

Institute for Social Research in Zagreb Repository

This version of the article has been accepted for publication and is subject to Springer Nature's terms of use, but is not the Version of Record and does not reflect post-acceptance improvements, or any corrections. The Version of Record is available online at: <https://doi.org/10.1007/s10212-025-00977-z>.

Petrović, D., Pedić Duić, P., & Pavin Ivanec, T. (2025) Student-reported early-career STEM teachers' classroom management, emotional engagement, and students' interest in subject: a multilevel analysis. *European Journal of Psychology of Education*, 40, Article 73. <https://doi.org/10.1007/s10212-025-00977-z>

Student-reported early-career STEM teachers' classroom management, emotional engagement and students' interest in subject: a multilevel analysis

Abstract:

The study examined the associations between perceived early-career teachers' classroom management, emotional engagement, and students' interest in STEM subjects. A total of 918 lower-secondary students rated classroom management and emotional engagement of their early-career STEM teachers (N=56) and their interest in the subject. Data was analysed using doubly latent multilevel modelling, exploring the mediation climate effect. As expected, in classes where the teacher is perceived as more efficient in managing the class, the teacher is also perceived as more emotionally engaged, whereas students in those classes experience higher interest in the subject. Surprisingly, the direct effect of perceived classroom management was not significant, indicating that the relationship between perceived teachers' classroom management and class-level students' interest in the subject might be (fully) explained by perceived teachers' emotional engagement. The results highlight the importance of fostering self-efficacy and emotional engagement among early-career teachers to support and enhance students' motivation in STEM subjects.

Keywords: early-career teachers; STEM; student interest; classroom management; teacher engagement; multilevel analysis

1. Introduction

Numerous studies indicate the importance of teacher-related characteristics on students' academic outcomes, whereby these broad and complex constructs can be comprehended as an aggregate of various specific aspects (Darling-Hammond, 2000; Hattie, 2008; Lazarides & Schiefele, 2021). Within the context of teacher-related aspects, teachers' motivational characteristics are often emphasised as one of the key factors, and teachers' self-efficacy, as one of the motivational constructs, is often explored in relation to instructional practices and students' outcomes (Klassen & Tze, 2014; Lauermann & Berger, 2021; Perera & John, 2020). Moreover, various manifestations of teachers' emotions are also recognised as one of the determinants of instructional practices and student outcomes (Burić & Frenzel, 2020). However, these associations seem to be rather complex, and the literature suggests the indirect association between teachers' motivation and emotions and students' outcomes through instructional practices and quality (Burić & Kim, 2020; Fauth et al., 2014; Zee & Komen, 2016). According to Lazarides and Schiefele (2021), despite the expanding literature on teacher motivational characteristics and their outcomes, further research is needed to clarify how these motivational characteristics relate to specific teaching practices that may ultimately shape students' classroom experiences and learning, especially in different contexts. Hence, this study aims to provide a more detailed understanding of the association between perceived early-career teachers' classroom management and emotional engagement and its association with students' interest in STEM subjects. In addition, Burić and Kim (2020) point out that many studies treat classroom-level climate constructs as individual student-level constructs, which may confound the effects of classroom-level variables. Therefore, this was considered in this study by encompassing multilevel analysis.

1.1 Teachers' efficacy for classroom management, teachers' emotional engagement and students' interest in the subject

Teachers' self-efficacy and emotional engagement represent the core aspects of teacher motivation (Praetorius et al., 2017); hence, it is unsurprising that these constructs are the focus of numerous studies. A teacher's efficacy belief refers to a teacher's judgement of his or her capability to successfully achieve positive outcomes regarding students' engagement and learning (Tschannen-Moran & Woolfolk Hoy, 2001), and as such, represents an essential motivational construct since it is generally linked with individual's decision to engage in the activity (Praetorius et al., 2017). Further, teachers' sense of efficacy reflects on instructional practices, students' perception of various aspects of teaching quality, and student outcomes (Jerrim et al., 2023; Zee & Koomen, 2016). However, relations between teacher self-efficacy and students' academic outcomes, depending on the level of analysis (student or class level), are not always consistent (Zee et al., 2018).

The association of teacher efficacy and instructional practices with student outcomes initially has been predominantly linked to students' academic achievement. However, there is a growing number of studies addressing other student-related outcomes – from motivational ones to those related to students' well-being, emphasising good teacher-student relationships (Roorda et al., 2011; Chamizo-Nieto et al., 2021; Zheng, 2022). Correspondingly, a substantial number of studies explore the role of teacher self-efficacy with other teacher-related factors, whereby numerous previous findings imply that teachers with a higher level of self-efficacy are more confident, more likely to overcome difficulties and be persistent, believe that they can have a positive impact on student learning, foster students' academic confidence and create more supportive classroom climate (e.g. Fackler & Malmberg, 2016; Fauth et al., 2019; Jerrim et al., 2023).

Since the construct of teacher self-efficacy has been of interest for more than four decades, it has undergone various conceptualisations, and, according to literature, the most agreed dimensions of teacher self-efficacy are instructional support, student engagement and classroom management (Fackler et al., 2021; Kunter et al., 2007; Tschannen-Moran et al., 1998), with the latter being in the

focus of this study. Efficacy for classroom management generally refers to the teacher's ability to organise the instructional process in a well-structured manner and manage student behaviour effectively to ensure a smooth learning process and overcome potential difficulties (Lazarides et al., 2020; Tschannen-Moran & Woolfolk Hoy, 2001). Since teachers' beliefs reflect on teaching practices, teachers with higher self-efficacy beliefs are more likely to manage the classroom effectively and create a supportive learning environment characterised by quality student-teacher relationships, and, accordingly, they are more likely to encourage students' learning and interest (Fackler & Malmberg, 2016; Hettinger et al., 2023). Accordingly, students perceive that teachers who can control the learning process, who successfully engage students in learning, and who develop caring and supportive teacher-student relationships are those teachers who are, at the same time, effective in classroom management (Egeberg & McConney, 2017).

Based on the literature, it can be concluded that effective classroom management, in terms of students' perception of the rules' clarity and monitoring classroom interactions (if not performed in a controlling way that leaves little room for autonomy), promotes students' interest for the subject (Kunter et al., 2007; Schiefele, 2017). Further, numerous studies also suggest the association between classroom management and teachers' emotions (Burić et al., 2020; Valente et al., 2022). Teachers' emotions encompass a broad spectrum of manifestations within the teaching profession, and the literature suggests the importance of emotion regulation in the classroom in line with explicit or implicit rules regarding their expression and intensity and expected manifestation (and maintenance) of enthusiasm (Burić & Frenzel, 2020). As previously mentioned, the emotions teachers display in the classroom can foster various positive student outcomes, including their interest in the subject (Fauth et al., 2019; Kunter et al., 2007), and teachers' emotions, including emotional engagement and enthusiasm, are of crucial relevance for providing supportive emotional climate.

