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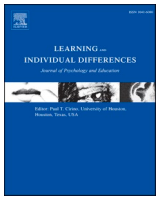

Motivated and feeling good? Reciprocal relations between motivational regulation and student well-being over one semester

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ABSTRACT

While prior research shows that motivational regulation (MR) predicts study motivation and academic success, its relations with students' subjective well-being (SWB) are not yet well understood. It can be theoretically assumed that MR and SWB are reciprocally linked over time, but longitudinal evidence is lacking. To advance our understanding of these associations, we conducted a three-wave longitudinal study with 527 university students across one semester. We included frequency of strategy use, situation-specific fit, and application quality as MR components. Results from cross-lagged panel analyses indicate that high SWB serves as a resource for applying MR strategies frequently and with a high quality, while situation-specific fit and application quality can boost SWB over time. These findings provide insight into the interplay between MR and SWB over time, illuminate the role of SWB as a MR precondition, and can help to develop support measures fostering study success and health in higher education.

Educational relevance and implications statement: This longitudinal study advances our understanding of how three core components of motivational regulation as well as students' overall tendency to engage in motivational regulation are linked with students' subjective well-being over time. The results indicate that high subjective well-being serves as a resource for applying motivational regulation strategies frequently and with a high quality. The situation-specific fit between regulation strategies that are used and the motivational problems they target, and the application quality of strategy use, in turn, can boost subjective well-being over time. Students' overall tendency to engage in motivational regulation has a positive impact on subjective well-being over time, and vice versa. In conclusion, developing integrative support programs that foster motivational regulation competencies (e.g., how to select suitable motivational regulation strategies and how to implement these strategies well) as well as skills to master emotional challenges while studying is a valuable pathway for fostering students' learning, success, and health.

1. Introduction

While motivational regulation has been identified as an important predictor of study motivation, learning behaviors, and academic success (e.g., Kryshko et al., 2020; Schwinger et al., 2009; Steuer et al., 2019; Wolters, 1998, 1999), its relations with students' subjective well-being have been investigated considerably less. However, there are initial theoretical deliberations about these linkages (Zimmerman & Schunk, 2008) and cross-sectional evidence suggests that regulating one's motivation successfully is also associated with well-being which, in turn, forms a critical component of students' health (e.g., Grunschel et al., 2016; von der Mülbe et al., 2024). From a theoretical perspective, it can be assumed that the impact of motivational regulation might extend not only to students' motivation and learning behavior, but also their well-being. Higher well-being, in turn, might be a valuable resource for students' self-regulatory efforts. However, prior research provides no

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insight into the directions of effects between motivational regulation and well-being and has rarely included well-being as a potential precondition of motivational regulation (e.g., Grunschel et al., 2016; see Kryshko et al., 2022 for a longitudinal study on linkages between frequency of motivational regulation strategy use and study satisfaction). Furthermore, recent research shows that effective motivational regulation comprises multiple components, namely *frequency of motivational regulation strategy use*, *situation-specific fit between used regulation strategies and motivational problems*, and *application quality of motivational regulation strategies*. All these components have not only been linked to the perceived effectiveness of students' motivational self-regulation (Engelschalk et al., 2017; Steuer et al., 2019), but also to affective and cognitive subjective well-being (von der Mülbe et al., 2024). However, longitudinal research on the linkages between each of these components with well-being is lacking (e.g., Trautner et al., 2025). To advance our understanding of the associations between different motivational regulation components and subjective well-being, especially regarding their temporal ordering, the present paper provides an overview of possible reciprocal linkages between different components of students' motivational regulation and their well-being over time. To test our propositions, we conducted a three-wave longitudinal study with university students across one semester examining the longitudinal relations of the three motivational regulation components with students' well-being, respectively. Additionally, as prior research often employs summative or global indicators for motivational regulation (e.g., Bäulke et al., 2019; Fong et al., 2024; Garn & Morin, 2021), we also included a measure of students' overall motivational regulation in terms of their perceived overall tendency to engage in motivational regulation in response to motivational challenges and examined the longitudinal relations between their tendency to regulate their motivation (from here on referred to as overall motivational regulation) and students' well-being. Such findings can provide insight into the interplay between motivational regulation and subjective well-being, illuminate the role of well-being as a resource for successful motivational regulation, and help to develop support measures for higher education students to foster learning, achievement, and health.

1.1. Three components of successful motivational regulation

Motivational self-regulation refers to all deliberate activities that aim at initiating, maintaining, or increasing one's motivation for accomplishing a certain task or goal (Wolters, 2003). Contemporary models of motivational regulation conceptualize it as a process that involves continuously monitoring one's motivation to detect and manage motivational problems (Miele & Scholer, 2018; Schwinger & Stiensmeier-Pelster, 2012). Prior research has identified a range of relevant motivational regulation strategies, for example, ability-focus self-talk (increasing one's awareness of one's abilities or similar past accomplishments), enhancement of personal significance (enhancing awareness of connections between tasks and one's life), or proximal goal setting (dividing a complex task into smaller subtasks to render it more achievable; Engelschalk et al., 2015; Schwinger et al., 2009; Wolters, 2003). Moreover, extant research has identified three components that contribute to successful motivational regulation – uniquely *and* in concert (Engelschalk et al., 2017; Steuer et al., 2019; von der Mülbe et al., 2024).

The first component, frequency of motivational regulation strategy use, constitutes the most commonly considered component in prior research and is positively linked to various facets of students' motivation (e.g., self-efficacy, value, goal orientations), their use of (meta-)cognitive strategies (Wolters, 1998, 1999; Wolters & Benzon, 2013), effort, and academic success regarding achievement and dropout intentions (Kryshko et al., 2020; Schwinger et al., 2009, 2012; Schwinger & Stiensmeier-Pelster, 2012). However, as frequency of strategy use often had smaller effects on students' learning than expected (Engelschalk et al., 2017), two additional components that are pivotal for successful motivational regulation have emerged.

The situation-specific fit component reflects the notion that regulating one's motivation successfully requires conditional knowledge about the fit between used regulation strategies and to-be-regulated motivational problems to select suitable strategies for the specific problem and situation at hand (Paris et al., 1983; Steuer et al., 2019). This is closely related to the idea of metamotivational knowledge about the self, tasks, and strategies that is important for selecting motivational regulation strategies in Miele and Scholer's (2018) model. Strategy fit involves a matching process between the affordances and constraints of specific strategies, the nature and origin of the motivational problem (e.g., expectancy vs. value problems), and the learning phase during which the problem arises (e.g., pre-actional or actional phase). Regarding the problem nature, for example, enhancement of personal significance should be more suitable for motivational challenges resulting from low subjective task value (e.g., due to uninteresting topics). Similarly, Schwinger and Stiensmeier-Pelster's (2012) process model of motivational regulation posits that, in a monitoring subphase, learners identify causes for motivational problems and select suitable strategies accordingly. Furthermore, learners face different demands and motivational challenges during different learning phases (Schmitz & Wiese, 2006): For example, while establishing motivation is prevalent in the pre-actional phase to set learning goals and initiate learning tasks, the actional phase requires learners to monitor and maintain their motivation, and therefore, learners might need to select different strategies. Prior research has revealed favorable longitudinal effects of situation-specific fit on procrastination (Bäulke et al., 2021). Moreover, Steuer et al. (2019) reported positive cross-sectional links of situation-specific fit with perceived regulatory effectiveness and effort that were stronger than the rather small relations of frequency of strategy use with effectiveness and effort.

