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Intertwining self-efficacy, basic psychological need satisfaction, and emotions in higher education teaching: A micro-longitudinal study

Melanie V. Keller¹ · Raven Rinas¹ · Stefan Janke² · Oliver Dickhäuser² · Markus Dresel¹ · Martin Daumiller¹

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Abstract

Prior research has explored various factors to explain differences in teaching experiences and behaviors among school teachers, including self-efficacy, basic psychological need satisfaction, and emotions. However, these factors have predominantly been examined in isolation, and limited research has investigated their role in the context of higher education teaching. To address these research gaps, analyses on both the within and between teacher level are needed. The aim of the present study was therefore to investigate the interplay between these motivational and emotional constructs on both levels, as well as the relevance and applicability of prior research findings on school teachers to the context of higher education teaching at universities. In a micro-longitudinal study, 103 university teachers from Germany (49 female; average age: 41.4 years, $SD=11.0$) completed assessments of their self-efficacy in 748 sessions directly before their teaching sessions, as well as their basic psychological need satisfaction and discrete emotions directly after. Multilevel structural equation modeling revealed positive associations between self-efficacy and basic psychological need satisfaction. Self-efficacy was negatively associated with negative emotions, and positive indirect effects on positive emotions as well as negative indirect effects on negative emotions were identified through satisfaction of the needs for competence and relatedness. Basic psychological need satisfaction was positively related to positive emotions and vice versa—however, unexpected positive associations between relatedness and negative emotions emerged and require further research.

Keywords Higher education teachers · Self-efficacy · Basic needs · Emotions · Teacher motivation

1 Introduction

Motivation and emotion play crucial roles in fostering learning and achievement in school and higher education contexts—this holds true both for students and teachers. Accordingly, there has been significant growth in research investigating these constructs in educational contexts in recent decades (Hall & Goetz, 2013). Teaching, particularly in higher education, is a complex, emotion-laden profession that requires a high degree of self-control and self-management, making it important to understand teachers' motivational and emotional experiences to support high quality instruction (Lin et al., 2005). Higher education teachers make valuable contributions to society through their research and scientific advancements (e.g., Javitz et al., 2010) as well as their teaching—which significantly impacts student outcomes such as engagement (BrckaLorenz et al., 2012) and learning (Pascarella & Terenzini, 2005). Recent studies have therefore expanded their focus to explore the role of motivation and emotion in higher education teachers (Daumiller et al., 2020, Mendzheritskaya et al., 2019; Watt & Richardson, 2020). To describe and explain teachers' experiences, including those in higher education, self-efficacy, basic psychological need satisfaction (BPNS), and emotions have emerged as widely used and meaningful theoretical constructs (Daumiller et al., 2020).

The primary aim of the present study was to integrate these theoretical foundations to paint a comprehensive picture of motivation and emotion in higher education teachers. To accomplish this, we examined teachers' self-efficacy and the satisfaction of their needs for competence, autonomy, and relatedness as key motivational factors, along with their discrete emotions. Through teachers' immediate assessments of their experiences during specific teaching sessions, we closely examined the intricate relations between these constructs. Moreover, our analysis encompassed both between and within person levels of interaction, while also considering indirect relationships. This detailed and context-specific approach provides nuanced insights into the dynamics between motivation and emotion in higher education teaching that can guide further research on higher education teachers and aid in the development of effective strategies to support successful teaching.

2 Higher education teachers' self-efficacy, basic psychological need satisfaction, and discrete emotions

Higher education teachers' motivation can be defined as the overall processes that give rise to initiating, sustaining, and regulating goal-directed behaviors (Daumiller et al., 2020). Within this conceptualization, self-efficacy and BPNS can be considered as core aspects of teachers' motivation. Together, these two aspects serve as a powerful approach for describing teachers' motivation within specific teaching situations, as they represent different lenses through which

motivational dynamics can be understood. They are influenced by individual characteristics of the teacher (e.g., personal traits; person-specific) as well as by characteristics of the situational context (e.g., behaviors of others; context-specific), painting a holistic picture of motivation.

Self-efficacy for teaching represents beliefs that teachers hold about their teaching competence, while BPNS, as defined in Self-determination theory (SDT), considers how teachers' needs are satisfied within a given teaching situation. From a theoretical perspective, these different aspects of motivation regulate teachers' cognitions, behaviors, and affect, and within the affective component, are also related to experiences of emotions (Dresel & Hall, 2013). We conceptualize emotions as discrete emotions that are connected, but not identical to the term motivation. Specifically, following Pekrun and Stephens (2010), we view emotions as multifaceted phenomena including affective, cognitive, physiological, motivational, and expressive components, and focus on the discrete, affective component experienced within an achievement situation in the present study.

Prior research has highlighted the value of combining these three constructs to better understand individual experiences and behaviors. Sweet et al. (2012) combined self-efficacy and parts of SDT to explain health behaviors (i.e., physical activity) of university students and found that simultaneously examining and combining these constructs in a single model enhanced explanations of goal-directed behavior (Sweet et al., 2012). Bandura (1977) drew close links between self-efficacy and emotions in his theoretical framework, where beliefs about successfully managing and performing tasks are posited to influence emotional responses, and in turn, future beliefs. Moreover, Basic Psychological Need Theory, as one of the mini-theories within SDT (Vansteenkiste et al., 2010), is considered to be a part of functioning and well-being, with well-being, among other aspects, defined as experiencing more positive and less negative emotions (Ryan & Deci, 2017; Vansteenkiste et al., 2020), suggesting a link between BPNS and emotions. Empirical evidence in academic contexts, such as the work of Holzer et al. (2021), found consistent associations between positive emotions and satisfaction of all three of the basic psychological needs, further supporting the link between BPNS and emotions. Despite these encouraging findings, studies have yet to examine how self-efficacy and BPNS are related and how both constructs matter for teachers' emotions in the context of higher education teaching.

2.1 Self-efficacy for teaching and its relevance for teaching

Self-efficacy refers to an individual's beliefs about their ability to master situations and successfully overcome obstacles (Bandura, 1997). Previous research provides a wide range of evidence highlighting associations between self-efficacy and aspects of successful teaching. For instance, in the case of school teachers, high self-efficacy has been linked to effective teaching practices, the ability to cater to students' individual needs and motivate them successfully, as well as greater persistence, enthusiasm, commitment, and positive affect (Allinder, 1994; Ghaith & Yagi, 1997; Klassen et al., 2011; Schwerdtfeger et al., 2008; Skaalvik & Skaalvik, 2007;

Tschannen-Moran & Hoy, 2001). These findings underscore the significance of self-efficacy as a meaningful aspect of teacher motivation, which has implications not only for teachers themselves, but also for their students (Klassen & Tze, 2014).

Although less researched than in the school teacher context, self-efficacy has also been assessed in studies on higher education faculty, particularly in relation to the research domain (e.g., Hemmings & Kay, 2009; Pasupathy & Siwatu, 2014). The importance of self-efficacy for teaching in higher education has been illustrated in early descriptive research (Bailey, 1999) and in subsequent studies that have identified similar patterns as observed in school teachers. For example, in higher education, self-efficacy has been linked with teachers' motivation to improve their teaching through professional development workshops (Young & Kline, 1996), higher job satisfaction (Ismayilova & Klassen, 2020), adaptive framing of negative events (Morris & Usher, 2011), more enthusiasm for teaching and the subject (Daumiller et al., 2016), as well as reduced stress levels (Yin et al., 2020). Concerning student outcomes, self-efficacy for teaching has also been linked to the use of content-related humor in teaching (Daumiller, Janke, Hein et al., 2019), teaching quality (Daumiller et al., 2019), and student learning and engagement (Daumiller, Janke, Hein et al., 2021; Fong et al., 2019). These findings indicate that the importance of self-efficacy for teaching found among school teachers is also applicable and relevant in the context of higher education.

Despite the existing research on self-efficacy in higher education teachers, there is still little understanding of how self-efficacy is intertwined with BPNS during teaching, and how it relates to discrete emotions during teaching in higher education. Importantly, the mentioned associations have mostly been looked at regarding teaching in general, potentially omitting nuanced insights that can only be captured by considering teachers' experiences within specific teaching sessions and situations.

2.2 Basic psychological need satisfaction and its relevance for teaching

BPNS, as conceptualized in SDT (Deci & Ryan, 2000, 2008), is relevant for understanding how features of the teaching context influence (higher education) teachers' motivation through fulfillment of the needs for competence, autonomy, and (Stupnisky et al., 2018). In order to fulfill their basic psychological needs, teachers need to perceive themselves as effective and mastering (satisfaction of the need for competence), experience volition and willingness (satisfaction of the need for autonomy), as well as feel connected to and significant in the eyes of others (satisfaction of the need for relatedness, Vansteenkiste et al., 2020). Within SDT, it is assumed that high satisfaction of the needs for competence, autonomy, and relatedness contribute to effective functioning and well-being (Ryan & Deci, 2017; empirically validated in school contexts, e.g., by Taylor et al., 2008; Vansteenkiste et al., 2009). Research on SDT in higher education teachers, mainly in North America, has shown that satisfaction of basic psychological needs is connected to autonomous work motivation, teaching quality, and the use of best practices in teaching in higher education (e.g., Esdar et al., 2016; Stupnisky et al., 2016, 2017). Additionally, studies on basic psychological need satisfaction and achievement goals have confirmed that BPNS

of higher education teachers shows similar relations across different countries and institution types (Daumiller, Janke, Rinas et al., 2021; Stupnisky et al., 2018). These findings suggest that BPNS plays a significant role in shaping the teaching practices of higher education teachers.