Effective teaching, according to Klassen et al. (2013), depends on teachers who are fully engaged in their work – cognitively, emotionally, and socially, and emotional engagement is the focus of the present study. Emotionally engaged teachers are often described as enthusiastic since emotional engagement is closely intertwined with teacher enthusiasm. Although emotional engagement is measured as a distinct construct in the present study, it is conceptually treated as overlapping with teacher enthusiasm. Specifically, in this study emotional engagement reflects a broader emotional investment in teaching, including but not limited to subject-related enjoyment. Given this conceptualization and their empirical proximity, findings on teacher enthusiasm are also used to inform the theoretical framework and development of the study's hypotheses. Both constructs include an affective state that encompasses positive emotions (experience of excitement and enjoyment) and intrinsic motivation (immersion in teaching), accompanied and displayed by corresponding behavioural expressions (Burić & Macuka, 2017; Keller et al., 2016; Keller et al., 2014; Kunter et al., 2008; Kunter et al., 2011). According to Kim and Schallert (2014), these observable behavioural expressions are crucial for the impact of teachers' emotions on students' outcomes. Hence, students' perceptions of teachers as emotionally engaged and enthusiastic play an important role in exploring these associations, especially considering that fostering caring and supportive relationships with students is one of the essential characteristics of engaged and enthusiastic teachers. Emotionally engaged teachers are more likely to be responsive to students' needs and committed to educational objectives (Burić & Macuka, 2017; Klassen et al., 2013); similarly, enthusiastic teachers inspire and motivate students, promote learning and positively affect students' outcomes (Keller et al., 2016; Kunter et al., 2013). Teachers' emotional engagement and enthusiasm are often explored within teacher motivation and emotions studies, and the results imply that they are influenced by and influence both teacher and student characteristics (Praetorius et al., 2017). Previous findings imply that enthusiasm displayed by the teacher is an important feature of effective and engaging teaching (Kunter et al., 2011), and teachers' emotions are, in general, intertwined with teacher self-efficacy. Among other positive characteristics, teachers with a higher sense of efficacy also display higher

commitment and enthusiasm for teaching (Tschannen-Moran & Woolfolk Hoy, 2001). Further, teachers' enthusiasm is linked to classroom discipline and instructional quality (Kunter et al., 2013), and engaged and enthusiastic teachers are more likely to elicit students' enjoyment (Carmichael et al., 2017; Frenzel et al., 2018) and foster students' motivation (Ryan & Deci, 2000).

Studies focusing on interest as an essential motivational aspect of learning have demonstrated that various factors relate to students' interest in the subject, including teachers' classroom management and enthusiasm, constructs which are also the focus of the present study. For example, Lazarides et al. (2023) and Kunter et al. (2007) obtained that student-perceived classroom management relates to students' interest in mathematics. Carmichael et al. (2017) obtained a positive association between student-perceived teachers' enthusiasm for teaching mathematics and students' interest; however, at the class level, this association was negative. Lazarides et al. (2018) reported on the buffering effect of teachers' enthusiasm on the decline in mathematics interest at the class level.

Given that students' interest in subjects tends to decrease with advancing years of education, especially in STEM subjects (Jacobs et al., 2002; Potvin & Hasni, 2014), which is an internationally recognised phenomenon, it is crucial to investigate which teacher-related factors influence and shape students' subject interest. However, little is known about the mechanism of the association between teachers' classroom management and students' interest. It is plausible that teachers' efficacy indirectly affects students' interest through students' perception of teacher support (Oppermann & Lazarides, 2021). Nevertheless, another possible precursor of this relationship, which has not been given an extensive scientific outlook, are teachers' emotions and emotional engagement (Wang, 2022). Teachers who possess confidence in their teaching abilities and can set clear classroom rules are often more inclined to express enthusiasm, care, and encouragement toward students (Pajares, 1996; Burić & Moè, 2020). Therefore, it is possible that teachers' emotions could mediate the relationship between classroom management and student interest.

1.2 The present study

Students' academic interest is inherently important, as it positively correlates with academic achievement, self-concept, and subsequent academic choices (Lazarides et al., 2018; Marsh et al., 2005). Previously presented results and recent literature on teacher motivation and emotion demonstrate the complexity of the role of motivational and emotional constructs in students' subject-specific interests (Keller et al., 2014; Bardach & Klassen, 2021). Further, both self-efficacy and teachers' emotional engagement and enthusiasm, as crucial motivational aspects, are of key importance for teachers and teaching (Kunter et al., 2011). In line with the observation by Lazarides and Schiefele (2021), the focus of studies in this field is moving beyond whether these motivational characteristics matter to the question of the underlying mechanisms and potential moderators of these relations. Hence, the present study aims to obtain a more detailed insight into one of these specific associations and contribute to the still relatively underrepresented body of studies that enable inference on the climate effects at the class level.

More specifically, and in accordance with the general assumption on the indirect path of teachers' efficacy and student outcomes via mediating variables (Lauermann & Berger, 2021), in this study, the indirect pathway between perceived classroom management and lower-secondary school students' interest in the STEM subjects via perceived teachers' emotional engagement is explored. Since the literature highlights the significance of students' perceptions in influencing motivational factors such as their interest in the subject (Oppermann & Lazarides, 2021), this study focuses on examining these perceptions. Additionally, this study's aim is positioned within the context of early-career STEM teachers. Namely, teachers' efficacy for classroom management can be influenced by various teacher-related and context-related factors (i.e. those at the school, class, or student level). Regarding teacher-related factors, years of teaching experience play a crucial role in teachers' professional competence in general (Klassen & Chiu, 2010; Brandenburg et al., 2016). Early-career teachers worldwide have to

cope with many challenges for which they have not necessarily been fully prepared during their initial teacher education. The practice (or reality) shock is most likely to occur in the first three years of teaching (Casperson & Raaen, 2014), and, according to Admiraal et al. (2023), the decision to leave the profession occurs within the first five years of teaching. One of the challenges that beginning teachers encounter is certainly related to classroom management, i.e. creating an encouraging learning environment, setting clear rules and routines, effective behaviour management and maintaining discipline (Parsad et al., 2001; Meister & Melnick, 2003; Poznanski et al., 2018). Further, this challenge might be even more enhanced for early-career STEM teachers due to the observed decline in students' interest in this area throughout schooling (Fraser et al., 2021) and the decline in perceived teacher support (Lazarides et al., 2018). The severity of this scenario becomes even more prominent, having in mind the issues regarding the attractiveness of the teaching profession and the teacher shortage observed (and even more expected in coming years) in many EU countries, which seems to be particularly worrying in STEM subjects (European Commission, 2023).

In exploring this particular aim, previously mentioned methodological concerns regarding the proper level of analysis in similar studies have been addressed in this study by using class-level climate constructs. Students' perceptions of teachers' classroom management and emotional engagement were treated as aggregates of students' ratings within each class the teacher taught. Conceptualising these variables as reflective constructs with the reference point being a teacher (not a student) enhances the validity of the study and is in line with the common guidelines on analysing and interpreting the climate effects, especially important in an educational context (Morin et al., 2014).

This study is grounded in two complementary theoretical perspectives: the Job Demands-Resources (JD-R) model (Bakker et al., 2003) and the theory of emotion transmission (Frenzel et al., 2018). These frameworks offer insight into the mechanisms through which classroom management may influence students' interest in the subject via teachers' emotional engagement.

The JD-R model proposes that every occupation involves job demands - aspects of the job that require sustained effort and may lead to psychological costs (e.g., stress, exhaustion) - and job resources, which support goal achievement, reduce demands, and promote motivation and development. According to the JD-R model, job resources play a motivational role by fostering work engagement (Bakker et al., 2007).

In the teaching context, classroom management efficacy can be conceptualised as a job resource. Effectively managing student behaviour helps reduce one of the most prominent job demands for teachers - disruptive classroom environments, which are consistently linked to teacher stress and burnout (Hakanen et al., 2006). Teachers who feel confident in their ability to establish and maintain order in the classroom tend to report lower levels of emotional exhaustion and depersonalization, and higher levels of personal accomplishment (Aloe et al., 2014). A well-managed classroom thus enables teachers to allocate their cognitive and emotional resources more effectively, facilitating deeper engagement with teaching (Bakker et al., 2007). This emotional engagement represents a motivational outcome within the JD-R model. When teachers experience supportive and structured environments, they are more likely to be emotionally invested in their work (Burić et al., 2020; Valente et al., 2022).