Finally, successful motivational regulation also depends on the quality of strategy application meaning that strategy use should be optimally controlled, accurate, and target-oriented to be effective. Controlling strategy application encompasses various metacognitive processes, including planning, coordinating, implementing, and monitoring one's strategy use and adapting ineffective strategy use (Pintrich, 2000; Zimmerman, 2000). For example (cf., Engelschalk et al., 2017), to increase expectancy of success (and thus motivation) during exam preparation, university students might use ability-focus self-talk. This entails monitoring changes in their motivation and evaluating the effectiveness of their strategy use. If motivation remains low, students might recognize the need to adapt their strategy use and apply their chosen strategy more accurately: By choosing a better-fitting comparison more closely linked to the task at hand (e.g., completing course exercises for the exam instead of high-school achievements), they can make their strategy application more target-oriented, meaning that they implement the strategy in a way that it has the desired result. Additionally, to increase application quality further, they could plan their strategy use, for example by establishing implementation intentions to remind themselves of using ability-focus self-talk as soon as thoughts of failure arise. Prior research points to positive relations between application quality and perceived regulatory effectiveness, effort, and academic performance (Engelschalk et al., 2017). Eckerlein et al. (2019) revealed positive longitudinal effects of frequency of strategy use and application quality on effort in exam preparation and exam performance while only application quality was linked to reduced negative effects of arising motivational difficulties on invested effort.

Taken together, prior research has provided evidence that successful motivational regulation is a matter of frequency of strategy use, situation-specific fit, *and* application quality: All three components determine students' perceived regulatory effectiveness (e.g., von der Mülbe et al., 2024), learning behaviors (e.g., Steuer et al., 2019), and academic performance (Engelschalk et al., 2017). Regarding the interplay of the three components in shaping regulatory effectiveness, von der Mülbe et al. (2024) also found that good application quality can

compensate lacking strategy knowledge to some extent, and vice versa. Higher frequency of strategy use alone could not compensate for a lack of suitable strategies. These findings further underline the importance of considering situation-specific fit and application quality besides frequency of strategy use when studying antecedents and outcomes of successful motivational regulation.

1.2. Subjective well-being

Subjective well-being refers to people's evaluations of their lives and, following multidimensional conceptualizations (Diener et al., 2009; Marsh et al., 2020), comprises affective and cognitive facets that make unique contributions to people's subjective well-being and can be measured either globally (general well-being) or in a context-specific manner (well-being in different life domains). Regarding affective facets, subjective well-being pertains to the relative frequency and intensity of experiencing negative and positive emotions, such as – within the higher education context – study-related anxiety, boredom, joy, or hope. Cognitive subjective well-being in the higher education context comprises students' satisfaction with their academic lives (study satisfaction) and their overall evaluations of their lives (general life satisfaction). As prior research has linked subjective well-being with various positive outcomes such as academic achievement and health (Diener et al., 2018; Lyubomirsky et al., 2005), it is an important pathway to improve students' experiences in higher education.

1.3. Motivational regulation and subjective well-being

Few studies have so far examined linkages of subjective well-being with self-regulatory processes such as motivational regulation despite respective theoretical deliberations. Zimmerman and Schunk (2008) proposed positive relations between motivational regulation and positive emotional experiences and negative relations with negative emotional experiences based on findings linking self-regulation strategies with affective outcomes (e.g., depression, anxiety, self-satisfaction, elation; Wolters, 2003). In general, research on linkages between motivational regulation and well-being has mostly focused on frequency of strategy use and often applied a narrow concept of subjective well-being. Furthermore, while theoretical models (e.g., Schwinger & Stiensmeier-Pelster, 2012) include broad assumptions on individual factors influencing learners' motivational regulation, empirical evidence regarding the development and preconditions of motivational regulation is scarce, especially as most motivational regulation research, including research on its interrelations with well-being, is based on cross-sectional designs (Fong et al., 2024; Trautner et al., 2025; Villar et al., 2024; for exceptions, see Bäulke et al., 2025, and Kryshko et al., 2026, for longitudinal studies on developmental patterns of motivational regulation, although relations with well-being are not considered). Moreover, well-being has mostly been considered as an outcome of motivational regulation, but not as a precondition in prior research (see Trautner et al., 2025, for an overview of prior motivational regulation research). Regarding cross-sectional research targeting university students, Grunschel et al. (2016) reported positive associations between the frequency of overall motivational regulation strategy use as well as the frequency of use for individual strategies (except performance-avoidance self-talk) and affective (positive and negative affect) and cognitive well-being (study and life satisfaction). Trautner and Schwinger (2020) found a positive relation between frequency of strategy use and broader positive affect. In a longitudinal study with university students across four semesters (Kryshko et al., 2022), frequency of strategy use and study satisfaction were related at the between-person level; however, no significant cross-lagged effects were found at the within-person level. Adopting a comprehensive approach to motivational regulation and subjective well-being, two cross-sectional studies with university students by von der Mülbe et al. (2024) revealed frequency of strategy use, situation-specific fit, application quality, and regulatory effectiveness to be associated with greater affective and cognitive well-being indicating that all three components are in fact essential for well-being.

In sum, previous research has provided initial evidence that frequency of strategy use, situation-specific fit, and application quality of motivational regulation strategies are linked to subjective well-being (von der Mülbe et al., 2024). However, as most of this research was limited to cross-sectional designs focused on the impact of motivational regulation on well-being, the underlying patterns of linkages driving these relations remain unclear: While, based on theoretical deliberations, motivational regulation should influence well-being, well-being should also influence motivational regulation, resulting in reciprocal feedback loops over time. We will outline the reasoning underlying these assumptions in the following sections.

1.3.1. Effects of motivational regulation on subsequent well-being

Students' achievement motivation and emotions are not only both key elements of students' learning, academic success, and well-being, but also closely linked: they share similarities regarding their conceptualization and functions (e.g., Eccles & Wigfield, 2020; Pekrun, 2023) and typically co-occur in academic achievement settings (Meyer & Turner, 2006; Pekrun, 2023). Building on two key theories on students' motivation and emotion, namely expectancy-value theory (EVT; Eccles & Wigfield, 2020) and control-value theory (CVT; Pekrun, 2018), achievement motivation and emotions share similar antecedents. EVT proposes that students' motivation stems from their expectancy of success, that is, the degree to which they believe they can achieve tasks successfully, and the subjective value they ascribe to tasks, meaning to what extent they perceive them as important, interesting, or useful. According to CVT, students' achievement emotions originate from control- and value-related appraisals of learning tasks and their outcomes. Students' perceptions of control can refer to their expectancy of success in future tasks, current perceptions of control within a situation, and causal attributions of success and failure. Task and outcome values pertain to whether tasks or outcomes are rated as positive or negative and to the level of their importance. Accordingly, due to this overlap in antecedents, and because several key motivational regulation strategies directly aim at expectancy- and value-related appraisals, motivational regulation may impact motivation *and* emotions which, in turn, shape students' well-being. For example, when students boost their expectancy of success for difficult tasks with ability-focus self-talk, they should perceive greater control over the learning situation resulting in less anxiety and more hope and joy. Similarly, applying the strategy of enhancing personal significance to increase the perceived value of dull tasks should be conducive to reducing boredom and increasing enjoyment.

Regarding cognitive subjective well-being, applying motivational regulation strategies, and consequently, increasing expectancy of success and subjective value might lead to more positive evaluations of students' academic lives in general, and thus, boost study satisfaction. This assumption is in line with previous theoretical work linking motivational regulation with expectancy of success and subjective value (Miele & Scholer, 2018) and research documenting positive relations between expectancy- and value-related study motivation and study satisfaction (Fleischer et al., 2017; Fleischer et al., 2019). More generally speaking, motivational regulation can help students to achieve personally meaningful goals, which is an essential factor for experiencing subjective well-being (Emmons, 1996), by increasing their motivation, and consequently persistence and effort, as motivation is fundamental for defining and working towards these goals (Rheinberg & Vollmeyer, 2012).

