improved academic functioning that leads to increased student achievement and retention.

**Authors’ contribution**

A.G. developed the study design and was responsible for project administration and writing of the article. A.S. carried out formal analysis, writing, and review and editing of the article.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

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