Complementary to this, the theory of emotion transmission (Frenzel et al., 2018) explains how teachers' emotional expressions—particularly enthusiasm and enjoyment—are perceived by students and can influence their own emotional and motivational responses. Emotions are socially contagious; thus, students who perceive their teachers as emotionally engaged are more likely to experience greater enjoyment and interest in the subject (Frenzel et al., 2010; 2018).

Based on these theoretical considerations and previous research, the positive effect of students' perceptions of teacher classroom management on students' perceptions of teachers' emotional

engagement was expected (H1), as well as the positive effect of students' perceptions of teachers' emotional engagement on students' interest (H2). We presumed that these effects would produce a positive indirect effect. More precisely, we hypothesised that students' perceptions of teachers' emotional engagement would mediate the relationship between students' perceptions of classroom management and their interest in the subject (H3). The direct positive effect of perceived classroom management on students' interest in the subject was also expected (H4).

2. Method

2.1 Measures

Student-reported teacher classroom management was assessed by subscale from the adapted Teacher self-efficacy scale used in TALIS (OECD, 2019). The research team adapted the subscale for student reports of teachers' classroom management efficacy. In adapting the subscale, the wording of the introductory sentence was changed from "I believe I succeed in..." to "My teacher...". Additionally, the language of the items was simplified to ensure clarity for students, while preserving the original meaning of each item. Students rated the extent to which they perceived their teacher was behaving in a described way while teaching a specific subject. The subscale consisted of four items (e.g. Our teacher calms a student who is disruptive or noisy), and the answers were given on a 4-point scale from Not at all to A lot.

Student-reported teacher emotional engagement was assessed with the Emotional Engagement subscale from the Engaged Teachers Scale (Klassen et al., 2013). The subscale was adapted for students, who rated how frequently their teacher behaves or feels in a described way. In adapting the subscale, the phrase "it seems our teacher" was added at the beginning of each item, while the rest of the item content remained unchanged. The subscale consisted of four items (e.g. It seems our teacher finds teaching fun), and answers were given on a 5-point frequency scale from Never to Always.

The Student-reported interest in mathematics scale (Lazarides et al., 2018) measured student-reported interest in STEM subjects. The wording of the scale was adapted for ratings of interest in different subjects (e.g. I am willing to sacrifice my leisure time for studying this subject). The scale consisted of three items, and ratings were given on a 5-point Likert scale from Strongly disagree to Strongly agree.

Descriptive statistics and internal reliability of scales are presented in Table 1.

2.2 Procedure

Prior to the main study, a pilot study was conducted to validate the adapted measures and evaluate the most effective procedures for data collection. The pilot study involved 189 seventh-grade students from 11 classes across five lower-secondary schools in the city of Zagreb. During the pilot study students did not report difficulties in understanding the questionnaire items, nor did they accidentally skip any questions. Confirmatory factor analysis confirmed validity of both teachers' emotional engagement subscale (CFI=.98, TLI=.95, SRMR=.02, RMSEA=.13) and teachers' classroom management (CFI=.99, TLI=.99, SRMR=.02, RMSEA=.05), and both subscales presented high reliability, with Cronbach's alpha .87 and .81, respectively.

Students completed a paper-pencil questionnaire during one of the regular school classes. During the main study, one of the researchers was present in the classroom, guiding the procedure. The teacher was not present in the classroom during the data collection to ensure confidentiality of students'

answers. The procedure was standardized across all classes. To ensure consistency across schools and classes, standardized instructions were developed for all members of the research team. Each teacher was rated by the students from only one class.

The procedure was in line with all ethical principles, including voluntary and anonymous participation and informed consent (school principals, teachers, and students' parents were all informed about the research). The ethical approval for the study was obtained by the Ethical Committee of the (*one of the authors' institutions*) and with the consent of the Ministry of Science and Education of the Republic of Croatia.

2.3 Participants

For the purposes of the present study, a random sample of public lower-secondary schools was selected from a pool of 168 eligible schools located in the City of Zagreb and Zagreb County. Eligible schools were those offering the regular national curriculum and not involved in prior pilot phases of the project. Within each participating school, seventh-grade classes taught by early-career STEM teachers (defined as having up to five years of teaching experience) were included. In cases where an early-career teacher taught multiple seventh-grade classes, one class was randomly selected to participate in the study. This approach was used to minimize potential bias by teachers in selecting a preferred class for participation. All students in these classes were invited to participate, provided that written informed parental consent was obtained. Since the focus of the study were early-career teachers, no other exclusion or inclusion criteria were applied at the student level.

This study involved 918 lower-secondary students. All students were currently enrolled in the 7th grade in lower-secondary school and were between 13 and 14 years old. The sample is balanced regarding students' gender, with 48.6% of male students. Together, the sample included students from 56 different classes and 39 different schools in Zagreb city and Zagreb county, Croatia. On average, classes consisted of 16 students.

Students from each class estimated the characteristics of the same pre-targeted early-career teacher teaching a STEM subject. There were 5 STEM subjects included: mathematics (36.7%), biology (19%), physics (18.2%), informatics (14%), and chemistry (12.1%). All teachers had up to five years of teaching experience with, on average, three years of teaching experience ($M=35.6$ months, $SD=19.5$). More precisely, 27% of the teachers had up to two years of teaching experience, 23% had two or three years, and the remaining 50% had four to five years of experience. Most teachers were women (84.6%), as expected for the teaching profession.

2.4 Data analysis

With student reports nested within classes/teachers, we considered a hierarchical organisation of the data in this study. Hence, we conducted a multilevel analysis, with students' ratings of teacher classroom management and emotional engagement, and students' ratings of subject interest at Level 1 (L1), and class-aggregated student ratings of all constructs at Level 2 (L2). All constructs were measured at L1, resulting in a 1-1-1 multilevel design (Preacher et al., 2010). Since different students rated classroom management and emotional engagement of the same teacher, these constructs are considered as reflective, while student interest is a formative construct (Marsh et al., 2012).

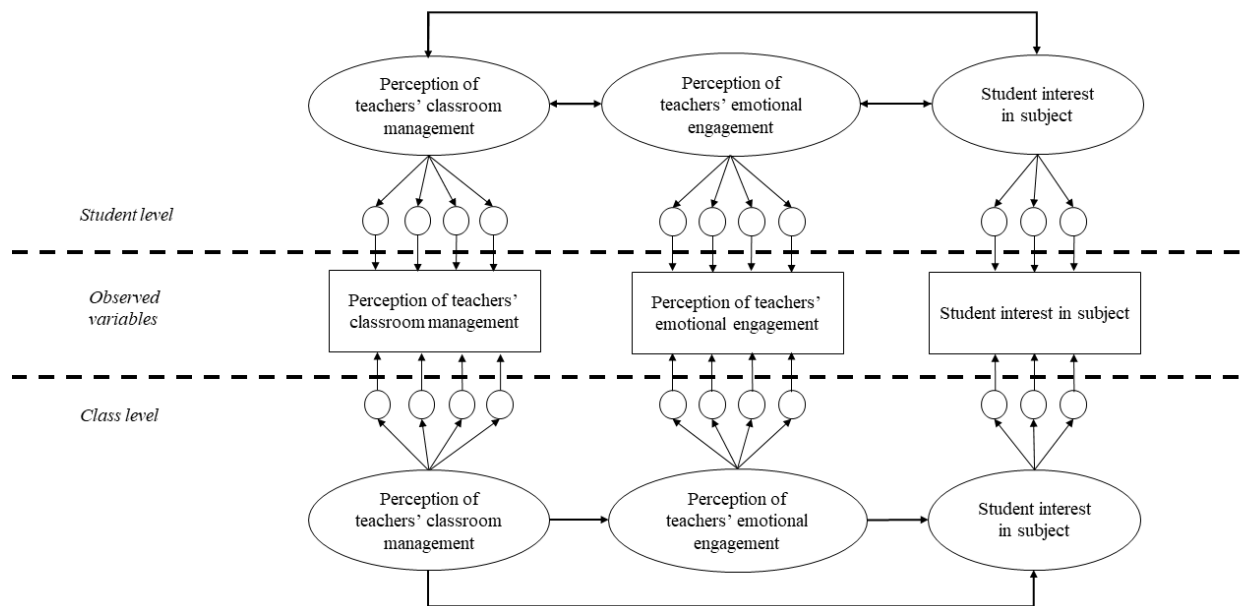
Specifically, the doubly latent multilevel SEM was applied, which integrates the traditional CFA/SEM approaches to control for measurement error and the MLM approach to control for sampling error (Marsh et al., 2009; Lüdtke et al., 2011; Muthén & Asparouhov, 2012). This approach examined how students' perception of teacher classroom management, beyond its direct effect,