In sum, contemporary theorizing on achievement motivation and emotions provides grounds for the assumption that motivational regulation can impact subjective well-being. However, it can be theoretically assumed that linkages may vary across the three motivational regulation components: Specifically, merely applying strategies more frequently

Table 1
Reciprocal linkages between motivational regulation and well-being.

Linkage	Assumed effect	Assumed mechanisms for the effect
Effects of motivational regulation on subsequent subjective well-being		
Frequency of strategy use → Well-being	No effect (Hypothesis 1a)	Mere frequency of strategy use can be either beneficial or detrimental.
Situation specific fit → Well-being	Positive effect (Hypothesis 2a)	Strategy fit should improve regulatory effectiveness and thus appraisals, motivation, achievement, and well-being.
Application quality → Well-being	Positive effect (Hypothesis 3a)	High application quality should improve regulatory effectiveness and thus appraisals, motivation, achievement, and well-being.
Overall motivational regulation → Well-being	Positive effect (Hypothesis 4a)	Motivational regulation addresses important antecedents of affective and cognitive well-being.
Effects of subjective well-being on subsequent motivational regulation		
Well-being → Frequency of strategy use	Positive effect (Hypothesis 1b)	High levels of well-being result in more capacity for frequent strategy use in terms of cognitive and motivational resources, self-regulation, mental flexibility, and effort.
Well-being → Situation-specific fit	No effect (Hypothesis 2b)	Situation-specific fit is a knowledge-based component of motivational regulation, and increased well-being should not directly contribute to students' conditional strategy knowledge.
Well-being → Application quality	Positive effect (Hypothesis 3b)	High levels of well-being result in more capacity for controlling one's strategy application in terms of cognitive and motivational resources, self-regulation, mental flexibility, and effort.
Well-being → Overall motivational regulation	Positive effect (Hypothesis 4b)	High levels of well-being result in more capacity for motivational regulation in terms of cognitive and motivational resources, self-regulation, mental flexibility, and effort.

might not be inherently beneficial for well-being (von der Mülbe et al., 2024). While applying strategies that are effective in regulating one's motivation more frequently might improve well-being, for other strategies that are not effective in solving the motivational problem, higher frequency might even be detrimental, as increased regulatory efforts not resulting in desired effects might increase negative feelings such as frustration, anxiety, or hopelessness, and decrease satisfaction with one's situation. Moreover, applying strategies more frequently might also diminish resources (e.g., cognitive or time) for other self-regulatory and learning processes, which could impact cognitive and affective learning outcomes, and consequently well-being negatively (Kryshko et al., 2022). Therefore, we would not expect frequency of strategy use alone to impact students' well-being.

Students' well-being should depend on whether students select strategies that fit their motivational problem, as this should render motivational regulation more effective in terms of resolving motivational problems, consequently improving motivation and emotions, and promoting well-being. As successful motivational regulation can also boost students' achievement, having better strategy knowledge might also lead to more satisfaction with one's academic life. Thus, we would expect positive effects of situation-specific fit in terms of students' conditional strategy knowledge on subjective well-being. In the same vein, application quality should also be beneficial to well-being, as applying strategies well makes it more likely to master motivational challenges effectively. Hence, we assume that application quality positively impacts subjective well-being.

Taken together, we assume that motivational regulation positively affects students' well-being, which is primarily driven by strong situation-specific fit and application quality of motivational regulation strategies. Table 1 displays a summary of our propositions for these effects.

1.3.2. Effects of well-being on subsequent motivational regulation

While theoretical deliberations and prior research support the assumption that motivational regulation influences subjective well-being (e.g., von der Mülbe et al., 2024), it is also theoretically sound that well-being, in turn, shapes learners' subsequent motivational regulation. The effects of emotional experiences and satisfaction, which form core elements of subjective well-being, on self-regulatory processes have been alluded to in cyclical self-regulation models (Schmitz & Wiese, 2006; Zimmerman, 2013). Following these models, motivational regulation can be seen as part of a cyclical process entailing feedback loops: After completing learning tasks, students reflect not only on cognitive learning outcomes but also on their satisfaction and emotions regarding their learning performance and outcome. This self-reflection in the post-actional phase is assumed to inform subsequent learning cycles and self-regulatory processes. In what follows, we discuss possible mechanisms driving the influence of subjective well-being regarding emotions and satisfaction on students' motivational self-regulation in more depth.

Fredrickson's (2001) broaden-and-build theory posits that positive emotional experiences broaden thought-action repertoires, while negative emotions have a narrowing effect on people's thinking and actions. Emotions entail not only affective, cognitive or physiological aspects, but also elicit specific tendencies to think or act. Negative emotions signal challenges or threat, and thus, compel people to take immediate and decisive actions to avert threats. In contrast, positive emotions signal that a situation is safe, and consequently, encourage approach behavior, so that people are more likely to think creatively, explore new ideas and be open to new experiences. This expansion of thought-action repertoires supports the development of durable, personal resources (intellectual, psychological, physical, social) such as problem-solving skills, resilience, and social connections that help to navigate future challenges more effectively, and consequently, fosters well-being. Being able to think and act more flexibly is also an important prerequisite for motivational regulation. Engaging in motivational regulation requires cognitive resources (e.g., attention), motivation, self-regulation entailing various metacognitive processes, and effort. Furthermore, motivational regulation strategies often require students to engage in cognitive activities similar to those entailed in flexible, cognitive learning strategies such as elaboration and critical thinking (compared to more rigid strategies such as rehearsal): For example, when students deal with difficult tasks using ability-focus self-talk, they need to elaborate on their beliefs about their abilities and resources, critically analyze their problem and progress to choose suitable strategies and adapt them if necessary.

Consequently, research findings on the effects of achievement emotions on cognitive learning strategies might also be relevant for the linkages between achievement emotions and motivational regulation. Prior research has shown that positive activating emotions (e.g., joy, hope) not only foster students' use of flexible cognitive learning strategies, but also preserve cognitive resources, facilitate self-regulation, and increase motivational resources (i.e., effort; Ahmed et al., 2013, Pekrun et al., 2011; Pekrun et al., 2023), while negative emotions deplete cognitive and motivational resources and hinder self-regulation and the use of flexible cognitive learning strategies (Cheng & McCarthy, 2018; Pekrun et al., 2011; Pekrun et al., 2023). In a similar vein, results from a three-wave longitudinal study spanning 12 months by Beaumont

et al. (2023) indicate that secondary-school students' school-related well-being might increase their cognitive resources and consequently enable students' use of emotional regulation strategies. Furthermore, there is empirical evidence that study satisfaction can also impact motivational resources: In a study targeting self-regulated learning cycles from day to day, Bellhäuser et al. (2019) revealed positive effects of daily study satisfaction on next-day intrinsic motivation. Based on these theoretical deliberations and empirical findings, it can be assumed that emotions and satisfaction can impact important prerequisites for motivational regulation, and that consequently, subjective well-being has the potential to shape students' motivational regulation as an important precondition and resource.