2.3 The role of discrete emotions in teaching

Teaching is an inherently emotional task (Frenzel, 2014; Sutton & Wheatley, 2003), which also holds true for the higher education context (Gardner & Leak, 1994; Mendzheritskaya & Hansen, 2019; Postareff & Lindblom-Ylänne, 2011; Thies & Kordts-Freudinger, 2019). Research on school teachers has identified positive links between teacher enjoyment and effective instructional strategies, student performance, and engagement in informal learning activities (Frenzel et al., 2020, 2021; Huang et al., 2020). In the higher education context, teachers' emotions have also been closely linked to their perceived success (Stupnisky et al., 2019) as well as the value they attribute to teaching (Stupnisky et al., 2016). Furthermore, emotions experienced by higher education teachers have been associated with motivational constructs such as self-efficacy beliefs (Burić & Frenzel, 2019; Burić & Moe, 2020) and achievement goals (Rinas et al., 2020). This illustrates that teacher emotions play a central role in the nexus of teaching experiences and student outcomes (see also Frenzel et al., 2021).

Given the significance of emotions in teaching, gaining nuanced insights into teachers' discrete emotions and their relationships with motivational constructs, such as self-efficacy and BPNS, represents a promising research direction for understanding teachers' experiences. In the present study, we cover an array of discrete emotions, namely joy, pride, anxiety, anger, shame, and boredom, which encompass both positive/negative value and activating/deactivating object focus (see Pekrun et al., 2007). These specific emotions have been frequently reported in higher education teaching (Hagenauer & Volet, 2014; Keller et al., 2014; Thies & Kordts-Freudinger, 2019) and have been found to be related to perceived success in teaching (Stupnisky et al., 2019).

2.4 Interplay between self-efficacy, basic psychological need satisfaction, and emotions in teaching

Understanding the interplay between self-efficacy, BPNS, and the discrete emotions experienced during teaching is crucial for gaining a deeper understanding of how motivation and emotions intertwine within the context of higher education teaching. In the following sections, we outline how, based on theoretical considerations and prior empirical findings, self-efficacy, BPNS, and emotions can be expected to be associated with one another. Specifically, we propose that self-efficacy for teaching in a specific lesson is directly linked to teachers' satisfaction of the needs for competence, autonomy, and relatedness. These core psychological needs, when fulfilled, can be expected to contribute to emotions experienced during teaching.

Furthermore, we suggest that self-efficacy has both direct and indirect influences on discrete emotions, with the indirect impact being mediated through BPNS.

2.4.1 Interplay between self-efficacy and BPNS

Before describing the interplay between self-efficacy and satisfaction of the three basic psychological needs, it is important to acknowledge the similarity between self-efficacy and the experience of competence, as both focus on teachers' perceived teaching competence. Nevertheless, we draw a clear differentiation between the two constructs: Self-efficacy for teaching, as it is perceived prior to a lesson, describes teachers' beliefs about being able to successfully teach and overcome obstacles within a lesson, and is thus rooted in the teachers themselves and their previous experiences, but directed at an upcoming lesson. In contrast, satisfaction of the need for competence focuses on a retrospective view of a given lesson and how it went, assessing whether the teacher felt competent during their teaching. Thus, satisfaction of the need for competence is more contingent upon the circumstances of the specific lesson.

Regarding the interconnections between self-efficacy and BPNS, from a theoretical perspective, high self-efficacy facilitates confidence and better performance, which should lead to teachers feeling more competent during teaching. This expectation is supported by research that has found teacher self-efficacy to be associated with effective classroom processes and student academic adjustment (Ashton & Webb, 1986; Zee & Koome, 2016). Thus, we expect self-efficacy for teaching to be positively connected to satisfaction of the need for competence during a teaching session.

Furthermore, it stands to reason that teacher self-efficacy is positively related to satisfaction of the need for autonomy: According to the underlying theory (Bandura, 1997), teachers with high self-efficacy beliefs for teaching may be more capable of effectively navigating challenges in their teaching, leading to a sense of autonomy in their decision-making and responses. Conversely, teachers with lower self-efficacy may perceive themselves as less competent when encountering unexpected challenges, leading them to simply react to problems occurring during teaching rather than proactively addressing them and potentially undermining their sense of autonomy. Thus, teachers' self-efficacy should be closely related to the extent to which their need for autonomy is satisfied during teaching.

Lastly and also according to Bandura's theoretical conceptions of self-efficacy (Bandura, 1997), teachers with strong self-efficacy beliefs are expected to be more effective in engaging with and motivating their students, contributing to higher teaching quality (see Praetorius et al., 2018). Consequently, their satisfaction of the need for relatedness to their students may be supported by effectively engaging students in a lesson and thus enhance the feeling of connectedness to those students by enhancing interpersonal communication. In summary, we anticipate strong positive connections between self-efficacy for teaching and the satisfaction of the three basic psychological needs.

2.4.2 Interplay between self-efficacy and emotions

Emotions are often considered to be antecedents of self-efficacy beliefs (Pekrun et al., 2007), as supported by empirical findings such as those of Burić et al. (2020), who identified negative emotions as antecedents of lower teacher self-efficacy in a longitudinal study with school teachers. At the same time, emotions are influenced by an individual's perception of their ability to achieve goals, which is captured by self-efficacy (Frenzel et al., 2009). In our study, we specifically aim to examine the relationship between self-efficacy for teaching prior to a lesson and the emotions experienced during that session, thus focusing on the relevance of self-efficacy for emotions.

For this relationship, control-value theory suggests that self-efficacy, which informs the teachers' perceived control in a teaching situation, serves as one appraisal for emotions (Pekrun et al., 2007). Specifically, high self-efficacy for teaching implies perceptions of high control, favoring rather positive emotions depending on the situation's value. Conversely, low self-efficacy for teaching implies rather low control over teaching situations, which favors experiencing rather negative emotions depending on the accompanying value.

Furthermore, self-efficacy can be expected to be positively associated with positive emotions such as joy and pride, and negatively associated with negative emotions such as anxiety, anger, shame, and boredom, based on the theoretical rationale that high self-efficacy promotes more effective teaching and better coping abilities (e.g., Skaalvik & Skaalvik, 2007; Tschannen-Moran & Hoy, 2001). Thus, teachers with higher self-efficacy are inclined to hold the belief that they can effectively navigate teaching challenges and are more likely to demonstrate successful problem-solving skills in practice. Consequently, these teachers may experience more positive emotions, such as joy and pride, and encounter less anger during their instructional activities, as they are better equipped to manage demanding situations.

In addition to dealing with actual problems that arise during teaching, the anticipation of teaching problems could already lead to emotional effects. For instance, if a teacher has low self-efficacy beliefs, they might be afraid of making mistakes and consequently experience increased anxiety during their teaching. Similarly, feelings of shame during teaching may arise from a perceived inadequacy in their ability to effectively handle difficult situations. Concerning boredom, teachers with high self-efficacy beliefs are more likely to engage in effective instructional strategies that promote student interest and engagement, reducing the likelihood of boredom in the classroom (e.g., Fong et al., 2019).

While there is limited empirical research examining the above-mentioned interconnections in higher education teachers, some studies have provided preliminary support for the proposed pattern of linkages (see Lobeck et al., 2018, for results focused on emotions and self-concept). These findings, combined with the theoretical foundations highlighting their interrelatedness, indicate that self-efficacy may play a meaningful role in shaping the emotions experienced by higher education teachers. Nevertheless, there is a need for empirical testing and validation of this assumption.

2.4.3 Interplay between BPNS and emotions

Following SDT, satisfaction of the needs for competence, autonomy, and relatedness is closely connected to well-being, which encompasses both positive and negative affective experiences. In SDT, the positive and negative affect components of well-being can be further differentiated into finer grained emotional experiences (Ryan & Martela, 2016). Following this, we take a detailed approach by examining several discrete emotions that are relevant for achievement and teaching contexts (Pekrun et al., 2007; Stupnisky et al., 2016). Besides well-being, BPNS facilitates intrinsic motivation (as defined in SDT), which has been found to be positively associated with positive emotions, and negatively associated with negative emotions (Deci & Ryan, 2000). Accordingly, the same pattern of linkages can be proposed for the satisfaction of the needs for competence, autonomy, and relatedness. Guided by these broader theoretical notions, each of the basic psychological needs and their relations with the six discrete emotions examined (joy, pride, anxiety, anger, shame, and boredom) are described in the following sections.

Beginning with satisfaction of the need for competence, we draw upon the principles of SDT to propose that higher satisfaction of this need is positively linked to positive emotions. Specifically, when teachers feel more competent during their teaching, they are more likely to experience greater joy and a sense of pride in their teaching. Moreover, teachers who feel competent during teaching can be expected to be less likely to experience anxiety, anger, and shame in a lesson (e.g., when facing mistakes) and to be less bored during their teaching. A reason for this is that higher satisfaction of the need for competence is associated with more engaging teaching practices and teaching quality (see Esdar et al., 2016; Stupnisky et al., 2016) and teachers teaching successfully are less likely to encounter situations eliciting negative emotions.