indirectly influences their interest in the subject through their perception of teacher emotional engagement. We focused on the impact of aggregated ratings of students' perceptions of teacher's emotional engagement and classroom management on the class-average interest in the subject, regarded as a climate effect. Since both predictors were reflective constructs, residual differences in rating teachers' classroom management and emotional engagement (L1 variance), after controlling for the shared student agreement, are considered as the source of unreliability in the L2 climate constructs (Marsh et al., 2009). Hence, the structural model included the aforementioned hypothesised relations at L2, while the model was saturated at L1 (Figure 1).

The analysis was conducted in the Mplus Version 8.11 (Muthén & Muthén, 1998-2017) through a series of steps. In the first step, the average agreement between students within the same class (ICC1) of all variables and the reliability of the group average (ICC2) of reflective constructs was evaluated (Raudenbush & Bryk, 2002). A value of ICC1 greater than 0.05 was deemed indicative of the necessity for a multilevel analysis (Muthén & Satorra, 1995), and an ICC2 value exceeding 0.70 was considered indicative of acceptable reliability of the group average (Klein et al., 2000). Additionally, the descriptive statistics, reliability coefficients, and Pearson correlation coefficients between study variables at both levels of analysis were calculated. In the second step, a series of multilevel confirmatory factor analyses (MCFA) were conducted to test the construct validity of the instruments. Finally, in the third step, we tested hypothesised climate effects. Parameters related to the mediation effects were tested using Bayesian methods with 95 % credible intervals, following the recommendation by Muthén and Asparouhov (2012). The maximum likelihood estimation with robust standard errors (MLR) method, which corrects the standard errors of the parameter estimates and the test of fit, was used (Rhemtulla et al., 2012). The model fit was determined acceptable based on the criteria: CFI and TLI values surpassing 0.90 and RMSEA and SRMR values below 0.08 (Hu & Bentler, 1999; Marsh et al., 2004).

The data was robust and reliable, with low levels of missing data (0.1 % for students' perceptions of teacher classroom management, 0.2 % for students' perceptions of teacher emotional engagement, and 0.4 % for students' interest in the subject). Little's MCAR test (Little, 1981) showed that data was missing completely at random ($\chi^2(139) = 157.862, p = .131$), and missing data was handled using the full-information maximum likelihood (FIML) method.

Fig.1 Hypothesised doubly latent multilevel SEM model



3. Results

Table 1 presents ICC1, ICC2 values, Pearson correlations among studied variables, descriptive statistics, and Cronbach alpha coefficients for all scales used in this research. All ICC1 values exceeded the cut-off values of 0.10. Hence, a significant proportion of the variability in the study variables stems from variations among higher-level units (classes). ICC2 for both reflective constructs of perceived teachers' classroom management and emotional engagement was high, indicating that students within the same classes agreed well in rating the examined teachers' characteristics. Internal reliability is high for perceived teachers' emotional engagement and satisfactory for perceived teachers' classroom management and student interest in the subject. For the student interest scale, the Cronbach's alpha (0.64) was similar to that reported in previous research using the same three-item measure (e.g., Lazarides et al., 2018, $\alpha = 0.66$). As the scale is very brief, consisting of only three items, a lower alpha value is not unexpected, since shorter scales tend to yield lower reliability estimates (Cortina, 1993). Nonetheless, values above 0.50 are generally considered acceptable for brief, unidimensional measures (Carmines & Zeller, 1979). As expected, latent correlations between tested constructs were positive and moderate at L1 and positive and high at L2.

[Insert Table 1 here]

A series of MCFAs was carried out to examine the latent structure of each scale used in the present study. All parameters in measurement models of perceived teachers' classroom management and emotional engagement were freely estimated, whereas the measurement model of student interest in the subject was tau-equivalent at L1 due to a lower number of indicators. These analyses demonstrated satisfactory model fit for all scales, supporting their unidimensional structure (Table 2). Moreover, factor loadings were in the acceptable range for all variables at L1 and almost all variables at L2, except student interest in the subject with two-factor loadings lower than 0.20.

[Insert Table 2 here]

The structural model also demonstrated adequate fit: $\chi^2(84) = 347.11$, $p < .001$, CFI = .935, TLI = .915, RMSEA = .058, SRMRW = 0.071, and SRMRB = 0.081. The hypothesised climate effects using Bayes estimator are presented in Table 3. The effect of students' perception of teacher classroom management on students' perception of teacher emotional engagement was positive and high, i.e.

students from classes that evaluate their teachers as effective in managing the class also see them as more emotionally engaged, supporting H1. Moreover, the effect of students' perception of teacher emotional engagement on their interest in the subject was also positive and high, indicating that students in classes where teachers are perceived as more emotionally engaged tend to have a greater interest in the subject, confirming H2. Finally, the indirect effect of students' perceptions of teacher classroom management on students' interest through students' perceptions of teacher emotional engagement was positive, supporting H3.

This finding indicates that students from classes where teachers are perceived as good at managing the class also see their teachers as more emotionally engaged, which is, in turn, associated with overall greater interest in the subject among students in those classes. Contrary to H4, the direct effect of students' perceptions of teacher classroom management on students' interest was not significant, indicating that perceived teachers' emotional engagement acts as a full mediator of this relationship based on our data.

[Insert Table 3 here]

4. Discussion

This study aimed to shed more light on the relationship between perceived teachers' efficacy and emotions and students' interest in the subject. More specifically, we tested whether students' perception of teachers' emotional engagement mediates the relationship between their perception of teachers' efficacy in classroom management and class interest in STEM subjects.

In line with our expectations, the findings revealed a significant mediation climate effect, indicating that in classes where the teacher is perceived as more efficient in managing the class, the teacher is also perceived as more emotionally engaged, and the students exhibit higher interest in the subject. In other words, based on these results, teachers' emotional engagement is an intermediary factor that explains how effective classroom management translates into increased student interest in STEM subjects.

Teachers' effective classroom management creates a structured and supportive learning environment, resulting in decreased disruptive behaviour in the classroom (Oliver et al., 2011) and students' higher engagement in instructions (Gage et al., 2018). Given that cognition and emotions are neurologically interrelated (Dolan, 2002), it is plausible that teachers who teach in such environments experience and display more positive emotions and enjoyment while teaching and, thus, are more emotionally engaged. Additionally, working in a positive environment might be considered a teacher's job resource, which is, according to the Job demands and resource theory (Bakker et al., 2023), a key determinant of work engagement. Based on the theories of emotion transmission (Frenzel et al., 2009; 2018), teachers' and students' emotions are interlinked, whereas students show higher enjoyment when perceiving teachers' enthusiasm in teaching (Frenzel et al., 2018). Moreover, teachers' enjoyment in teaching positively shapes student interest in the subject (Frenzel et al., 2010). This mediation effect has not been tested in previous studies; however, it supports the results of similar studies. For instance, Kunter et al. (2007) found that the positive relationship between classroom management strategies and students' interest may be explained by students' experience of intrinsic needs satisfaction, like feeling competent or challenged. Furthermore, Burić (2019) showed that class-perceived teacher enthusiasm predicts students' intrinsic motivation, positive affect, and deep learning strategies at the class level.