Furthermore, well-being can impact the three motivational regulation components differently. We argue that higher levels of well-being should be associated with higher subsequent frequency of strategy use. Applying motivational regulation strategies frequently requires students to invest a significant amount of attention, motivation, and self-regulatory efforts. Thus, higher well-being lays the foundations for students being able to apply strategies more frequently without neglecting other key elements of the learning process. In contrast, we would not expect an effect of well-being on situation-specific fit regarding conditional strategy knowledge as a knowledge- rather than behavior-based component. While increased cognitive and motivational resources should influence students' behavior, the same does not apply for students' knowledge, particularly within shorter time periods such as a semester: Having more resources when motivational problems arise does not directly increase students' conditional strategy knowledge within learning situations (see also Miele et al., 2020, for a discussion on the acquisition of metamotivational knowledge). Application quality, in contrast, should also be positively influenced by well-being. The metacognitive processes involved in optimally controlling one's strategy use (e.g., monitoring, adapting) can be cognitively and motivationally taxing and require high self-regulation levels. Therefore, higher well-being can increase students' resources, self-regulation, and mental flexibility for focusing on the details of strategy application. Table 1 displays a summary of our propositions for these effects.

1.4. The present research: aims and hypotheses

Previous research on linkages between motivational regulation and subjective well-being is limited in several regards (cross-sectional designs; focus on frequency of strategy use, single well-being facets and the effects of motivational regulation on well-being; e.g., Grunschel et al., 2016). To the best of our knowledge, research on the impact of well-being on situation-specific fit and application quality is entirely lacking. However, recent research underlines that all three motivational regulation components are linked to effective motivational regulation and well-being (von der Mülbe et al., 2024). Furthermore, the idea of well-being as an important resource and precondition for successful motivational regulation is gaining momentum but has not been examined in prior research (e.g., Trautner et al., 2025) despite sound theoretical arguments for this direction of effects. In the present paper, we propose and test the assumption that the three motivational regulation components and overall motivational regulation have differential effects on subjective well-being over time, and vice versa. As motivational regulation and well-being have been linked to students' academic success (e.g., Eckerlein et al., 2019) and as well-being is an important element of students' health (Diener et al., 2018; Lyubomirsky et al., 2005), motivational regulation and well-being are promising pathways for fostering students' academic efforts and experiences. Therefore, exploring these linkages is also important from a practical perspective for developing effective and efficient support measures for higher education students.

Following multidimensional conceptualizations (e.g., Diener et al., 2009), subjective well-being was conceptualized in terms of affective and cognitive facets. As prior research has provided evidence that discrete positive and negative achievement emotions capture students' emotional experiences better than broader positive and negative affect (Pekrun et al., 2023), we addressed affective well-being in terms of two negative (anxiety, boredom) and two positive activating (hope, joy) achievement emotions that are frequently experienced in higher education and closely linked to academic success and health as well as important preconditions for motivational regulation (e.g., cognitive and motivational resources; Pekrun et al., 2002; Pekrun et al., 2023). Furthermore, as motivational regulation strategies are important in the pre-actional and actional learning phase, we selected two prospective emotions arising from expectancy of failure versus success (anxiety, hope) and two activity emotions originating from current control perceptions (boredom, joy). Cognitive subjective well-being was conceptualized in terms of study satisfaction and general life satisfaction (e.g., Diener et al., 2009). Following our propositions for the reciprocal linkages between motivational regulation and subjective well-being, we investigated the eight hypotheses summarized in Table 1.

2. Method

2.1. Participants and procedure

We conducted a three-wave longitudinal study over one semester. The data were collected as part of a larger research project on prevention of study dropout in STEM subjects. We asked staff members working with STEM students at 55 German universities across all federal states to forward an invitation to an online survey to their students. Undergraduate STEM students at 28 German universities participated in the first online survey in the first week of the summer term 2023 (T1). The second (T2) and third survey (T3) took place three and six months later, respectively. In total, 527 students (33.8 % female, Age: $M = 21.3$; $SD = 2.7$) participated at T1 and reported on their motivational regulation at university and well-being. Of these students, 39.5 % were enrolled in engineering, 23.5 % in computer science, 13.5 % in physics, and 21.6 % in other STEM programs. On average, they were enrolled in the third semester of their study program ($M = 2.6$; $SD = 1.6$). Two-hundred and forty-four students participated in all waves; 100 students participated at T1 and one additional wave, and 183 students participated only at T1. Prior to the study, students were informed of the purpose of the study and data protection measures and provided informed consent. Institutional review board approval was granted. Students received 10 Euro per survey for participating.

2.2. Measures

Internal consistencies for all measures are reported in Table 2 and were acceptable.

2.2.1. Motivational regulation

2.2.1.1. Frequency of motivational regulation strategy use. Frequency of strategy use was assessed with a well-established German questionnaire developed by Schwinger et al. (2007); see Schwinger et al., 2009 for an English version) which covers eight motivational regulation strategies building on Wolters's (2003) taxonomy: enhancement of situational interest (e.g., "I consider a way to make work more entertaining"), enhancement of personal significance (e.g., "I look for connections between the tasks and my life as such"), mastery self-talk (e.g., "I persuade myself to work intensely for the sake of learning"), performance-approach self-talk (e.g., "I call my attention to the fact of how important it is to obtain good grades"), environmental control (e.g., "I make sure that distractions occur as seldom as possible"), self-consequating (e.g., "I promise myself that, after work, I will do something that I like"), and proximal goal setting (e.g., "I approach work step-by-step in order to get the feeling that I proceed well"). We excluded the strategy of

Table 2
Descriptive statistics and internal consistencies.

Construct	Potential range	T1 (N = 470–495)					T2 (N = 306–314)					T3 (N = 260–265)				
		Actual range	*M*	*SD*	α	ω	Actual range	*M*	*SD*	α	ω	Actual range	*M*	*SD*	α	ω
Motivational regulation																
Frequency of motivational regulation strategy use	1–5	1.45–4.67	3.2	0.5	.71	.72	1.00–5.00	3.2	0.6	.79	.80	1.52–5.00	3.2	0.6	.78	.77
Situation-specific fit of motivational regulation strategies	–5–5	–2.67–4.63	1.6	1.2	.89	.88	–1.31–4.38	1.7	1.2	.91	.91	–1.25–4.38	1.8	1.2	.92	.91
Application quality of motivational regulation strategies	1–6	1.00–6.00	3.3	1.1	.95	.95	1.00–5.90	3.2	1.1	.96	.96	1.00–6.00	3.2	1.2	.97	.97
Overall motivational regulation	1–5	1.00–5.00	3.0	0.7	.83	.83	1.00–5.00	3.0	0.7	.84	.84	1.00–5.00	3.1	0.7	.87	.86
Subjective well-being	1–6	1.77–5.74	3.9	0.7	.71	.74	1.34–5.80	3.8	0.7	.75	.78	2.08–5.67	4.0	0.7	.72	.75

Note. Well-being comprises students' experiences of achievement emotions, study satisfaction, and life satisfaction.

performance-avoidance self-talk as it has been found maladaptive in several studies (e.g., Grunschel et al., 2016; Schwinger & Otterpohl, 2017). In line with Engelschalk et al. (2015), four additional items measured the frequency of strategy use for ability-focus self-talk (e.g., "I tell myself that I have always mastered similar situations well so far"). Following a general instruction ("How do you motivate yourself? We want to know what you do when you work on an important study task and then lose motivation to continue. Reasons for this could be the task being too boring, too difficult or irrelevant to you. Below are various ways in which students can handle this problem. For each of the following statements, please indicate how often you have used the method described in the past."), participants answered 31 items (three to five items per strategy) on a Likert-type scale ranging from 1 (*very rare/never*) to 5 (*very often*). We computed a total mean score reflecting the frequency of motivational regulation strategy use following Schwinger et al. (2009) by averaging frequency scores across strategies.