Moreover, we propose that the associations between satisfaction of the need for autonomy and emotions follow the same underlying assumptions as for competence. Teachers who perceive themselves as autonomous during their teaching are more likely to experience joy and pride. This link may be further emphasized by the notion that teachers who have the autonomy to make their own decisions in teaching assume more responsibility for teaching outcomes and derive greater pride from their successes. Conversely, teachers whose need for autonomy is not fulfilled are more likely to experience negative emotions during their teaching, including anxiety, anger, shame, and boredom (Deci & Ryan, 2000), as the impression of being controlled by outer circumstances might lead to feeling pressure and annoyance. Empirical evidence supports this reasoning, demonstrating that university teachers' sense of control over teaching situations is positively associated with positive emotions and negatively associated with negative emotions (Hagenauer & Volet, 2014).

Regarding satisfaction of the need for relatedness, teachers whose need for relatedness to their students is more satisfied may exhibit greater emotional investment in their teaching and their students' learning. As a result, they may be more likely to experience positive emotions: Teachers who establish satisfying social connections with their students when teaching may experience higher levels of joy and pride, both in their own teaching and regarding their students' learning experiences.

Additionally, they can be expected to be less likely to feel anxiety, anger, shame, and boredom, as relatedness might be accompanied by a higher level of trust and ease. First empirical evidence supports these assumptions, with studies having found positive associations between social connectedness and enjoyment, as well as negative associations with anxiety and anger among teachers (Hagenauer & Volet, 2014; Klassen et al., 2012).

These theoretical and empirical foundations point to satisfaction of the needs for competence, autonomy, and relatedness being positively related to positive emotions and negatively related to negative emotions during teaching. We acknowledge that the reverse direction between BPNS and emotions is also plausible, however, from a SDT perspective, we expect a path from BPNS to emotions. Moreover, as previously argued, self-efficacy at the start of a teaching session might influence BPNS during the session by shaping how teachers perceive and interpret their experiences. Taken together, it stands to reason that self-efficacy for teaching matters for the emotions that teachers experience during teaching, directly and indirectly, through their BPNS.

2.5 Temporal and situational changes in higher education teachers' motivation

How self-efficacious higher education teachers feel towards their teaching does not only vary between different teachers, but also from situation to situation within a teacher. For example, a teacher might hold higher or lower self-efficacy beliefs from one session to the next depending on the lesson topic. Additionally, recent evidence suggests that stable and session-specific aspects of self-efficacy may be differently relevant, with person-stable parts of self-efficacy having been found to matter more for student learning than session-specific self-efficacy (Daumiller, Janke, Hein et al., 2021). Besides that, it has been recommended that self-efficacy should be measured in a precise and context-specific manner, tailored to the specific teaching context (Bandura, 1986; Pajares, 1996). Thus, in the context of the present study, we focus on individual teaching sessions and seek to capture teachers' experiences more accurately by assessing their self-efficacy for each session.

Next to self-efficacy, BPNS is highly context-specific given that the satisfaction of basic psychological needs heavily depends on the context itself (Deci & Ryan, 2008). Analogous to self-efficacy for teaching, it is thereby important to measure BPNS within the context relevant to the respective research questions. It is, for example, plausible that certain characteristics of a session facilitate different levels of satisfaction of the need for competence (e.g., depending on how well the lesson went), autonomy (e.g., depending on the lesson plan for the session), and relatedness (e.g., depending on how the students acted or responded in a particular session). In this light, employing session-specific assessments targets the experiences of teachers in a valid, fine-grained manner, directly addressing the specific context in which they operate.

Lastly, it is widely recognized that emotions vary within individuals and across different situations (Nett et al., 2017; Seo & Patall, 2021). This is particularly relevant for higher education teachers who often engage in various domains in their

work beyond teaching (e.g., research, administration). Thus, to ensure more valid assessments of the emotional experiences of (higher education) teachers during teaching, emotions should be assessed closely to the teaching context and separately for different sessions (Thies & Kordts-Freudinger, 2019). By doing so, nuanced emotional experiences can be captured that account for specific teaching contexts and the unique experiences that emerge within them.

It is reasonable to expect differences not only in the motivational patterns between different teachers (i.e., at the between level), but also in the fluctuations of teachers' motivation and emotion from session to session (i.e., at the within level). Some higher education teachers may generally experience higher levels of self-efficacy for teaching right before their sessions compared to other teachers. However, even among teachers with high overall self-efficacy, it is possible for them to feel less self-efficacious before a particular session, such as when testing out a new teaching concept and feeling unsure of its success. According to Goetz et al. (2016), "[...] most psychological theories focus on intraindividual psychological functioning, and the same holds true for educational theories of student learning." These intraindividual connections can be, but are not necessarily, equivalent to interpersonal connections (Goetz et al., 2016; Schmitz & Skinner, 1993), implying that both interindividual and intraindividual aspects should be considered when testing assumptions grounded in psychological theories.

We expect that the same relationships will emerge between self-efficacy, BPNS, and emotions at both the between and within person level, i.e., both on the interindividual and on the intraindividual level. For instance, we expect that teachers who report high self-efficacy before their sessions will also report higher levels of joy compared to teachers with lower self-efficacy (at the between level). At the same time, we anticipate that a teacher who generally reports low self-efficacy but experiences higher self-efficacy before a specific session will also report higher levels of joy in that session compared to their other sessions. However, it is important to note that the interplay between self-efficacy, BPNS, and emotions may not be identical at both levels. Previous research by Goetz et al. (2016) showed that the relationships between emotions and achievement goals differ between the between and within levels in students. This illustrates that stable and generalizable associations found at the between level may not necessarily be perfectly reflected at the within level, highlighting the need for more research on situational relationships alongside overarching ones. Moreover, deriving accurate situation-centered interventions from the between level proves to be challenging. Therefore, it is necessary to examine and understand the interplay between self-efficacy, BPNS, and emotions at both the between and within levels in the context of higher education teaching.

3 Research question and hypotheses

The central research focus of the present study is to investigate the interplay between self-efficacy, BPNS, and emotions during teaching in higher education teachers. To this end, we combine previous empirical findings from related contexts (teaching

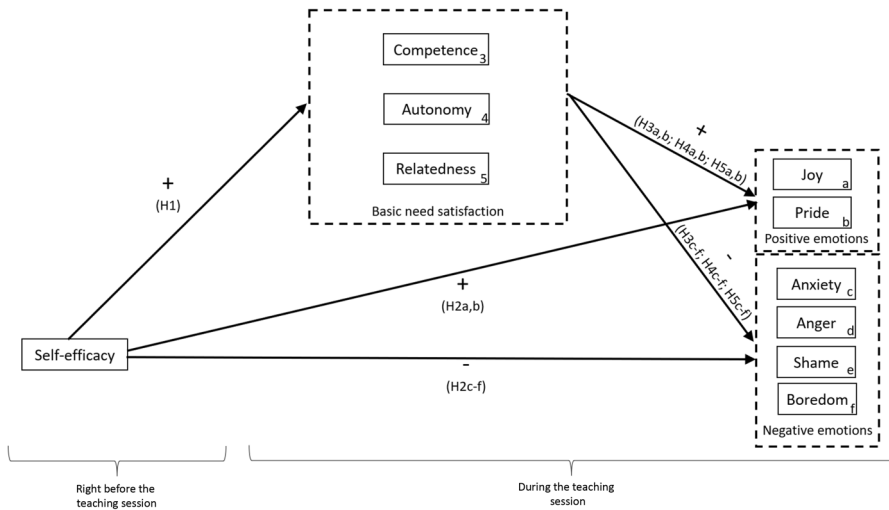


Fig. 1 Expected relations of self-efficacy, BPNS, and emotions. *Note* The arrows pointing from self-efficacy to the respective BPNS and emotions represent temporal directions from the beginning of each session to the end. Arrows from BPNS to emotions represent the theoretical notion that motivational aspects (BPNS) statistically predict emotions. However, we do not claim causal relations between them

in schools) and theoretical considerations to build hypotheses about the motivation and emotions of higher education teachers and condense them in an overall model (see Fig. 1 for an overview). For a thorough analysis of their interplay, we formulate mediation hypotheses and distinguish between within and between person effects.

Specifically, we expect high self-efficacy to be related to high satisfaction of the needs for competence, autonomy, and relatedness in a given teaching session (Hypothesis 1; H1). Furthermore, we hypothesize associations between self-efficacy for teaching at the beginning of a session and emotions experienced during teaching (H2). Extending prior research, we expect self-efficacy to be positively associated with joy (H2a) and pride (H2b), and negatively associated with anger (H2c), anxiety (H2d), shame (H2e), and boredom (H2f). These hypotheses are congruent with the theoretical assumptions regarding self-efficacy proposed by Bandura (1997).