Surprisingly, despite a significant and positive bivariate correlation between perceived classroom management and students' interest in the subject at the class level, the direct effect of perceived classroom management in the mediation model was non-significant. Previous studies that did not encompass multilevel analyses showed that perceived classroom management is directly associated with different student outcomes. Students who perceive their teachers as more efficient in classroom

management have higher academic motivation for social sciences (Hung & Fan, 2014), greater achievement in mathematics (Asare et al., 2024), and higher interest in learning English (Sagita, 2023). A study conducted on longitudinal data using a multilevel approach showed that perceived teachers' classroom management influences students' interest in mathematics at the class level (Lazarides et al., 2023). Burić and Kim (2020) also found a positive relationship between perceived teachers' classroom management and class intrinsic motivation. However, potential mediators of this association were not tested in either of the two studies mentioned above. Our results aid previous studies, indicating that the relationship between perceived teachers' classroom management and class-level students' interest in the subject might be (fully) explained by perceived teachers' emotional engagement.

These results have practical implications since they emphasise the relevance of teachers' emotional engagement in fostering students' interest in STEM subjects. Given the internationally observed teacher shortage, particularly in STEM (European Commission, 2023; Feder, 2022), coupled with the decrease in students' interest in STEM subjects as they progress through schooling (Jacobs et al., 2002), positioning this study in the context of early-career STEM teachers is one of its key contributions. In the early years of teaching, teachers experience reality shock and a decline in self-efficacy, which is still developing at this career stage (Woolfolk Hoy & Spero, 2005). Lazarides et al. (2020) found that teachers' self-efficacy for classroom management was related to class-level teachers' perception of classroom management, particularly during early career, while Lazarides et al. (2023) found that it was related to class-level students' perception of classroom management. These results indicate that teachers' self-efficacy plays an important role in actual classroom management perceived by themselves and their students. Hence, the results of the present study support previous results emphasising the importance of encouraging teachers' self-efficacy (Elliott, 2010), especially at the beginning of the career, indicating that it might be an important determinant of teachers' emotional engagement and indirectly of students' interest in the subject. Following the Job demands and resources theory (Bakker et al., 2023), teachers' self-efficacy in classroom management seems to be an important personal resource, and our results imply that perceived teachers' efficacy in classroom management can be seen as a job resource, supporting teachers' emotional engagement.

5. Study limitations and conclusion

This study helps in understanding the relationship between perceived early-career teachers' classroom management and emotional engagement and students' interest in STEM subjects by overpassing methodological limitations in previous research regarding the level of analysis. However, these results should be interpreted cautiously due to several limitations. First, this study was cross-sectional, which did not allow for drawing causal conclusions of the tested effects. It is also possible that teachers who perceive that students in their class have a higher interest in the subject might experience higher emotional engagement. Incorporating longitudinal design would be of key importance to better understand these complex relations. We have also found positive and moderate correlations between residual L1 climate ratings and L1 student interest, which might reflect systematic method effects (Marsh et al., 2012; Morin et al., 2014). These correlations suggest that students who are more interested in the subject also rated their teachers more favourably and vice versa. Furthermore, only 56 clusters (classes) were included in the analysis, which might have attenuated the reliability of measures at L2. This limited number of Level 2 units was primarily a result of the characteristics of the target population: relatively few early-career teachers are present in Croatian schools, and, based on information collected during the study, an average of only two early-career teachers per school was estimated. Accordingly, the available pool of eligible classes remained small. As a consequence, the inclusion and examination of class- and teacher-level covariates (e.g., teacher demographics, school contextual factors) as potential confounding variables was restricted. Although the sample exceeded the commonly recommended minimum threshold for basic ML-SEM models (Maas & Hox, 2005; González-Romá & Hernández, 2023), it was not sufficiently large to support the stable estimation of

more complex models involving multiple Level 2 predictors. It is therefore suggested that future research should aim to include larger samples, which would allow for a more comprehensive examination of potential covariates and confounding influences.

Finally, the relationships were tested for five different STEM subjects simultaneously; however, it would be interesting to have a more nuanced approach and test if these relationships differ between the STEM subjects. In further studies, the role of class size as a potential moderator of the explored association could be accounted for. Namely, concerns regarding the challenges that early-career teachers in many countries face might be especially emphasised for those who teach in larger classes, which can be one of the contextual factors that can increase teacher stress (Kunter et al., 2011). Larger classes can be more demanding in terms of achieving effective classroom management and student engagement, which is, in the literature, more associated with smaller class sizes (Finn et al., 2003).

Despite the aforementioned limitations, this study contributes conceptually and methodologically to a deeper understanding of complexly intertwined motivational constructs. Specifically, this study is one of the few to incorporate a doubly latent model, which controls for both measurement and sampling error, thereby yielding more reliable and unbiased results (Marsh et al., 2009; Lüdtke et al., 2011; Muthén & Asparouhov, 2012). Practical implications of obtained results primarily refer to the relevance of fostering teachers' self-efficacy for classroom management at an early stage of their career since we identified plausible ways in which teachers' self-efficacy may affect teachers' emotional engagement and students' interest in the subject. However, to obtain further insight into these effects, additional studies on diverse samples of teachers and longitudinal study designs would be a valuable contribution that could shed more light on the obtained associations.