2.2.1.2. Situation-specific fit between used regulation strategies and motivational problems. Situation-specific fit was assessed using a short version of the Situational Judgment Test (SJT) developed by Steuer et al. (2019). With a standardized scenario-based approach, it tests students' conditional motivational regulation strategy knowledge. After reading four vignettes describing specific motivational problems typically encountered by university students (e.g., "You are faced with the task of studying for an exam [e.g., written or oral exam]. You have to independently prepare and study large amounts of content. Understanding the subject matter is essential for exam preparation. The content you have to study is difficult [e.g., complex, hard to understand]."), participants rated the suitability of nine motivational regulation strategies to deal with the described motivational problem after each vignette on a Likert-type scale ranging from 1 (*not suitable at all*) to 6 (*completely suitable*). These included all strategies for which frequency of strategy use was measured (see Section 2.2.1.1). The SJT is based on standards that were identified via expert ratings and that include strategies that were consistently seen as unambiguously functional or unambiguously dysfunctional, to compare students' suitability ratings with these standards via pair comparison scores within each vignette: A high comparison score reflects that a functional strategy was rated as very suitable and a dysfunctional strategy as not suitable, indicating good conditional knowledge about the situation-specific fit between motivational regulation strategies and motivational problems. Overall, across all vignettes, 16 pair comparison scores were computed and averaged into an overall indicator for situation-specific fit.

2.2.1.3. Application quality of motivational regulation strategies. Application quality was measured with five established items for each of the four vignettes described in Section 2.2.1.2 that were developed by Engelschalk et al. (2017). These items cover target orientation, implementation accuracy, and control (i.e., monitoring one's strategy use). A sample item reads: "When I use this strategy, I check regularly to determine if my motivation is improving or not". After reading each vignette, students were asked to describe a strategy they would apply to improve their motivation in the described scenario and then rate their agreement with the five items regarding this strategy on a Likert-type scale ranging from 1 (*completely disagree*) to 6 (*completely agree*). Overall, we averaged 20 items (five items across four vignettes) into a total score indicating application quality.

2.2.1.4. Overall motivational regulation. Students' general perceived tendency to engage in motivational regulation in response to motivational problems beyond specific strategies was measured with a German translation of the corresponding subscale of the Brief Regulation of Motivation Scale (Kim et al., 2018; see Bäulke et al., 2019 for the German translation). The scale comprises eight items ("Even when studying is hard, I can figure out a way to keep myself going"), following a general instruction ("How do you motivate yourself?"). Responses ranged from 1 (*strongly disagree*) to 5 (*strongly agree*).

2.2.2. Subjective well-being

We followed multidimensional conceptualizations of subjective well-being (Diener et al., 2009; Marsh et al., 2020) and measured affective facets in terms of achievement emotions and cognitive facets in terms of study satisfaction and general life satisfaction.

Regarding affective facets, two negative and two positive achievement emotions were measured using a validated short version of the Achievement Emotions Questionnaire (AEQ-S; Bieleke et al., 2021) with four items for each emotion. We included anxiety (e.g., "When I study, I am anxious and nervous"), boredom (e.g., "I am bored with the work for my studies"), hope (e.g., "I am confident when learning"), and joy (e.g., "I enjoy engaging with the subject matter"). Responses ranged from 1 (*disagree completely*) to 5 (*agree completely*).

Regarding cognitive facets, study satisfaction was measured with 10 items covering satisfaction with study subjects (e.g., "Overall, I am satisfied with my current study subject"), with study conditions (e.g., "I wish that study conditions were better at my university"), and with coping with study-related stress (e.g., "I often feel tired and exhausted due to my studies"; Schiefele & Jacob-Ebbinghaus, 2006). Participants answered on a Likert-type scale ranging from 1 (*disagree completely*) to 6 (*agree completely*). We computed a total score for all items.

Life satisfaction was assessed using a one-item-scale ("How satisfied are you at present, all in all, with your life?"; Beierlein et al., 2014). Responses ranged from 1 (*not satisfied at all*) to 10 (*completely satisfied*). We chose this single-item measure as it offers a reliable, valid, and economic measurement of general life satisfaction.

Table 3
Bivariate manifest correlations of scale means.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Frequency of motivational regulation strategy use (T1)														
2. Frequency of motivational regulation strategy use (T2)	.67													
3. Frequency of motivational regulation strategy use (T3)	.67	.71												
4. Situation-specific fit of motivational regulation strategies (T1)	.22	.22	.27											
5. Situation-specific fit of motivational regulation strategies (T2)	.13	.19	.17	.62										
6. Situation-specific fit of motivational regulation strategies (T3)	.16	.08	.22	.62	.70									
7. Application quality of motivational regulation strategies (T1)	.38	.41	.37	.09	.11	.03								
8. Application quality of motivational regulation strategies (T2)	.36	.45	.37	.12	.07	–.00	.68							
9. Application quality of motivational regulation strategies (T3)	.29	.33	.39	.15	.05	.01	.63	.66						
10. Overall motivational regulation (T1)	.50	.44	.44	.17	.13	.13	.50	.39	.36					
11. Overall motivational regulation (T2)	.45	.54	.45	.19	.14	.08	.45	.52	.32	.60				
12. Overall motivational regulation (T3)	.45	.46	.55	.23	.20	.19	.42	.42	.47	.57	.57			
13. Subjective well-being (T1)	.28	.33	.27	.24	.25	.22	.28	.28	.22	.49	.45	.45		
14. Subjective well-being (T2)	.33	.43	.32	.24	.24	.14	.28	.33	.20	.46	.52	.46	.82	
15. Subjective well-being (T3)	.24	.29	.34	.23	.26	.22	.24	.29	.25	.34	.43	.51	.67	.74

Note. $N = 235–473$. All correlations $|r| \geq .09$ are statistically significant at $p < .05$ (one-tailed).

2.2.3. Auxiliaries

In addition to participants reporting their gender, current semester of study program, and current semester enrolled at university, we also measured academic motivation in terms of expectancy of success and subjective task value with the Motivation: Value and Expectancies for Success Scale (Schnettler et al., 2020) as auxiliary variables used for estimation of missing data. Expectancy was assessed with three items (e.g., "I believe I can be successful in my major"). Value was assessed in terms of intrinsic value, importance of achievement, personal importance, utility for personal development, and utility for job with 15 items (e.g., "I enjoy dealing with the content in my major"). Responses ranged from 1 (*disagree completely*) to 6 (*agree completely*).

2.3. Analyses

We estimated four cross-lagged panel models containing frequency of strategy use,[2] situation-specific fit, application quality, or overall motivational regulation and well-being, respectively, as manifest variables. For well-being, we computed a total score by averaging the scores for anxiety (inverted), boredom (inverted), hope, joy, study satisfaction, and life satisfaction.[3] In the cross-lagged panel models, we omitted second-order autoregressive paths and fixed the autoregressive and cross-lagged paths from T1 to T2 and from T2 to T3 to be equal for reasons of parsimony. Missing values were handled via full information maximum likelihood (FIML) estimation via the lavaan-package (v.06-19; Rosseel, 2012) in R (Version 4.2.1; R Core Team, 2022). Missing data were mainly due to participants not participating at subsequent waves. As Little's (1988) Missing Completely at Random (MCAR) test was statistically significant ($p < .001$), the data could not be assumed to be MCAR. Therefore, we conducted one-way ANOVAs for all motivational regulation constructs, well-being, current semester of study program, current semester enrolled at university, expectancy of success, and task value and a chi-square-test for gender at T1 to test for differences between participants who participated only at T1, who participated at T1 and one additional wave, and participants who participated in all waves. Significant differences were found for situation-specific fit, well-being, gender, current semester of study program, and task value ($ps < .05$; see supplement for detailed results). As these variables could account for missing data and be included in subsequent analyses, the data were treated as missing at random (MAR) and students' gender, current semester of study program, and task value were added to the models as auxiliaries via the semTools-package (Version 0.5-6.942; Jorgensen et al., 2022) to improve the estimation of missing data with FIML (Enders, 2010; Graham, 2009). Prior research has shown that handling missing data under the assumption of MAR with FIML is suitable (Enders, 2010; Enders & Bandalos, 2001). We applied Orth et al.'s (2022) guidelines for interpreting the magnitude of effects in longitudinal, cross-lagged analyses (.03, .07, .12 for small, moderate, and large effects, respectively). Model fit was evaluated using the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). According to Hu and Bentler (1998), a CFI and TLI greater than .90 and close to .95, and a RMSEA and SRMR smaller than .10 and close to .06 indicate acceptable or good model fit.