Finally, based on theoretical considerations and previous research, we hypothesize associations between the respective BPNS during teaching and emotions experienced within a given session. Satisfaction of the needs for competence (H3), autonomy (H4), and relatedness (H5) are proposed to be positively associated with experiences of joy and pride (H3a/b, H4a/b, H5a/b), respectively, while anxiety, anger, shame, and boredom are proposed to be negatively associated with satisfaction of the needs for competence, autonomy, and relatedness (H3c/d/e/f, H4c/d/e/f, H5c/d/e/f). We expect these hypotheses to hold true on both the between as well as the within person level, i.e., both for differences between different teachers and for differences that a particular teacher experiences from session to session.

Additionally, we hypothesize self-efficacy to be related to discrete emotions via teachers' individual basic psychological needs (H6), i.e., self-efficacy for teaching

right before a given session is expected to shape how teachers perceive and interpret their experiences, determining the extent to which their basic psychological needs for competence, autonomy, and relatedness are fulfilled during a given session. BPNS, in turn, is expected to be related to the emotions teachers experience during their teaching. Thus, we expect positive indirect effects of self-efficacy on positive emotions (joy, pride) and negative indirect effects on negative emotions (anxiety, anger, shame, boredom), with BPNS as a mediator, in our statistical model.

Following our aim to better understand how self-efficacy, BPNS, and emotions relate, we comprehensively tested all associations proposed in Fig. 1 in an overall model.

4 Methods

4.1 Procedure

A high-frequency micro longitudinal study was conducted among German higher education teachers to measure the constructs used to test our hypotheses. We assessed session-specific data on self-efficacy, BPNS, and emotions in five consecutive teaching sessions of each course. Each teacher could participate with as many of their courses as they wanted. If a teacher participated with more than one course, we conducted our study separately for each course, resulting in five datapoints for each course. In these five consecutive sessions of every course that the teachers agreed to participate with, the teachers were asked to complete a short paper-and-pencil questionnaire. Directly before the start of their session, they made assessments regarding their self-efficacy beliefs concerning that session. Directly at the end of the session, they reported on their degree of satisfaction of their needs for competence, autonomy, and relatedness as well as their discrete emotions experienced during that session. The questionnaires were distributed and collected by a research assistant right before and after each session to minimize the disruptive impact on the higher education teachers' teaching. The time between two measurement points was generally one week, with a few shorter or longer exceptions when a course was taught twice a week or if one session was cancelled (e.g., due to illness). In cases like the latter, we continued the study the week after.

4.2 Sample

Higher education teachers from two average-sized universities in southern Germany were asked to participate on a voluntary basis. In total, we collected 1090 session-specific assessments in 218 different courses (ranging from lectures to seminars) from 103 higher education teachers (49 female, age $M=41.4$ years, $SD=11.0$, 21 full professors, 38 academic staff members with PhD, 41 academic staff members without PhD). As the first session we assessed was the first meeting in the semester and thus rather atypical (e.g., taking a third of the time of a regular lesson), we excluded the first datapoint ex post, resulting in four data points for each course.

This resulted in a total of 748 session-specific datasets with 3.7 measures per course on average. Teachers were recruited from a broad range of subjects, for example, educational sciences, American studies, physics, and music, which were taught in seminars and lectures of different sizes.

4.3 Measures

The measures used for the questionnaires consisted of adapted scales that have been established in research on higher education teachers. Internal consistency for all assessed variables was high (with Cronbach's Alpha / McDonald's Omega values ranging between 0.72 and 0.91, See Table 1 for details). As we calculated a multi-level model, we additionally used ICC2 values to assess whether our measures are reliable on the person level (Marsh et al., 2012). All ICC2 values were high, ranging between 0.75 and 0.96. In general, we aimed to keep the questionnaire short to be minimally disruptive and to reduce the load of items that had to be answered right before the start and right at the end of the lessons. As this dataset is part of a larger project, additional measures were also included within the surveys to assess separate research questions outside of those focused on in the present study.¹

4.3.1 Self-efficacy

Self-efficacy for teaching was measured with an adapted, German version of the scale developed by Nie et al. (2012) that has been used in past research on higher education teachers' motivation (Daumiller et al., 2016). The scale includes three subscales that assess self-efficacy regarding instruction, classroom management, and student motivation. We used one item to assess each subscale, and as such, self-efficacy for teaching was measured by three items with a focus on the specific upcoming teaching session (e.g., "What do you think, how well will you be able to present alternative explanations or examples today if students do not get something immediately?"). The answers were measured using a Likert-type scale ranging from 1 (*not true at all*) to 8 (*completely true*).

4.3.2 Basic psychological need satisfaction

To measure basic psychological need satisfaction within a given session, a scale by Janke and Dickhäuser (2018) was used. Two items were used to assess each of the basic psychological needs on an eight-point Likert-type scale ranging from 1 (*not true at all*) to 8 (*completely true*). Similar to the self-efficacy scale, the item stems

¹ The dataset used for this paper was part of a larger study, where in addition to self-efficacy, basic needs, and emotions, other psychological constructs were assessed that were used in other published works without any overlap, namely Daumiller et al. (2021a, 2022), Hein et al. (2020), and Schwab et al. (2022). One publication (Daumiller et al., 2023) used the same emotion scales as in the publication at hand, investigating the stability and context specificity of achievement goals and emotions. The hypotheses and associations investigated in this article were not a part of any of these prior articles.

Table 1 Descriptive statistics and latent correlations on the between and within level

	Descriptive statistics				Latent correlations (within/between)													
	ω/α	<i>M</i> (L2)	<i>SD</i> (L2)	<i>SD</i> (L1)	Min	Max	ICC1	ICC2	1	2	3	4	5	6	7	8	9	10
[1] Self-efficacy	.82	6.56	1.01	1.04	2.44	8.00	.81	.96		.48***	.31**	.31**	.26**	-.10	.13	.07	-.25***	.02
[2] Satisfaction of competence	.91	6.81	1.22	1.10	2.58	8.00	.64	.92	.81***	.40***	.44***	.41***	.18***	-.10	-.02	-.29***	.01	
[3] Satisfaction of autonomy	.91	6.96	1.22	1.01	3.42	8.00	.62	.91	.60***	.64***	.16*	.29***	.17***	-.03	-.24**	-.01	-.11*	
[4] Satisfaction of relatedness	.90	5.46	1.55	1.38	1.08	8.00	.73	.95	.49***	.45**	.30	.37***	.17***	.04	-.10*	-.17**	-.10*	
Emotions																		
[5] Joy	-	6.48	1.35	1.05	2.50	8.00	.44	.86	.67***	.66***	.26	.54**	.43***	-.06	-.08	-.04	-.41**	
[6] Pride	-	3.92	2.11	1.62	1.00	7.00	.54	.91	.02	.66***	.26	.54**	.41***	.28**	.29**	.28**	.01	
[7] Anxiety	-	1.45	0.99	0.80	1.00	5.50	.32	.84	-.24	-.03	.25	-.23*	-.18**	-.08	.65***	.68***	.51***	
[8] Anger	-	1.63	1.28	0.88	1.00	5.00	.43	.79	.07	.03	.28*	.16	-.35***	-.16**	.83***	.33*		
[9] Shame	-	1.41	0.94	0.68	1.00	4.25	.35	.80	-.19	-.07	.01	-.06	-.26***	-.14*	.29**	.40***	.36*	
[10] Boredom	-	2.08	2.08	1.00	1.00	5.25	.28	.75	.02	-.20	-.08	-.12	-.24***	-.17**	.31***	.13*	.15*	

N = 748. Displayed are the descriptive statistics, intraclass correlations, and latent correlations for self-efficacy, BPNS, and emotions on both levels. Correlations on the between level are reported in the upper triangle, correlations on the within level are reported in the lower triangle. Internal consistencies are reported with McDonald's Omega if possible (three items or more, i.e., for self-efficacy) or with Cronbach's Alpha for scales with two items (i.e., BPNS), and with ICC (1) shows the variability of the constructs located at the teacher level. Statistically significant correlations at the *p* < .001 level are marked with ***, *p* < .01 with **, and *p* < .05 with *

of the items were adapted to refer specifically to the session that had just ended, for example, “In today’s session, I felt like I was able to manage my teaching in a good and competent way” (competence), “In today’s session, I felt like I was free to shape my teaching by myself” (autonomy), and “In today’s session, I felt like I was socially involved with my students” (relatedness).

4.3.3 Emotions

The six selected discrete emotions (joy, pride, anxiety, anger, shame, and boredom) were measured with single items, as single items have been found to be suitable for measuring motivational-affective constructs like emotions in situational contexts (Goetz et al., 2016; Gogol et al., 2014). After reading the item stem (“In this session, I experienced ...”) participants rated the different emotions on an eight-point Likert-type scale ranging from 1 (*do not agree at all*) to 8 (*fully agree*).

4.4 Analyses

We tested our hypotheses in the model shown in Fig. 1 by estimating two-level structural equation models using Mplus 7.1 (Muthén & Muthén, 2017), which allowed us to examine the proposed relations on both the within level and the between level. Specifically, this analysis distinguishes within person relations that are focused on changes within teachers from session to session (level 1) and between person differences that are focused on the differences between the individual teachers (level 2). The session-specific assessments were nested within courses, and courses were nested within teachers. This data was strictly hierarchical, meaning that each session and course had only one teacher. We grouped our multilevel model by teacher and analyzed mechanisms between and within teachers (scripts for the full analyses are available in an open repository: https://osf.io/vgxrd/?view_only=a87a197c3ed84350bc569e9ebf4eadfd). We did not conduct analyses on the course level as teachers participated with 2.18 courses on average, with a third of the teachers only participating with one course, which did not result in enough courses per teacher to yield satisfying power.