References

- Admiraal, W., Kittelsen Røberg, K. - I., Wiers-Jenssen, J., & Saab, N. (2023). Mind the gap: Early-career teachers' level of preparedness, professional development, working conditions, and feeling of distress. *Social Psychology of Education*, 26, 1759-1787. <https://doi.org/10.1007/s11218-023-09819-6>
- Aloe, A. M., Amo, L. C., & Shanahan, M. E. (2014). Classroom management self-efficacy and burnout: A multivariate meta-analysis. *Educational Psychology Review*, 26(1), 101–126. <https://doi.org/10.1007/s10648-013-9244-0>
- Asare, B., Welcome, N. B., & Arthur, Y. D. (2024). Investigating the impact of classroom management, teacher quality, and mathematics interest on mathematics achievement. *Journal of Pedagogical Sociology and Psychology*, 6(2), 30-46. <https://doi.org/10.33902/jpsp.202426232>
- Bakker, A. B., Demerouti, E., & Sanz-Vergel, A. (2023). Job demands–resources theory: Ten years later. *Annual review of organizational psychology and organizational behavior*, 10(1), 25-53. <https://doi.org/10.1146/annurev-orgpsych-120920-053933>.
- Bakker, A. B., Demerouti, E., de Boer, E., & Schaufeli, W. B. (2003). Job demands and job resources as predictors of absence duration and frequency. *Journal of Vocational Behavior*, 62, 341 – 356. [https://doi.org/10.1016/S0001-8791\(02\)00030-1](https://doi.org/10.1016/S0001-8791(02)00030-1)
- Bakker, A. B., Hakanen, J. J., Demerouti, E., & Xanthopoulou, D. (2007). Job resources boost work engagement, particularly when job demands are high. *Journal of Educational Psychology*, 99(2), 274–284. <https://doi.org/10.1037/0022-0663.99.2.274>
- Bardach, L., & Klassen, R. M. (2021). Teacher motivation and student outcomes: searching for the signal. *Educational Psychologist*, 56(4), 283–297. <https://doi.org/10.1080/00461520.2021.1991799>
- Brandenburg, R., McDonough, S., Burke, J., & White, S. (Eds.). (2016). *Teacher education: Innovation, intervention and impact*. Springer. <https://doi.org/10.1007/978-981-10-0785-9>
- Burić, I. (2019). The role of emotional labor in explaining teachers' enthusiasm and students' outcomes: A multilevel mediational analysis. *Learning and Individual Differences*, 70, 12-20. <https://doi.org/10.1016/j.lindif.2019.01.002>
- Burić, I., & Frenzel, A. C. (2020). Teacher emotional labour, instructional strategies, and students' academic engagement: a multilevel analysis. *Teachers and Teaching*, 27(5), 335-352. <https://doi.org/10.1080/13540602.2020.1740194>
- Burić, I., Slišković, A., & Sorić, I. (2020). Teachers' emotions and self-efficacy: A test of reciprocal relations. *Frontiers in Psychology*, 11, 1650. <https://doi.org/10.3389/fpsyg.2020.01650>
- Burić, I., & Kim, L. (2020). Teacher self-efficacy, instructional quality, and student motivational beliefs: An analysis using multilevel structural equation model. *Learning and Instruction*, 66, 101302. <https://doi.org/10.1016/j.learninstruc.2019.101302>
- Burić I., & Macuka I. (2017). Self-efficacy, emotions and work engagement among teachers: A two wave cross-lagged analysis. *Journal of Happiness Studies*, 19, 1917–1933. <https://doi.org/10.1007/s10902-017-9903-9>
- Burić, I., & Moè, A. (2020). What makes teachers enthusiastic: The interplay of positive affect, self-efficacy and job satisfaction. *Teaching and Teacher Education*, 89, 103008. <https://doi.org/10.1016/j.tate.2019.103008>

- Carmichael, C., Callingham, R., & Watt, H. M. G. (2017). Classroom motivational environment influences on emotional and cognitive dimensions of student interest in mathematics. *ZDM Mathematics Education*, 49(3), 449-460. <https://doi.org/10.1007/s11858-016-0831-7>
- Carmines, E. G., & Zeller, R. A. (1979). *Reliability and validity assessment* (Vol. 17). Sage. <https://doi.org/10.4135/9781412985642>
- Casperson, J., & Raaen, F. D. (2014). Novice teachers and how they cope. *Teachers and Teaching*, 20(2), 189-211. <https://doi.org/10.1080/13540602.2013.848570>
- Chamizo-Nieto, M. T., Arrivillaga, C., Rey, L., & Extremera, N. (2021). The role of emotional intelligence, the teacher-student relationship, and flourishing on academic performance in adolescents: A moderated mediation study. *Frontiers in Psychology*, 12, 695067. <https://doi.org/10.3389/fpsyg.2021.695067>
- Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology*, 78(1), 98-104. <https://doi.org/10.1037/0021-9010.78.1.98>
- Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives*, 8(1), 1-44. <https://doi.org/10.14507/epaa.v8n1.2000>
- Dolan, R. J. (2002). Emotion, cognition, and behavior. *Science*, 298(5596), 1191-1194. <https://doi.org/10.1126/science.1076358>
- Egeberg, H., & McConney, A. (2017). What do students believe about effective classroom management? A mixed-methods investigation in Western Australian high schools. *The Australian Educational Researcher*, 45, 195-216. <https://doi.org/10.1007/s13384-017-0250-y>
- Elliott, E. M., Isaacs, M. L., & Chugani, C. D. (2010). Promoting Self-Efficacy in Early Career Teachers: A Principal's Guide for Differentiated Mentoring and Supervision. *Florida Journal of Educational Administration & Policy*, 4(1), 131-146.
- European Commission (2023). *Education and Training Monitor 2023*. <https://op.europa.eu/webpub/eac/education-and-training-monitor-2023/en/index.html>
- Fackler, S., & Malmberg, L.-E. (2016). Teachers' self-efficacy in 14 OECD countries: Teacher, student group, school and leadership effects. *Teaching and Teacher Education*, 56, 185-195. <https://doi.org/10.1016/j.tate.2016.03.002>
- Fackler, S., Sammons, P., & Malmberg, L.-E. (2021). A comparative analysis of predictors of teacher self-efficacy in student engagement, instruction and classroom management in Nordic, Anglo-Saxon and East and South-East Asian countries. *Review of Education*, 9(1), 203-239. <https://doi.org/10.1002/rev3.3242>
- Fauth, B., Decristan, J., Decker, A.-T., Büttner, G., Hardy, I., Klieme, E., & Kunter, M. (2019). The effects of teacher competence on student outcomes in elementary science education: The mediating role of teaching quality. *Teaching and Teacher Education*, 86, 102882. <https://doi.org/10.1016/j.tate.2019.102882>
- Fauth, B., Decristan, J., Rieser, S., Klieme, E., & Büttner, G. (2014). Student ratings of teaching quality in primary school: Dimensions and prediction of student outcomes. *Learning and Instruction*, 29, 1-9. <https://doi.org/10.1016/j.learninstruc.2013.07.001>
- Feder, T. (2022). The US is in dire need of STEM teachers. *Physics Today*, 75(3), 25-27. <https://doi.org/10.1063/PT.3.4959>

- Finn, J. D., Pannozzo, G. M., & Achilles, C. M. (2003). The “Why’s” of class size: Student behaviour in small classes. *Review of Educational Research*, 73(3), 321-368. <https://doi.org/10.3102/00346543073003321>
- Fraser, B. J., McLure, F. I., & Koul, R. B. (2021). Assessing classroom emotional climate in STEM classrooms: Developing and validating a questionnaire. *Learning Environments Research*, 24, 1-21. <https://doi.org/10.1007/s10984-020-09316-z>
- Frenzel, A. C., Becker-Kurz, B., Pekrun, R., Goetz, T., & Lüdtke, T. (2018). Emotion transmission in the classroom revisited: A reciprocal effects model of teacher and student enjoyment. *Journal of Educational Psychology*, 110(5), 628–639. <https://doi.org/10.1037/edu0000228>
- Frenzel, A. C., Goetz, T., Lüdtke, O., Pekrun, R., & Sutton, R. E. (2009). Emotional transmission in the classroom: Exploring the relationship between teacher and student enjoyment. *Journal of Educational Psychology*, 101(3), 705–716. <https://doi.org/10.1037/a0014695>
- Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of research on adolescence*, 20(2), 507-537. <https://doi.org/10.1111/j.1532-7795.2010.00645.x>
- Gage, N. A., Scott, T., Hirn, R., & MacSuga-Gage, A. S. (2018). The relationship between teachers’ implementation of classroom management practices and student behavior in elementary school. *Behavioral disorders*, 43(2), 302-315. <https://doi.org/10.1177/019874291771480>
- González-Romá, V., & Hernández, A. (2023). Conducting and evaluating multilevel studies: Recommendations, resources, and a checklist. *Organizational Research Methods*, 26(4), 629–654. <https://doi.org/10.1177/10944281211060712>
- Hakanen, J. J., Bakker, A. B., & Schaufeli, W. B. (2006). Burnout and work engagement among teachers. *Journal of School Psychology*, 43(6), 495–513. <https://doi.org/10.1016/j.jsp.2005.11.001>
- Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analysis relating to achievement*. Routledge.
- Hettinger, K., Lazarides, R., & Schiefele, U. (2023). Motivational climate in mathematics classrooms: teacher self-efficacy for student engagement, student- and teacher-reported emotional support and student interest. *ZDM – Mathematics Education*, 55, 413-426. <https://doi.org/10.1007/s11858-022-01430-x>
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, 6(1), 1-55. <https://doi.org/10.1080/10705519909540118>
- Hung, C. L., & Fan, C. C. (2014). Perceived classroom management and student learning motivation in social studies of Taiwan junior high school students. *European Journal of Research in Social Sciences*, 2(3), 40-51.
- Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development*, 73(2), 509-527. <https://doi.org/10.1111/1467-8624.00421>
- Jerrim, J., Sims, S., & Oliver, M. (2023). Teacher self-efficacy and pupil achievement: much ado about nothing? International evidence from TIMSS. *Teachers and Teaching*, 29(2), 220-240. <https://doi.org/10.1080/13540602.2022.2159365>