3. Results

3.1. Descriptive statistics

Descriptive statistics are reported in Table 2, and bivariate correlations among the motivational regulation components, overall motivational regulation, and subjective well-being in Table 3. Descriptively, means were slightly above the midpoint of the rating scale for all constructs. The observed value range and standard deviations indicate substantial interindividual differences between students. All motivational regulation constructs were positively and significantly associated with well-being. The means and the magnitude of autocorrelations between waves indicated that all variables were rather stable across the semester (Geiser, 2012). However, one to two thirds of variability in motivational regulation and well-being at later waves could be explained by the respective values thereof at the previous wave. Thus, there were still considerable amounts of to-be-explained variance left.

Table 4
Fit indices for cross-lagged panel models.

Model	χ^2	*df*	*CFI*	*TLI*	*RMSEA*	*SRMR*
Frequency of strategy use ↔ Subjective well-being	55.714	8	.953	.913	.106	.035
Situation-specific fit ↔ Subjective well-being	39.354	8	.966	.936	.086	.026
Application quality ↔ Subjective well-being	40.974	8	.966	.935	.088	.028
Overall motivational regulation ↔ Subjective well-being	39.180	8	.969	.942	.086	.029

Note. χ^2 = Yuan-Bentler robust test statistic.

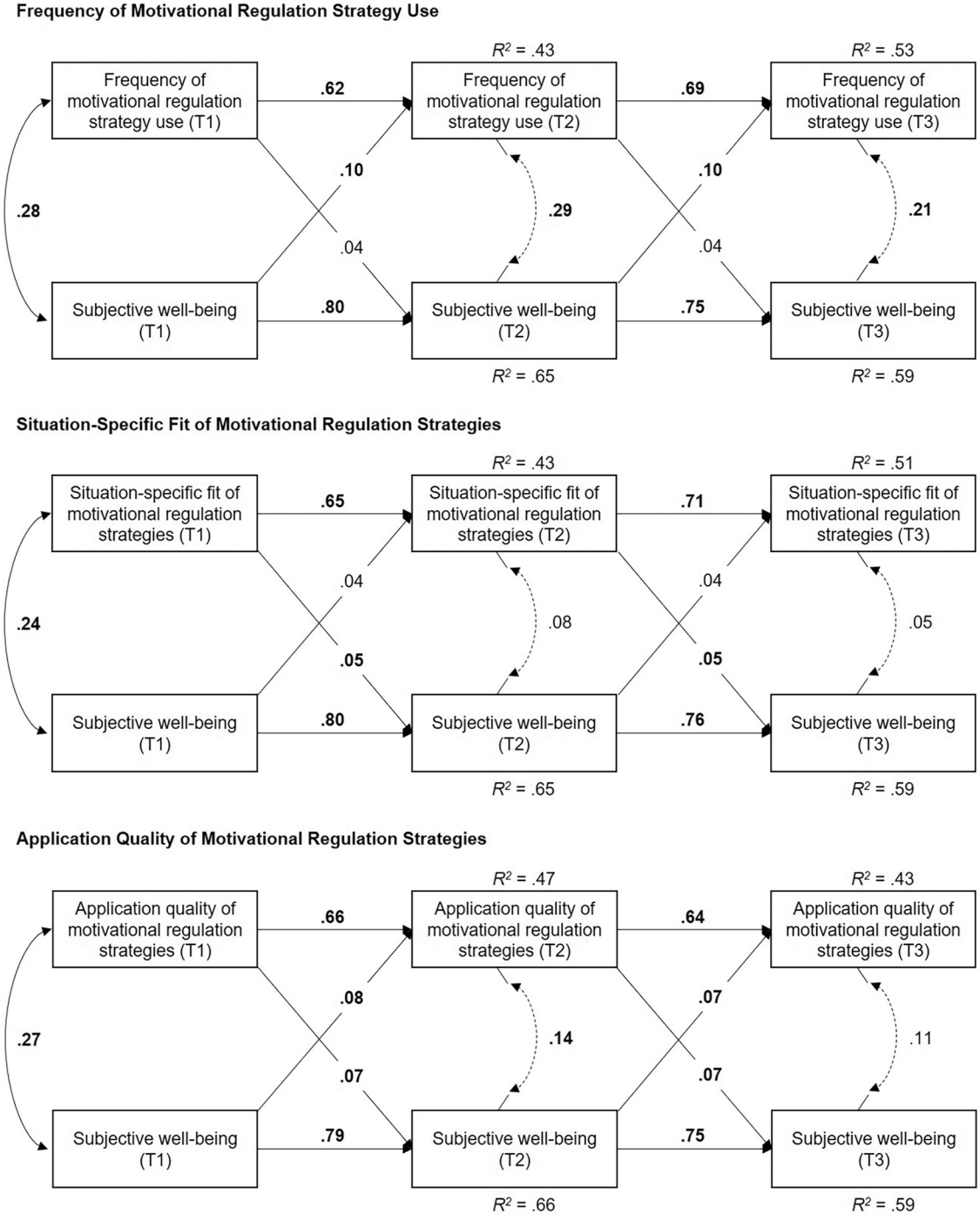
[2] Following Schwinger et al. (2009), overall frequency of strategy use was used in the respective model. The correlations between frequency of use of individual strategies, overall frequency of strategy use, and students' well-being are displayed in the supplement.

[3] Regarding the modeling of well-being as a single factor, supporting evidence from CFA analyses can be obtained from the supplement.

3.2. Cross-lagged panel models

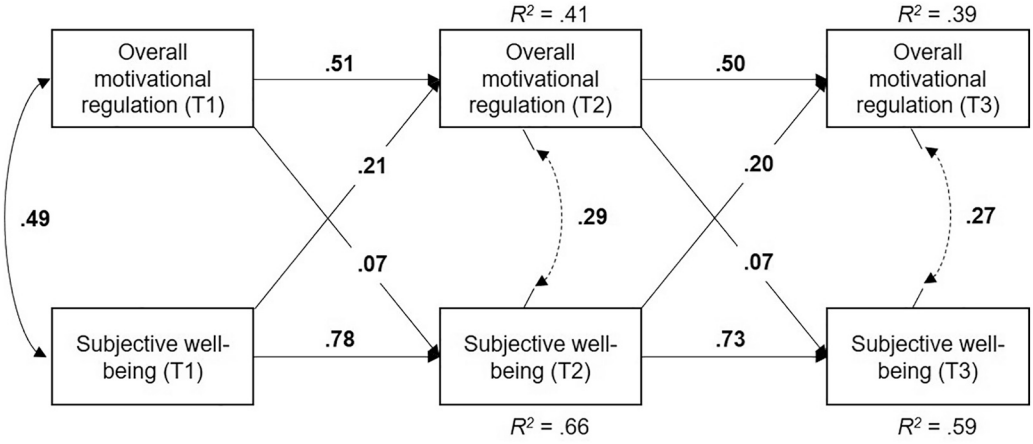
We examined longitudinal relations between the three motivational regulation components and overall motivational regulation, on the one hand, and well-being, on the other, in four cross-lagged panel models. Fit indices for these models ranged from acceptable to good (see Table 4).