We modeled self-efficacy as well as each of the basic psychological needs as latent variables using the individual items as indicators. Moreover, we modeled indirect effects between self-efficacy, BPNS, and emotions using the “model indirect” command. MLR was used as an estimator to account for potential non-normal data distribution. Missing values were handled using full information maximum likelihood (FIML). Missing values on item level were less than 3% in all cases where teachers answered at least one item. Missing cases (less than 16%) were not systematically related to any of the variables of interest and were thereby considered missing at random (MAR). We

interpreted the model fit based on the following cut-off values following the recommendations by Schermelleh-Engel et al. (2003) and Hu and Bentler (1998): CFI > .90, TLI > .90, RMSEA ≤ .08, and SRMR ≤ .10. To additionally check for robustness, we calculated separate models where we only included one of the three aspects of BPNS each, and tested for indications for potential suppression effects.

5 Results

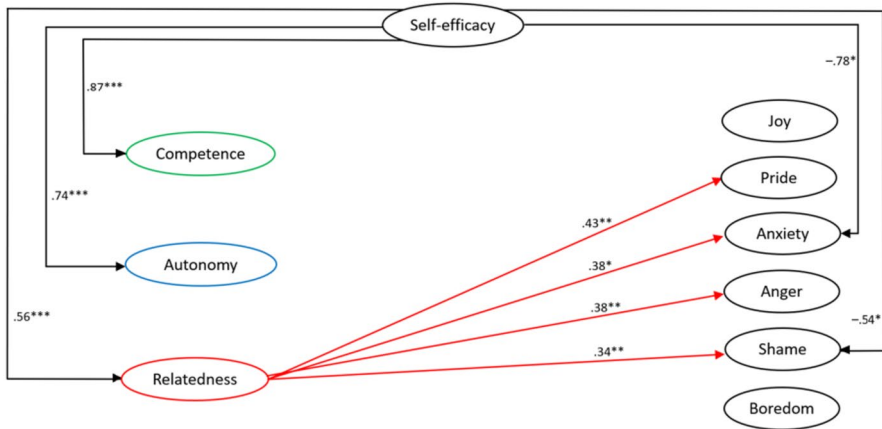
5.1 Preliminary results

First, we calculated the measurement model as a multilevel confirmatory factor analysis, which resulted in an acceptable fit: $\chi^2(df=102, n=748)=186.410$; $p < .001$; CFI = .967; TLI = .931; RMSEA = .033; SRMR_{within} = .029; SRMR_{between} = .041. Descriptive results on both the within and between level as well as latent correlations on both levels can be found in Table 1. In addition, manifest bivariate correlations are provided in the supplementary materials (Table S1).

The mean values for self-efficacy and basic psychological need satisfaction were relatively high. Concerning the discrete emotions, while a high mean was observed for joy and pride, we found low means for anxiety, anger, shame, and boredom compared to the theoretical mean of the scales. Regarding these mean values, it is worth noting that the teachers participated voluntarily in our study, potentially leading to a highly motivated sample. Nevertheless, results included the full theoretical range of the scale for all emotions aside from shame, indicating variability in responses (as also reflected in the substantial standard deviations). None of the motivational or emotional aspects were highly correlated to demographic variables. Regarding correlations between constructs, we found the expected positive correlations between BPNS and self-efficacy. Moreover, the pattern of positive emotions being positively correlated, and negative emotions being negatively correlated with both BPNS and self-efficacy also became apparent at the within level, i.e., within individual teachers. At the between level, an exception was observed for the satisfaction of the need for relatedness, which was surprisingly positively correlated with the negative emotions of anxiety, anger, and shame.

Intraclass correlations (ICC1) are reported in Table 1. It is notable that for self-efficacy, the proportion of variability located on the person level was rather high. For BPNS, approximately two thirds of variability was located at the within person level, with satisfaction of the need for relatedness descriptively showing the highest person-specificity. The intraclass correlations of the six discrete emotions varied, with pride being the most stable emotion on a within person level ($ICC1 = .54$) and boredom being the least stable ($ICC1 = .28$). Despite this variation, the intraclass correlations showed substantial variability both from session to session within one teacher and between different teachers. Together with the high ICC2 values, this shows that two-level structural equation modeling is a fitting analytical approach.

Between subjects



Within subjects

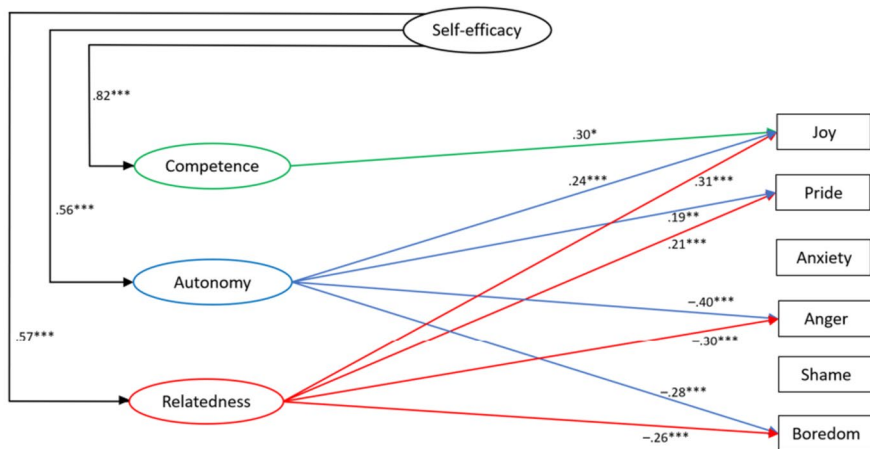


Fig. 2 Results of multilevel structural equation modeling with self-efficacy, BPNS, and emotions. *Note:* $N=748$ sessions (within level), $N=103$ teachers (between level). Regressions that are statistically significant at the $p < .001$ level are denoted by ***, $p < .01$ with ** and $p < .05$ with *. The model yielded a satisfactory model fit ($\chi^2(df=108, n=103)=214.05; p < .001; CFI=.958; TLI=.918; RMSEA=.036; SRMR_{within}=.037; SRMR_{between}=.044$). For clarity, only statistically significant relations are shown, and indicators of the latent variables (self-efficacy, BPN) are not displayed. Residual correlations are included but not depicted

5.2 Structural equation modeling

Overall, our results of the two-level SEM showed an acceptable model fit: $\chi^2(df=108, n=103)=214.05; p < .001; CFI=.958; TLI=.918; RMSEA=.036; SRMR_{within}=.037; SRMR_{between}=.044$. In Fig. 2, all statistically significant

Table 2 Results of two-level structural equation modeling

	BPNS							Emotions			
	Competence	Autonomy	Relatedness	Joy	Pride	Anxiety	Anger	Shame	Boredom		
Between level											
Self-efficacy	.87*** (.07)	.74*** (.10)	.56*** (.08)	.35 (.16)	-.20 (.15)	-.78* (.16)	-.12 (.17)	-.54* (.14)	.06 (.21)		
BPNS											
Competence				.14 (.22)	.02 (.21)	.18 (.14)	-.21 (.18)	-.01 (.15)	-.32 (.18)		
Autonomy				.24 (.16)	.23 (.17)	.04 (.20)	-.23 (.14)	-.01 (.16)	-.07 (.18)		
Relatedness				.07 (.11)	.43** (.13)	.38** (.11)	.38* (.14)	.34** (.11)	.14 (.17)		
Within level											
Self-efficacy	.82*** (.05)	.56*** (.06)	.57*** (.06)	-.04 (.04)	-.03 (.04)	-.36 (.07)	.38 (.04)	-.35 (.04)	.23 (.04)		
BPNS											
Competence				.30* (.05)	.19 (.04)	-.07 (.06)	-.24 (.06)	-.17 (.06)	-.10 (.05)		
Autonomy				.24*** (.05)	.19** (.04)	.07 (.04)	-.40*** (.06)	.09 (.05)	-.28*** (.05)		
Relatedness				.31* (.04)	.21*** (.04)	.09 (.05)	-.30*** (.05)	-.04 (.04)	-.26*** (.04)		

N = 748 sessions, *N* = 103 teachers. This table shows the modeled effects of self-efficacy on BPNS and emotions and of BPNS on emotions distinguishing within person relations that are focused on the changes within teachers from session to session (level 1) and between person differences that are focused on the differences between the individual teachers (level 2). Standard errors are given in the brackets. Regressions that are statistically significant at the *p* < .001 level are marked with ***, *p* < .01 with ** and *p* < .05 with *. The model yielded an acceptable model fit $\chi^2(df) = 108, n = 103) = 214.05; p < 0.001; CFI = .958; TLI = .918; RMSEA = .036; SRMR_{within} = .037; SRMR_{between} = .044$

regression coefficients are presented on within and between levels; the complete model results for both levels can be found in Table 2.