- Keller, M. M., Goetz, T., Becker, E. S., Morger, V., & Hensley, L. (2014). Feeling and showing: A new conceptualization of dispositional teacher enthusiasm and its relation to students' interest. *Learning and Instruction*, 33, 29–38. <https://doi.org/10.1016/j.learninstruc.2014.03.001>
- Keller, M., Woolfolk Hoy, Goetz, T., & Frenzel, A. C. (2016). Teacher enthusiasm: Reviewing and redefining a complex construct. *Educational Psychology Review*, 28, 743–769. <https://doi.org/10.1007/s10648-015-9354-y>
- Kim, T., & Schallert, D. L. (2014). Mediating effects of teacher enthusiasm and peer enthusiasm on students' interest in the college classroom. *Contemporary Educational Psychology*, 39(2), 134–144. <https://doi.org/10.1016/j.cedpsych.2014.03.002>
- Klassen, R. M., & Tze, V. M. C. (2014). Teachers' self-efficacy, personality, and teaching effectiveness: A meta-analysis. *Educational Research Review*, 12, 59–76. <https://doi.org/10.1016/j.edurev.2014.06.001>
- Klassen, R. M., Yerdelen, S. & Durksen, T. L. (2013). Measuring Teacher Engagement: Development of the Engaged Teachers Scale (ETS). *Frontline Learning Research*, 2, 33–52. <https://doi.org/10.14786/flr.v1i2.44>
- Klassen, R. M., & Chiu, M. M. (2010). Effects on teachers' self-efficacy and job satisfaction: Teacher gender, years of experience, and job stress. *Journal of Educational Psychology*, 102(3), 741–756. <https://doi.org/10.1037/a0019237>
- Klein, K. J., Bliese, P. D., Kozlowski, S. W. J., Dansereau, F., Gavin, M. B., Griffin, M. A., Hofmann, D. A., James, L. R., Yammarino, F. J., & Bligh, M. C. (2000). Multilevel analytical techniques: Commonalities, differences, and continuing questions. In K. J. Klein & S. W. J. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions* (pp. 512–553). Jossey-Bass/Wiley.
- Kunter, M., Baumert, J., & Köller, O. (2007). Effective classroom management and the development of subject-related interest. *Learning and Instruction*, 17, 494–509. <https://doi.org/10.1016/j.learninstruc.2007.09.002>
- Kunter, M., Frenzel, A., Nagy, G., Baumert, J., & Pekrun, R. (2011). Teacher enthusiasm: Dimensionality and context specificity. *Contemporary Educational Psychology*, 36, 289–301. <https://doi.org/10.1016/j.cedpsych.2011.07.001>
- Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology*, 105(3), 805–820. <https://doi.org/10.1037/a0032583>
- Kunter, M., Tsai, Y.-M., Klusmann, U., Brunner, M., Krauss, S., & Baumert, J. (2008). Students' and mathematics teachers' perceptions of teacher enthusiasm and instruction. *Learning and Instruction*, 18(5), 468–482. <https://doi.org/10.1016/j.learninstruc.2008.06.008>
- Lauermann, F., & Berger, J.-L. (2021). Linking teacher self-efficacy and responsibility with teachers' self-reported motivating styles and student engagement. *Learning and Instruction*, 76, 101441. <https://doi.org/10.1016/j.learninstruc.2020.101441>
- Lazarides, R., Buchholz, J., & Rubach, C. (2018). Teacher enthusiasm and self-efficacy, student-perceived mastery goal orientation, and student motivation in mathematics classrooms. *Teaching and Teacher Education*, 69, 1–10. <https://doi.org/10.1016/j.tate.2017.08.017>

- Lazarides, R., & Schiefele, U. (2021). Teacher motivation: Implications for instruction and learning. Introduction to the special issue. *Learning and Instruction*, 76, 101543. <https://doi.org/10.1016/j.learninstruc.2021.101543>
- Lazarides, R., Schiefele, U., Hettinger, K., & Frommelt, M. C. (2023). Tracing the signal from teachers to students: How teachers' motivational beliefs longitudinally relate to student interest through student-reported teaching practices. *Journal of Educational Psychology*, 115(2), 290-308. <https://doi.org/10.1037/edu0000777>
- Lazarides, R., Watt, H. M. G., & Richardson, P. W. (2020). Teachers' classroom management self-efficacy, perceived classroom management and teaching contexts from beginning until mid-career. *Learning and Instruction*, 69, 101346. <https://doi.org/10.1016/j.learninstruc.2020.101346>
- Little, R. J. (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association*, 83(404), 1198-1202. <https://doi.org/10.1080/01621459.1988.10478722>
- Lüdtke, O., Marsh, H. W., Robitzsch, A., & Trautwein, U. (2011). A 2×2 taxonomy of multilevel latent contextual models: accuracy-bias trade-offs in full and partial error correction models. *Psychological methods*, 16(4), 444-467. <https://doi.org/10.1037/a0024376>
- Marsh, H. W., Hau, K. T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural equation modeling*, 11(3), 320-341. https://doi.org/10.1207/s15328007sem1103_2
- Marsh, H. W., Lüdtke, O., Robitzsch, A., Trautwein, U., Asparouhov, T., Muthén, B. O., & Nagengast, B. (2009). Doubly-latent models of school contextual effects: Integrating multilevel and structural equation approaches to control measurement and sampling error. *Multivariate Behavioral Research*, 44, 764-802. <https://doi.org/10.1080/00273170903333665>
- Marsh, H. W., Lüdtke, O., Trautwein, U., & Morin, A. J. (2012). Classical latent profile analysis of academic self-concept dimensions: Synergy of person-and variable-centered approaches to theoretical models of self-concept. *Structural Equation Modeling*, 19(3), 377-408. <https://doi.org/10.1080/10705510902751010>
- Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development*, 76(2), 397-416. <https://doi.org/10.1111/j.1467-8624.2005.00853.x>
- Maas, C. J. M., & Hox, J. J. (2005). Sufficient Sample Sizes for Multilevel Modeling. *Methodology: European Journal of Research Methods for the Behavioral and Social Sciences*, 1(3), 86-92. <https://doi.org/10.1027/1614-2241.1.3.86>
- Meister, D. G., & Melnick, S. A. (2003). National New Teacher Study: Beginning Teachers' Concerns. *Action in Teacher Education*, 24(4), 87-94. <https://doi.org/10.1080/01626620.2003.10463283>
- Morin, A. J. S., Marsh, H. W., & Nagengast, B., & Scalas, L. F. (2014). Doubly latent multilevel analyses of classroom climate: An illustration. *Journal of Experimental Education*, 82, 143-167. <https://doi.org/10.1080/00220973.2013.769412>
- Muthén, B., & Asparouhov, T. (2012). Bayesian structural equation modeling: a more flexible representation of substantive theory. *Psychological methods*, 17(3), 313. <https://doi.org/10.1037/a0026802>