Fig. 1 displays the standardized effects of the cross-lagged panel models for the three motivational regulation components, and Fig. 2 for overall motivational regulation. In all models, we found significant, positive, and strong autoregressive effects indicating a high stability of the motivational regulation constructs (ranging between .51 and .71) and well-being (ranging between .73 and .80) over time. Except for situation-specific fit, the correlations between the residuals at T2 and T3 were significant, positive and small to moderate. Nevertheless, these correlations point to additional influences on the respective variables at the same wave beyond autoregressive and cross-lagged effects. Overall, between 39.3 % and 52.7 % of variance of the motivational regulation



Note. Presented are standardized coefficients. Significant coefficients are printed in bold (p <.05, one-tailed). T1/T2/T3 = first/second/third measurement time point.

Fig. 1. Cross-lagged panel models for linkages of frequency of motivational regulation strategy use, situation-specific fit, and application quality of motivational regulation strategies, with subjective well-being.



Note. Presented are standardized coefficients. Significant coefficients are printed in bold (p <.05, one-tailed). T1/T2/T3 = first/second/third measurement time point.

Fig. 2. Cross-lagged panel model for linkages of overall motivational regulation with subjective well-being.

constructs and between 58.6 % and 65.8 % of variance of well-being could be explained at T2 and T3, respectively.

In line with Hypotheses 1a and 1b, frequency of strategy use was not significantly related to subsequent well-being (H1a); higher well-being, in turn, was significantly associated with subsequent higher frequency of strategy use (H1b; moderate effects). Corroborating Hypotheses 2a and 2b, higher situation-specific fit was significantly related to subsequent higher well-being (H2a; small effects); no significant relation emerged between well-being and subsequent situation-specific fit (H2b). In line with Hypotheses 3a and 3b, we found a reciprocal relationship between application quality and well-being: Higher application quality was significantly associated with subsequent higher well-being (H3a; moderate effects), and higher well-being, in turn, with subsequent higher application quality (H3b; moderate effects). Finally, corroborating Hypotheses 4a and 4b, overall motivational regulation and well-being were also reciprocally linked: Higher overall motivational regulation was significantly related with subsequent higher well-being (H4a; moderate effects), and higher well-being with subsequent higher overall motivational regulation (H4b; large effects).

To check the robustness of the results, we estimated additional models which include interaction terms between frequency of strategy use, situation-specific fit, and application quality. These models revealed no significant interaction effects, which speaks to the validity of the reported main effects (see supplement for further details). It is important to note that this cannot be seen as a rigorous test of hypotheses targeting interactions between the three motivational regulation components, as those proposed by von der Mülbe et al. (2024), for example, because this would require a much larger sample size (e.g., Leon & Heo, 2009; Sommet et al., 2023).

4. Discussion

Previous research has shown that motivational regulation is linked to subjective well-being and that different components of motivational regulation, namely frequency of strategy use, situation-specific fit, and application quality, contribute not only to effective motivational regulation, but also well-being (von der Mülbe et al., 2024). However, it is also theoretically sound that well-being, in turn, can shape learners' subsequent motivational regulation. The present research provides more nuanced insights into the interplay between motivational regulation and well-being especially regarding the direction of their relations, illuminates the role of well-being as an outcome *and* a resource for successful self-regulation, and informs practitioners in higher education on how to foster students' learning, achievement, and health. By bridging different research traditions on motivation, emotion, and self-regulation, the present paper can also help to integrate theoretical approaches on motivational and affective self-regulatory processes. Accordingly, it builds on different theoretical models (Eccles & Wigfield, 2020; Fredrickson, 2001; Pekrun, 2018; Zimmerman, 2013), summarizes extant theoretical assumptions about possible linkages between motivational regulation components and well-being, and tests these assumptions using a longitudinal approach. In light of recent advances in motivational regulation research, we conceptualized and assessed both motivational regulation and subjective well-being as multicomponent constructs. Regarding motivational regulation, we considered not only how frequently students use motivational regulation strategies, but also their knowledge about the situation-specific fit of strategies and the quality with which strategies are applied. Regarding subjective well-being, we included cognitive as well as affective facets that were captured in terms of discrete achievement emotions. The central innovation of the present work is to include all three motivational regulation components and examine their bidirectional linkages with well-being in a longitudinal design.

4.1. Summary and discussion of findings

In line with Hypotheses 1a and 1b, frequency of strategy use did not predict students' subsequent subjective well-being. However, higher levels of well-being had a moderate positive effect on subsequent frequency of strategy use. While cross-sectional research (e.g., Grunschel et al., 2016; von der Mülbe et al., 2024) has linked frequency of strategy use with well-being, our results indicate that these associations might be driven by well-being serving as a resource for frequent strategy use and that merely applying strategies more frequently might not be beneficial for well-being per se. Higher levels of well-being may equip students with important resources (e.g., cognitive, motivational) required for applying self-regulatory strategies more frequently. These findings are in line with the notion that positive emotions can benefit students' learning through broadening their thought-action repertoires (Fredrickson, 2001) and the idea that emotions and satisfaction can inform subsequent self-regulatory efforts (Zimmerman, 2013). Furthermore, the findings point once more to the importance of other motivational regulation components.

In line with Hypotheses 2a and 2b, situation-specific fit of regulatory strategy use had a positive effect on subsequent well-being, while well-being, in turn, did not predict subsequent situation-specific fit. Although the effect of situation-specific fit on well-being was small, these results indicate that positive associations found in prior research (von der

Mülbe et al., 2024) might be primarily driven by the influence of students' conditional strategy knowledge on their well-being than vice versa. This underscores the importance of knowledge about the suitability of motivational regulation strategies for effectively managing specific motivational problems, but also for student well-being. Furthermore, our findings indicate that situation-specific fit in terms of students' conditional strategy knowledge might be the only one of the three motivational regulation components not affected by students' levels of well-being. We would argue that well-being mostly impacts students' resources for motivational regulation. However, as having more resources (e.g., motivation, self-regulation, or attention) when dealing with motivational problems does not increase knowledge, it should not directly contribute to their conditional strategy knowledge. Future research should explore whether subjective well-being influences whether students act in accordance with their knowledge when dealing with motivational problems and actually employ strategies that fit the situation. For example, students might lean towards using less demanding or better-known instead of fitting strategies in stressful situations with low resources (e.g., cognitive, motivational). Moreover, effects of higher well-being on conditional strategy knowledge may take longer stretches of time to manifest themselves and are contingent on students' gathering experience with different motivational regulation strategies and different motivational problems.

In line with Hypotheses 3a and 3b, application quality and well-being influenced each other positively and reciprocally over time. On a descriptive level, these effects were comparable in magnitude. In line with prior cross-sectional results (von der Mülbe et al., 2024), our findings highlight that teaching students how to apply strategies in an accurate and target-oriented manner and control their strategy use optimally can be a valuable pathway to fostering well-being. However, they also indicate that bringing such skills into practice might require students to feel (reasonably) well in the first place, as higher levels of well-being can provide students with broader thought-action repertoires and consequently, more personal resources for self-regulatory efforts and as the metacognitive processes involved in high-quality strategy use might be especially taxing. Taken together, these findings further speak to the importance of considering motivational regulation in terms of its different components when examining its antecedents and outcomes. They also corroborate the assumption that well-being may not only constitute an outcome of students' motivational self-regulation, but also a precondition for engaging in effective and effortful self-regulation.