Self-efficacy was strongly and positively related to satisfaction of the needs for competence, autonomy, and relatedness, both on the within level and on the between level, as proposed in H1 (within level: $\beta = .56-.82, p < .001$; between level: $\beta = .56-.87, p < .001$). On the within level, there were no statistically significant relations between self-efficacy and any emotions, which did not confirm H2a-f. Thus, teachers who felt more self-efficacious than usual in one session did not, for example, report statistically significantly more joy than usual in the respective session. However, we did find statistically significant relations between self-efficacy and anxiety and shame on the between level ($\beta = -0.78 / -.54, p < .05$). Both were negative, aligning with our assumptions (H2c and H2e). Thus, teachers who reported higher self-efficacy than others also reported less anxiety and less shame than their fellow participants.

For the associations between BPNS and emotions, differences emerged between the within level (variation within teachers from session to session) and the between level (variation between different teachers). On the within level, all statistically significant links between BPNS were positive with positive emotions and negative with negative emotions. Consistent with our expectations, teachers who experienced more satisfaction of their need for competence in a session experienced more joy ($\beta = .30, p < .05$; H3a) compared to other sessions. Similarly, teachers who had a greater sense of satisfaction of their need for autonomy in a session experienced more joy ($\beta = .24, p < .001$; H4a) and pride ($\beta = .19, p < .01$; H4b) and less anger ($\beta = -.40, p < .001$; H4d) and boredom ($\beta = -.28, p < .0001$; H4f) compared to other sessions. Furthermore, teachers who felt a stronger sense of satisfaction of their need for relatedness in a session also experienced more joy ($\beta = .31, p < .05$; H5a) and pride ($\beta = .21, p < .001$; H5b) and less anger ($\beta = -.30, p < .001$; H5d) and boredom ($\beta = -.26, p < .001$; H5f) compared to other sessions. Notably, not all basic psychological needs were found to be significantly associated with all emotions on the within level.

On the between level, we found a different pattern of associations between BPNS and emotions compared to the within level. There were no statistically significant associations between satisfaction of the need for competence or autonomy with any emotions, implying that teachers who experienced more satisfaction of the need for competence or autonomy did not feel more positive or less negative emotions than teachers who experienced less satisfaction of the need for competence or autonomy. However, our results imply that teachers who felt that their need for relatedness was satisfied during teaching experienced more pride ($\beta = .43, p < .001$; H5b), but also more anxiety ($\beta = .38, p < .01$; H5c), more anger ($\beta = .38, p < .05$; H5d), and more shame ($\beta = .34, p < .01$; H5e) during their teaching sessions than teachers whose need for relatedness was less satisfied.

Table 3 depicts the indirect effects of self-efficacy on emotions via the respective basic psychological needs. In summary, there were statistically significant indirect effects of self-efficacy via the satisfaction of all three basic psychological needs on emotions (for pride, anxiety, and anger), especially on the within level, while on the between level, satisfaction of the need for relatedness mediated the link between self-efficacy and experienced emotions (for pride, anxiety, and shame).

Table 3 Indirect effects of self-efficacy via BPNS on emotions within the overall model on between and within level

	Joy	Pride	Anxiety	Anger	Shame	Boredom
<i>Level: between</i>						
Total indirect effects of self-efficacy	.35 [-0.28, .98]	.42 [-0.17, .70]	.40 [-0.31, 1.11]	-.14 [-0.76, .48]	.19 [-0.34, .71]	-.41 [-1.19, .71]
Specific indirect effects						
Self-efficacy → Competence → Emotion	.21 [-0.35, .77]	.01 [-0.49, .52]	.16 [-0.23, .54]	-.18 [-0.65, .29]	-.01 [-0.37, .37]	-.28 [-0.81, .25]
Self-efficacy → Autonomy → Emotion	.10 [-0.18, .38]	.17 [-0.10, .44]	.03 [-0.32, .38]	-.17 [-0.46, .12]	-.01 [-0.29, .27]	-.05 [-0.20, .41]
Self-efficacy → Relatedness → Emotion	.04 [-0.11, .18]	.24* [0.04, .44]	.21* [0.02, .41]	.21 [0.00, .43]	.19* [0.02, .37]	-.08 [-0.28, .11]
<i>Level: Within</i>						
Total indirect effects of self-efficacy	.55*** [0.27, .83]	.38* [0.07, .70]	.03 [-0.62, .69]	-.58*** [-0.98, -.19]	-.11 [-0.50, .28]	-.38* [-0.74, -.03]
Specific indirect effects						
Self-efficacy → Competence → Emotion	.24* [0.03, .46]	.16 [-.07, .38]	-.05 [-0.16, .05]	-.19 [-0.48, .09]	-.14 [-0.44, .16]	-.08 [-0.33, .17]
Self-efficacy → Autonomy → Emotion	.14*** [0.06, .21]	.11*** [0.03, .18]	.04 [-0.06, .14]	-.22*** [-0.35, -.10]	.05 [-0.04, .14]	-.16** [-0.26, -.05]
Self-efficacy → Relatedness → Emotion	.17*** [0.09, .26]	.12*** [0.05, .19]	.05 [-0.05, .15]	-.17*** [-0.27, -.07]	-.03 [-0.11, .06]	-.15*** [-0.24, -.06]

N = 748. Depicted are the indirect effects of self-efficacy on emotions. Effects that are statistically significant at the $p < .001$ level are marked with ***, $p < .01$ with ** and $p < .05$ with *. Confidence intervals (95%) are in square brackets

6 Discussion

The present study contributes to painting a clearer picture of higher education teachers' motivation and emotion by combining established constructs that have primarily been examined independently from each other in research on primary and secondary education teachers. Specifically, the aim of this study was to investigate the interplay between self-efficacy, BPNS, and discrete emotions of higher education teachers during teaching. For this purpose, we tested hypotheses regarding their interrelations based on theoretical considerations and previous empirical findings using session-specific, longitudinal data from higher education teachers in four consecutive teaching lessons. In our model, we considered indirect effects from self-efficacy via BPNS on emotions and examined both the variance between teachers and the variance between sessions within each teacher (i.e., the between and the within teacher level, respectively). The results largely confirmed our hypotheses, with notable exceptions, and suggest that combining these constructs can help facilitate a better understanding of motivation and emotion of higher education teachers during teaching. Furthermore, our investigation of the associations between self-efficacy, satisfaction of the need for relatedness, and discrete emotions revealed significant differences when comparing both levels, i.e., regarding their interplay in differences between teachers compared with changes within teachers from session to session.

6.1 Interplay between self-efficacy, BPNS, and emotions

6.1.1 Discussion of descriptive statistics

Descriptively, we found rather high means of self-efficacy and BPNS. This was to be expected as we asked higher education teachers to participate on a voluntary basis which may have led to a rather motivated sample. For discrete emotions, prior studies found rather high means for positive emotions during teaching in higher education, especially for enjoyment, and rather low means for negative emotions, aligning with our results (e.g., Frenzel et al., 2016; Klassen et al., 2012; Thies & Kordts-Freudinger, 2019). Thus, the pattern of descriptive statistics found within our study lies within the expected range. Notably, the ranges and standard deviations of the scales used in our study suggest that there were substantial differences between teachers in their motivational and emotional experiences during teaching.

6.1.2 Stability of higher education teachers' self-efficacy, BPNS, and emotions

Teachers' self-efficacy for teaching was rather stable across sessions for individual teachers, as illustrated by high intraclass correlations. This stands in line with the theoretical reasoning that self-efficacy is a rather stable construct (Bandura, 1997), which has been documented in several studies on primary and secondary school teachers (e.g., Schwarzer & Warner, 2014).

More than two thirds of the variability of satisfaction of the need for relatedness could be attributed to the teacher level, as well as almost two thirds of the variability

of satisfaction of the needs for competence and autonomy, illustrating that BPNS is not exclusively determined by the context, but is also dependent on how the specific teacher experiences the context. It is notable that satisfaction of the need for relatedness emerged as being more person-specific than satisfaction of the other two needs. Seemingly, whether teachers feel that their need for relatedness is satisfied depends less on contextual factors than whether teachers feel that their need for competence and autonomy is satisfied during a given session.

The proportion of variability in the discrete emotions that could be located at the teacher level differed, with joy, pride, and anxiety being more person specific, while for anger, shame, and boredom, only about a third of the variability could be traced back to the individual teacher level. In previous studies, discrete emotions in the academic context were found to have equally temporally stable and variable parts, paralleling our results for joy, pride, and anxiety (see, e.g., Nett et al., 2017, who investigated the same emotions, apart from shame, in students). These findings emphasize the significance of considering both levels of analysis, as a substantial portion of the variability in the constructs can be attributed to both the between teacher and within teacher levels.

6.1.3 Interplay of self-efficacy, BPNS, and emotions

Overall, we found that higher education teachers' self-efficacy, BPNS, and emotions were intertwined, with associations between BPNS and emotions partly differing between the within and the between level. We also observed indirect relationships between self-efficacy for teaching and emotions, mediated by BPNS. Generally, our structural equation modeling results emerged as relatively robust when compared with the additional models calculated with one of the three aspects of BPNS each (see Tables S2–S4 in the supplementary material). We first discuss the results on the within level, followed by the between level, and contrast both.