- Muthén, L. K. & Muthén, B. O. (1998-2017). *Mplus User's Guide. Eighth Edition*. Los Angeles, CA: Muthén & Muthén
- Muthén, B. O., & Satorra, A. (1995). Complex sample data in structural equation modeling. *Sociological methodology*, 25, 267-316.
- OECD (2019). *TALIS 2018 Technical Report*.
https://www.oecd.org/education/talis/TALIS_2018_Technical_Report.pdf
- Oliver, R. M., Wehby, J. H., & Reschly, D. J. (2011). Teacher classroom management practices: Effects on disruptive or aggressive student behavior. *Campbell Systematic Reviews*, 7(1), 1-55. <https://doi.org/10.4073/csr.2011.4>
- Oppermann, E., & Lazarides, R. (2021). Elementary school teachers' self-efficacy, student-perceived support and students' mathematics interest. *Teaching and Teacher Education*, 103, 103351. <https://doi.org/10.1016/j.tate.2021.103351>
- Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, 66(4), 543-578. <https://doi.org/10.2307/1170653>
- Parsad, B., Lewis, L., & Farris, E. (2001). *Teacher preparation and professional development: 2000 (NCES 2001-088)*. U.S. Department of Education, National Center for Education Statistics.
- Perera, H. N., & John, J. E. (2020). Teachers' self-efficacy beliefs for teaching math: Relations with teacher and student outcomes. *Contemporary Educational Psychology*, 61, 101842. <https://doi.org/10.1016/j.cedpsych.2020.101842>
- Potvin, P., & Hasni, A. (2014). Interest, motivation and attitudes towards science and technology at K-12 levels: a systematic review of 12 years of educational research. *Studies in Science Education*, 50(1), 85-129. <https://doi.org/10.1080/03057267.2014.881626>
- Poznanski, B., Hart, K. C., & Cramer, E. (2018). Are teachers ready? Preservice teacher knowledge of classroom management and ADHD. *School Mental Health: A Multidisciplinary Research and Practice Journal*, 10(3), 301-313. <https://doi.org/10.1007/s12310-018-9259-2>
- Praetorius, A.-K., Lauermaun, F., Klassen, R. M., Dickhäuser, O., Janke, S., & Dresel, M. (2017). Longitudinal relations between teaching-related motivations and student-reported teaching quality. *Teaching and Teacher Education*, 65, 241-254. <https://doi.org/10.1016/j.tate.2017.03.023>
- Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods*, 15(3), 209-233. <https://doi.org/10.1037/a0020141>
- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (Vol. 1). Sage.
- Rhemtulla, M., Brosseau-Liard, P. É., & Savalei, V. (2012). When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. *Psychological Methods*, 17(3), 354-373. <https://doi.org/10.1037/a0029315>
- Roorda, D. L., Koomen, H. M. Y., Spilt, J. L., & Oort, F. J. (2011). The influence of affective teacher-student relationships on students' school engagement and achievement: A meta-analytic approach. *Review of Educational Research*, 81(4), 493-529. <https://doi.org/10.3102/0034654311421793>

- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55, 68-78. <https://doi.org/10.1037//0003-066x.55.1.68>
- Sagita, I. (2023). The Impact of Teachers' Classroom Management Skills on Students' Interest in Learning the English Subject: English. *Journal of English Development*, 3(1), 149-154.
- Schiefele, U. (2017). Classroom management and mastery-oriented instruction as mediators of the effects of teacher motivation on student motivation. *Teaching and Teacher Education*, 64, 115–126. <https://doi.org/10.1016/j.tate.2017.02.004>
- Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, 17, 783-805. [https://doi.org/10.1016/S0742-051X\(01\)00036-1](https://doi.org/10.1016/S0742-051X(01)00036-1)
- Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research*, 68(2), 202-248. <https://doi.org/10.2307/1170754>
- Valente, S., Lourenço, A. A., Dominguez-Lara, S., Derakhshan, A., Németh, Z., & Almeida, L. S. (2022). Teachers' emotion regulation: Implications for classroom conflict management. *Australian Journal of Teacher Education*, 47(8). <https://doi.org/10.14221/ajte.2022v47n8.2>
- Wang, L. (2022). Exploring the Relationship Among Teacher Emotional Intelligence, Work Engagement, Teacher Self-Efficacy, and Student Academic Achievement: A Moderated Mediation Model. *Frontiers in Psychology*, 12, 810559. <https://doi.org/10.3389/fpsyg.2021.810559>
- Woolfolk Hoy, A. E., & Spero, R. B. (2005). Changes in teacher efficacy during the early years of teaching: A comparison of four measures. *Teaching and Teacher Education*, 21(4), 343–356. <https://doi.org/10.1016/j.tate.2005.01.007>
- Zee, M., & Koomen, H. M. Y. (2016). Teacher self-efficacy and its effects on classroom processes, student academic adjustment, and teacher well-being. *Review of Educational Research*, 86, 981–1015. <https://doi.org/10.3102/0034654315626801>
- Zheng F. (2022). Fostering Students' Well-Being: The Mediating Role of Teacher Interpersonal Behavior and Student-Teacher Relationships. *Frontiers in psychology*, 12, 796728. <https://doi.org/10.3389/fpsyg.2021.796728>

Table 1

Pearson correlation matrix between studied variables, descriptive statistics, ICC1, ICC2 and internal reliability of tested constructs

Variable name	<i>M</i>	<i>SD</i>	ICC1	ICC2	1	2	3
1 Perceived teachers' classroom management	3.21	0.707	0.28	0.86	(.78)	.696***	.803***
2 Perceived teachers' emotional engagement	3.85	1.117	0.41	0.92	.550***	(.93)	.984***
3 Student interest in subject	3.63	0.933	0.12	-	.383***	.572***	(.64)

* $p < .05$, ** $p < .01$, *** $p < .001$; Cronbach's α are presented in parentheses in the main diagonal; correlations between Level 2 variables are presented above the diagonal; correlations between Level 1 variables are presented below the diagonal.

Table 2

Model-fit information for multilevel confirmatory factor analysis of the tested constructs

Variable name	χ^2 (df)	CFI	TLI	RMSEA	SRMR _w	SRMR _B	λ_w (min-max)	λ_B (min-max)
Perceived teachers' classroom management	12.399** (4)	0.988	0.96	0.048	0.023	0.011	.412***- .613***	.317***- .406***
Perceived teachers' emotional engagement	8.846 (4)	0.997	0.99	0.036	0.013	0.003	.760***- .877***	.681***- .797***
Student interest in subject	12.173** (2)	0.97	0.91	0.074	0.039	0.057	.699***	.115**- .610***

* $p < .05$, ** $p < .01$, *** $p < .001$; subscript *w* indicates within level of analysis (L1), subscript *b* indicates between level of analysis (L2); Student interest in the subject at within level was tau-equivalent, hence there is only one-factor loading.

Table 3

Results of the tested direct and indirect climate effects of students' perceived teacher classroom management and emotional engagement on student interest in the subject

Directional path	Estimate	SE	95 % confidence interval
Perceived teachers' classroom management → Perceived teachers' emotional engagement	.695**	0.12	[0.482 - 0.819]
Perceived teachers' emotional engagement → Student interest in subject	.791***	0.126	[0.528 - 1.027]
Perceived teachers' classroom management → Student interest in subject	.245	0.147	[-0.064 - 0.526]
Perceived teachers' classroom management → Perceived teachers' emotional engagement → Student interest in subject	2.974**	2.568	[0.833 - 10.318]

** $p < .01$, *** $p < .001$; Estimates of direct effects are standardised, estimate of indirect effect is unstandardized.