Lastly, our results concerning Hypotheses 4a and 4b support the assumption that overall motivational regulation and well-being are reciprocally related. We included overall motivational regulation regarding students' perceived overall tendency to engage in motivational regulation in response to motivational challenges, as prior research often used summative indicators for motivational regulation (e.g., Bäulke et al., 2019). Overall motivational regulation had a moderate positive effect on subsequent well-being which in turn, had a large positive effect on subsequent overall motivational regulation. Descriptively speaking, the effect of well-being on overall motivational regulation was considerably larger than the effect in the opposite direction, again stressing the importance of well-being as a resource for motivational regulation. These findings align with previous research on relations between effective motivational regulation and well-being (von der Mülbe et al., 2024): Motivational regulation can not only be adaptive for students' motivation, but also for their well-being.

Taken together, the present work provides supporting evidence for differential effects of three motivational regulation components and overall motivational regulation on subjective well-being, and vice versa, with situation-specific fit and application quality positively predicting subsequent well-being, and well-being, in turn, positively predicting frequency of strategy use and application quality.

4.2. Limitations and directions for future research

While this paper consolidates theoretical deliberations and empirical research with several strengths, the following limitations should be considered when interpreting our findings and deriving directions for future research. First, cross-lagged panel analyses were conducted at a manifest level, which might introduce measurement errors. Future research should employ latent modeling to control measurement errors better and corroborate our findings. Moreover, interaction effects of the motivational regulation components on well-being were only tested to check for robustness of the main effects. As the sample size was insufficient for a rigorous test of hypotheses regarding such interaction effects, future research should examine the differential effects of motivational regulation components on well-being in joint models and explore the interactions between these components. For example, the effects of frequency of strategy use on well-being might be dependent on whether students apply fitting strategies, as indicated in a study by von der Mülbe et al. (2024). Furthermore, while our analytic approach provides important insights into longitudinal relations between motivational regulation and subjective well-being, especially regarding the temporal ordering of their relations, we cannot rule out that unobserved third variables (e.g., personality, contextual factors in higher education) affect motivational regulation, well-being, and their relations, implying that we cannot unequivocally infer causality from the present study design. This calls for future experimental studies.

Second, motivational regulation and well-being demonstrated relatively high temporal stability across one semester which might account for the partly small effects. It may be possible that some effects unfold over longer time periods than those captured in our study or that motivational regulation and well-being might also influence each other on a situational level in shorter time spans, for example, during exam preparation periods when students are faced with a range of motivational challenges. While overall higher well-being should increase students' resources for successful motivational regulation, it might also be possible that within specific learning situations, negative emotional states might serve as triggers for engaging in regulatory efforts. Therefore, future research should consider longitudinal designs covering longer time periods *and* more fine-grained assessment of students' regulatory efforts and emotional experiences (e.g., with diary studies, experience sampling designs). Moreover, such assessments should also include possible mediating variables (e.g., motivational or cognitive resources) that might drive the linkages between motivational regulation and well-being.

Third, except for situation-specific fit, all constructs were assessed with self-report measures. While it can be argued that constructs such as students' emotions and well-being that inherently constitute and derive from subjective experiences and perceptions are best captured through self-report (e.g. Pekrun et al., 2023), future research might benefit from additional data channels (e.g., behavioral data) on students' frequency of strategy use, application quality, and overall motivational regulation. However, this is challenging for strategies mainly involving cognitive processes (e.g., self-talk). Moreover, considering the frequency of use of individual motivational regulation strategies in addition to overall frequency of strategy use might deepen our understanding of students' strategy use in future research.

Lastly, we cannot completely rule out potential influences of the dropout of participants between waves on the results, although we included auxiliary variables identified through missing data analyses to improve model estimation (Enders, 2010). Moreover, as our sample focused on STEM students in earlier study phases and included a high proportion of students identifying as male, future research should probe the robustness of our findings in other study phases and fields that might entail different sample demographics.

4.3. Conclusions and practical implications

Our findings show that, in line with contemporary theorizing, motivational self-regulation matters for students' well-being and, vice versa, well-being matters for their motivational self-regulation. These results advance our understanding of motivational regulation and its role in students' academic journeys: They provide longitudinal evidence that motivational regulation can also be functional for students' well-being and health, emphasizing that the importance of motivational regulation for students' learning, success, and health may even be more significant than previous research suggests. Building on the conceptual and functional overlap between motivation, emotions, and their regulation (Bong et al., 2023), recent findings and theoretical deliberations by Stockinger et al. (2025; in press) point to the relevance of both motivational and emotion regulation strategies for motivational as well emotional challenges and call for joint perspectives on motivational and emotion regulation. On a similar note, the present work also establishes a connection between research on motivation and emotion. This can help to refine and join theoretical approaches as well as disentangle the interplay of motivational self-regulatory and affective processes in the higher education context.

Furthermore, the present work indicates what makes motivational self-regulation successful in several regards: For one, our findings attest to the importance of adopting more differentiated conceptualizations and measurement of self-regulatory efforts in future research. As the present work highlights that merely applying self-regulatory strategies more frequently might not be beneficial for student well-being, taking a closer look on the role of situation-specific fit and application quality in regulatory processes as well can advance research on students' strategy use in self-regulated learning (see Glogger et al., 2012; Leutner et al., 2007, for similar suggestions). Moreover, as our findings show well-being to impact motivational regulation as well, future research on motivational regulation can benefit from considering potential preconditions and resources available to students such as their subjective well-being.

Insight into which motivational regulation components impact student well-being can also provide guidance for practitioners in higher education. While our findings highlight that promoting motivational regulation can be an important element in fostering students' well-being, it is pivotal to teach students not only which strategies they can use in general. They also need to learn how to select strategies suitable for the motivational problem and learning situation at hand and how to implement strategies in an accurate and target-oriented manner as well as monitor and adapt their strategy use adequately. Moreover, informing students about the benefits of improving situation-specific fit or application quality instead of simply increasing the frequency of their strategy use when facing motivational problems might help students to invest resources and effort more effectively and avoid negative feelings such as frustration. As motivational regulation has also been linked to students' learning behaviors and success (e.g., Engelschalk et al., 2017; Schwinger et al., 2009), addressing comprehensive regulatory competencies could be pivotal for developing effective and efficient support programs targeting student success and health. Although prior research has not commonly considered this causal direction of effects (e.g., Trautner et al., 2025), well-being also emerges as an important precondition of applying strategies frequently and well. Thus, it might also be a resource for other regulatory and learning processes. This suggests that higher education should devote more resources to promoting students' well-being to support their academic journeys. In the spirit of connecting insights from motivation and emotion research, integrating elements into programs fostering motivational regulation in which students develop skills to regulate emotional experiences and be mindful of positive aspects of their academic lives in (motivationally) challenging situations might boost students' abilities to apply regulatory skills more successfully.

CRediT authorship contribution statement

Sophie von der Mülbe: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Kristina Stockinger:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Anne Scheunemann:** Writing – review & editing, Investigation. **Lena S. Kegel:** Writing – review & editing, Investigation. **Jens Fleischer:** Writing – review & editing, Investigation. **Detlev Leutner:** Writing – review & editing, Investigation, Funding acquisition. **Joachim Wirth:** Writing – review & editing, Investigation, Funding acquisition. **Carola Grunschel:** Writing – review & editing, Investigation, Funding acquisition. **Markus Dresel:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.lindif.2025.102850.

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