6.1.3.1 Interplay of Self-efficacy, BPNS, and emotions within teachers from session to session On the within level, our findings mirrored the presumed positive associations between teaching self-efficacy regarding an upcoming session and satisfaction of the needs for competence, autonomy, and relatedness (in line with H1). This means that if teachers reported higher than usual self-efficacy in one session, they also reported higher than usual BPNS in that session. Thus, even though higher education teachers' self-efficacy seems to be rather stable, as the intraclass correlations suggest, changes in their self-efficacy for teaching right before teaching sessions were relevant for BPNS in the respective session.

Regarding the direct relations between self-efficacy and emotions, we did not find any statistically significant results at the within level. However, our results on total and specific indirect effects partly supported our theoretical assumption of mediation through BPNS. Specifically, when teachers' self-efficacy for teaching was higher than their usual level immediately before a session, it was associated with experiencing more joy and pride, as well as less anger and boredom in that session compared to other sessions. These relationships were statistically mediated by the

satisfaction of teachers' needs for competence, autonomy, and relatedness, with the satisfaction of competence only mediating the relation to joy.

While we could only identify a statistical mediation from the satisfaction of competence to joy but not to the other emotions, the effects on pride, anger, and boredom were also mediated by the satisfaction of the needs for autonomy and relatedness. It should be kept in mind that we proposed and tested this mediation based on theoretical considerations, but BPNS and emotions were measured at the same time, so, based on the empirical findings and the statistical results we cannot depict a causal mediation here. Indeed, it is also possible that the emotions experienced during teaching might influence to which degree the needs for competence, autonomy, and relatedness of teachers were satisfied. However, our considerations are supported by empirical research with designs that allow for causal inference, such as the study by León and Núñez (2013) who found casual relations from BPNS to well-being. Additionally, there are strong theoretical grounds for the direction that we tested: This finding supports the theoretical notion that self-efficacy for teaching can shape how teachers perceive and interpret their teaching experiences. Following our hypothesis, self-efficacy determines the extent to which teachers' basic psychological needs for competence, autonomy, and relatedness are fulfilled during the session. It stands to reason that when teachers have high self-efficacy, they are more likely to have motivationally favorable appraisals of their teaching experiences, similar to the reasoning proposed by Jerusalem and Schwarzer (1992) regarding self-efficacy and stress appraisals. These positive appraisals, in turn, contribute to a higher level of BPNS.

Direct associations between BPNS and emotions were found for all three aspects of basic psychological need satisfaction on the within level. In specific sessions where teachers felt that their needs for competence, autonomy, and relatedness were more satisfied than in other sessions, they also experienced more joy than in other sessions, paralleling the theoretical mechanisms proposed in SDT (Deci & Ryan, 2000) and aligning with prior evidence (Klassen et al., 2012). Next to that and in line with our expectations, satisfaction of the need of autonomy was significantly positively associated with pride. As reasoned before, teachers are more likely to feel proud of their achievements in a given session compared to other sessions if they believe they are responsible for their success, i.e., they felt autonomous in making the decisions that led to successful teaching. Similarly, the connection between satisfaction of the need for relatedness and pride is also in line with our expectations, as teachers may experience a greater sense of pride in a specific session when they not only take pride in fostering connections with their students (see Praetorius et al., 2018, for relatedness as a measure of teaching quality), but also when they feel proud of the students they have formed a meaningful connection with. Surprisingly, satisfaction of the need for competence was only connected with joy, which did not align with our hypotheses (see H3).

Concerning the negative emotions, for changes within teachers from session to session, satisfaction of the need for autonomy and the need for relatedness were negatively related to anger and boredom. Again, this did not extend to teachers' satisfaction of the need for competence. The pattern of satisfaction of the needs for autonomy and relatedness being negatively related to negative emotions during teaching aligns with our hypotheses as well as with prior research (Hagenauer &

Volet, 2014). Elucidating the source of the discrete emotions might explain why, against our hypotheses, the relations with satisfaction of the needs for autonomy and relatedness were more prevalent than relations with satisfaction of the need for competence. Concerning, for example, anger, the anger that teachers experience might not be rooted in being angry about their own performance (i.e., not feeling competent), but rather in the external circumstances that restricted them (i.e., not feeling autonomous), or students not participating as they were supposed to in this particular session. This notion is corroborated by prior research: Hagenauer and Volet (2014) conducted interview studies on the emotions of higher education teachers during teaching and identified student engagement and a lack of control over teaching situations as overarching factors influencing teachers' emotions, pointing to the satisfaction of the needs for relatedness and autonomy, but not to satisfaction of the need for competence. Burić and Frenzel (2019) obtained similar findings for anger in quantitative studies, pinpointing student behavior, but also parental involvement and organizational factors (i.e., factors that can reduce autonomy) as primary antecedents of anger among primary and secondary education teachers. However, in our study, teachers did not provide detailed explanations of what specifically elicited their emotions. Therefore, future studies could extend this line of research by combining session-specific assessments of emotions with retrospective interviews, wherein teachers can elaborate on the sources of the discrete emotions they experienced during teaching. The latter might also explain why, in our study, the negative emotions anxiety and shame were not statistically related to BPNS at all, even though we expected them to be related based on theoretical assumptions and prior evidence (see H3c,e; H4c,e; H5c,e).

It should be kept in mind that even though self-efficacy was assessed before each session and BPNS and emotions were assessed after the session ended—implying a temporal direction from self-efficacy to BPNS and emotions—this study design does not unambiguously allow for causal interpretation, and the described directions could also work in the reverse direction. For example, from a theoretical perspective, positive emotions can also foster self-efficacy, representing the opposite direction Pekrun et al., 2007).

6.1.3.2 Interplay of self-efficacy, BPNS, and emotions between different teachers Similar to the within level, we found that teachers who reported higher self-efficacy than their colleagues also reported higher satisfaction of the needs for competence, autonomy, and relatedness than their colleagues. Thus, comparing the results on both levels, teachers who generally held higher self-efficacy beliefs than their colleagues experienced higher BPNS, and at the same time, as elaborated before, if a teacher held higher self-efficacy beliefs than usual right before a session, their needs for competence, autonomy, and relatedness were more satisfied in that session.

Concerning the relations between self-efficacy and emotions, in line with our expectations, teachers with higher self-efficacy for teaching experienced less anxiety and shame during teaching compared to their colleagues (see H2c,e). These direct relations between self-efficacy and emotions were not apparent when looking at differences within teachers from session to session. This difference on both levels supports the notion that self-efficacy is a rather stable construct that can

act as a protective factor against the experience of negative emotions (see Schwedtfeger et al., 2008). However, this line of reasoning raises the question of why anger and boredom were not statistically significantly related to self-efficacy at the between level. In our context, this could be due to anxiety and shame being more closely tied to session-specific appraisals of competence, while anger or boredom might be influenced by contextual elements like malfunctioning technical infrastructure or repetitive topics in teaching. Regarding anger, this line of reasoning is supported by the earlier findings of Burić and Frenzel (2019), who identified various sources of anger in teaching beyond competence appraisals. Regarding boredom, various antecedents during teaching can be discerned following control-value theory, some of which are unrelated to one's abilities (e.g., repetitive topics; Pekrun, 2000).

Regarding our hypotheses (H2a,b), we would have expected self-efficacy for teaching to be additionally connected to the positive emotions of joy and pride, as suggested by both self-efficacy theory (Bandura, 1997) and control-value theory (Pekrun et al., 2007). While on a bivariate level, self-efficacy was in fact positively associated with joy, the missing connections to pride are puzzling. Following control-value theory, teachers' experiences of pride might, to a large extent, be based on students' success in the classroom, e.g., students raising interesting questions or understanding challenging topics. These student achievements might not necessarily be connected to teachers' perceptions of their own achievement in teaching, i.e., not with their self-efficacy for teaching. As we only asked teachers about their emotions in general (i.e., to rate the statement "In this session, I felt pride"), what they felt proud about remains a question of interpretation. Again, this informs future studies to include the reason or source for emotions when assessing them, allowing to test the interpretation given here.

In addition to these direct associations between self-efficacy and emotions, our results suggest indirect positive associations via relatedness on pride, anxiety, and shame. Regarding the indirect effect on pride, similar to the session-to-session differences, high levels of self-efficacy probably led to more positive appraisals of their teaching abilities, which, in turn, resulted in higher satisfaction of their need for relatedness. By feeling a sense of connection with their students, these teachers may subsequently experience greater pride in their students' achievements compared to teachers who have a lower level of satisfaction of their need for relatedness. This line of reasoning is supported by the idea that teachers reported pride as being proud of their students instead of pride as an achievement emotion concerning teachers' own achievement. However, it is worth noting that our further findings on indirect effects deviate from our initial expectations, as teachers reporting higher levels of self-efficacy also reported experiencing higher levels of anxiety and shame instead of fewer negative emotions, which raises theoretical questions discussed in the next paragraphs.

We did not find any significant associations between differences in teachers' satisfaction of the needs for competence and autonomy during their teaching and their experience of positive or negative emotions compared to their colleagues. However, our results indicated that teachers who reported a stronger sense of relatedness to their students experienced higher levels of pride, anxiety, anger, and shame

during their teaching in comparison to their colleagues. These findings align with our expectations concerning pride, as it is theoretically expected that the satisfaction of basic psychological needs is positively linked to positive emotions. However, the positive association between relatedness and negative emotions is not in line with the theoretical assumptions of SDT (Deci & Ryan, 2000).

One explanation for these unexpected findings of satisfaction of the needs of relatedness, self-efficacy, and negative emotions could be that satisfaction of the need for relatedness could go hand in hand with how socially invested teachers are in their teaching: For example, higher education teachers might experience more anger towards students during a session if they feel more socially connected to them, in contrast to feeling more indifferent, and teachers might be more anxious about making mistakes or be more ashamed of mistakes they might make when they feel a social connection to their students in contrast to being indifferent to them.

In summary, teachers who do not have their need for relatedness satisfied during teaching may exhibit a general sense of distance and lower emotional investment in their teaching, resulting in weaker emotional experiences. If teachers experience differences in their satisfaction of their need for relatedness in just some sessions, they might still be emotionally invested (within level), but teachers who generally experience low levels of satisfaction of their need for relatedness during teaching sessions (between level differences) might emotionally engage with their students less overall. Accordingly, these differences in emotional investment become especially apparent in between person comparisons (as reflected by the indirect positive relations between self-efficacy and anxiety/shame via relatedness becoming visible only at the between level). This is also supported by our finding that the satisfaction of the need for relatedness may be more specific to individual teachers, while satisfaction of the other two needs may be more session-specific (slightly higher ICC1 values for relatedness than for competence and autonomy). At the same time, we observed the expected positive associations with positive emotions and negative associations with negative emotions when examining the associations between emotions and satisfaction of the need for relatedness (and self-efficacy) within one teacher across different teaching sessions, aligning with the theoretical assumptions of SDT (Deci & Ryan, 2000). This composition shows that both levels are relevant and need to be included when analyzing teachers' motivation and emotion, as they seem to follow somewhat different theoretical processes.

Overall, the above-mentioned findings imply that teacher-student-relationships are an integral part of explaining differences in the emotional experiences of different teachers during teaching. For future research on motivation and emotions of higher education teachers during their teaching, it is therefore advisable to consider student-teacher-relationships when aiming to explain differences between teachers' motivation and emotion. Furthermore, the unique results observed at the within teacher and between teacher levels regarding the relationship between self-efficacy, satisfaction of the need for relatedness, and discrete emotions suggest that solely considering between level associations may not be sufficient when testing theoretical assumptions. It is important to acknowledge that mechanisms

and dynamics can differ across different levels of analysis. Therefore, future studies should incorporate both within teacher and between teacher analyses to gain a more nuanced understanding of the complex interplay between individual factors and contextual variables that shape teachers' emotional experiences.

6.2 Strengths, limitations, and implications

Although limited to the German higher education system, our study's sample covered universities of two states and a broad variety of subjects, and thus, the influence of bias based on organizational structure is lowered. The micro-longitudinal design allowed for multilevel analyses covering different teachers and sessions, contrasting effects on the between and within teacher level and making different connections on the levels visible. Moreover, our sample size was considerably high with variation in gender, age, and academic positions of higher education teachers, contributing to the generalizability of our findings. In addition to collecting data regarding several lessons, our design provided a session-based approach. As a result, the higher education teachers' answers may not have been as affected by memory biases and may more accurately reflect their self-efficacy, BPNS, and discrete emotions in their teaching.

Despite the strengths of our study, several limitations should be considered when interpreting our findings. First, our session-specific approach may have influenced the data by disturbing the natural procedure of a session, given that the teachers had to complete a short questionnaire right at the beginning and at the end of each session. Nevertheless, to reduce these effects, student assistants were present to help organize and support the teachers when answering the questionnaires. Additionally, as a result of our study design, the scales within the questionnaires needed to be very short, which partly limits interpretation—for example, our single-items for measuring emotions do not provide information about why the participants experienced these emotions, and thus, sources of emotions cannot be detected.

Moreover as we did not obtain a sufficient number of courses per teacher for an analysis on three levels, we chose the more conservative approach of analysing two levels. However, it would also be an interesting research direction to assess further control variables, such as the frequency of the course or number of participants, which might influence how related higher education teachers feel towards their students. Finally, our study only used self-reported data of teachers; it could be fruitful, however, to also include student reports concerning student motivation and their perception of the lesson. This could allow for further insights into whether the connection between BPNS of school teachers and students (see Roth et al., 2007) can also be found in the higher education context, or if the connection between motivation of teachers and teaching quality can be replicated.

Despite these limitations, our findings indicate that self-efficacy, BPNS, and emotions are interrelated within higher education teachers' teaching experiences. Thus, identifying practical methods to support these factors in higher education teaching can be considered an important direction. As self-efficacy has proven to be rather stable across teaching sessions, it seems to be more feasible to influence

contextual features that in turn lead to favorable BPNS which could support teachers to experience more positive and less negative emotions during teaching. For example, identifying specific aspects of teaching in higher education that promote and limit autonomy, through methods such as interview studies, could be a promising approach to enhance satisfaction of the need for autonomy. Additionally, since satisfaction of the need for relatedness was particularly linked to positive emotions on the within level, fostering a sense of relatedness between higher education teachers and their students, for instance, by implementing personal introductions in their teaching or through informal counselling hours (Averill & Major, 2020), may help establish a sense of relatedness and support positive emotional experiences for both teachers and students. However, it is important to note that the effects of satisfaction of the need for relatedness on negative emotions at the between level appear contradictory. Further research is needed to replicate and clarify the positive effects of satisfaction of the need for relatedness on negative emotions when examining differences between teachers. It might also be an important line of research to assess whether the experience of negative emotions during teaching is problematic. Feeling ashamed due to students' failures might be as important as feeling proud of their successes, and both might contribute to teachers' investment in and development of their teaching.

6.3 Conclusion

In this study, we successfully applied the theoretical constructs of self-efficacy, BPNS, and emotions to the context of teaching in higher education. We found them to be prevalent in higher education teachers during teaching sessions and to be interconnected, showing relations regarding more stable differences between teachers as well as changes within teachers from session to session. Our results suggest that self-efficacy might influence emotions indirectly via satisfaction of the needs for competence, autonomy, and relatedness. As expected, high self-efficacy was positively associated with positive and negatively associated with negative discrete emotions; satisfaction of the need for autonomy and the need for relatedness were linked to favorable emotions. However, differences emerged regarding within and between teacher levels: While the satisfaction of the need for relatedness seemed to be a protective factor against negative emotions in regard to specific sessions, teachers whose need for relatedness was generally more satisfied experienced both more positive and more negative emotions than colleagues whose need for relatedness was less satisfied.

Based on this, combining several motivational theories appears to be a promising approach to better understand how they work in specific situations. However, we untangled unexpected positive associations between satisfaction of the need for relatedness and negative emotions on the between level that require further research. In terms of practical implications, providing contexts that, besides fostering high self-efficacy for teaching, help satisfy basic psychological needs appears to be critical for promoting positive emotions during teaching. Within this, especially

autonomy and relatedness seem to be important for favorable motivation and emotions in teaching in higher education.

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Declarations

Conflicts of interest The authors have no known conflicts of interest or competing interests to declare.

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Melanie V. Keller is a researcher and Ph.D. student at the University of Augsburg, Germany. Her research interests include motivational aspects of feedback processes, motivation of higher education teachers, and climate protective behavior under the lens of motivation.

Raven Rinas is a postdoctoral researcher at the University of Augsburg, Germany. Her research interests entail fostering motivation and well-being in educational contexts, particularly in the realm of higher education, both of students and of teachers.

Stefan Janke is an educational psychologist and post-doctoral researcher at the University of Mannheim, Germany. His research interests are motivation and motivational development in educational contexts, academic dishonesty, decision processes impacting educational trajectories, and social disparities within education.

Oliver Dickhäuser Prof. Dr., earned his Ph.D. in Psychology in 2001. He is currently a full Professor of Educational Psychology at the University of Mannheim, Germany, and an affiliate at the Mannheim Centre for European Social Research. His research primarily focuses on the motivation and emotions of students and teachers in education, as well as on interventions designed to foster motivation.

Markus Dresel Prof. Dr., is a full professor in Psychology at the University of Augsburg, Department of Psychology. His research interests include motivation and self-regulated learning in school and higher education contexts, associations of academic achievement with gender and ethnic and social backgrounds as well as teacher training and teachers' professional development.

Martin Daumiller is an assistant professor at the University of Augsburg, Germany and a fellow at the College for Interdisciplinary Educational Research (CIDER). His research interests include motivation and fostering of motivation, self-regulated learning, instructional research, learning with digital media, and profession research in educational context.

Authors and Affiliations

Melanie V. Keller¹  · Raven Rinas¹  · Stefan Janke²  · Oliver Dickhäuser²  · Markus Dresel¹  · Martin Daumiller¹ 

✉ Melanie V. Keller
melanie.keller@uni-a.de

¹ Department of Psychology, University of Augsburg, Universitätsstr. 10, 86159 Augsburg, Germany

² Department of Educational Psychology, University of Mannheim, Mannheim 68159, Germany