Influence of empowering and disempowering motivational climates on academic self-concept amongst STEM, social studies, language, and physical education pre-service teachers: a test...

4 authors:

Antonio Granero-Gallegos
University of Almería
281 PUBLICATIONS   **3,140** CITATIONS

SEE PROFILE

Antonio Baena Extremera
University of Granada
314 PUBLICATIONS   **2,966** CITATIONS

SEE PROFILE

María del Mar Ortiz Camacho
University of Granada
40 PUBLICATIONS   **531** CITATIONS

SEE PROFILE

Rafael Burgueño
University of Malaga
110 PUBLICATIONS   **744** CITATIONS

SEE PROFILE

Routledge
Taylor & Francis Group

Check for updates

Influence of empowering and disempowering motivational climates on academic self-concept amongst STEM, social studies, language, and physical education pre-service teachers: a test of basic psychological needs

Antonio Granero-Galleros [a,b], Antonio Baena-Extremera[c], María del
Q1 Mar Ortiz-Camacho[c] and Rafael Burgueño [c]

[a]Department of Education, University of Almeria, Almeria, Spain; [b]Health Research Centre, University of Almeria, Almeria, Spain; [c]Faculty of Education Sciences, University of Granada, Granada, Spain

Coll:

QA:

ABSTRACT

Guided by the bright and dark side described in Self-Determination Theory, and following [Duda, J. L., & Appleton, P. R. (2016). Empowering and disempowering coaching climates: Conceptualization, measurement considerations, and intervention implications. In M. Raab, P. Wylleman, R. Seiler, A.-M. Elbe, & A. Hatzigeorgiadis (Eds.), *Sport and exercise psychology research* (pp. 373–388). Academic Press] hierarchical and integrative conceptualisation of motivational climates, the primary objective of this research was to test the predictive relationships between pre-service teachers' perceptions of educator-created (dis-)empowering climates and need-based and novelty-based experiences with their academic self-concept. Bearing in mind that the pre-service teachers' academic self-concept might vary depending on the knowledge domain, a secondary objective was to test invariance in the predictive model across the four knowledge domains (i.e. STEM, social studies, language, and physical education). The convenience sample included 1,410 pre-service secondary teachers (40.30% men; $M_{age} = 23.85$; $SD_{age} = 5.13$; domain: 23.2% STEM, 24.8% social studies, 30.5% language, and 21.4% physical education) who participated in this cross-sectional study. The results from the structural equation modelling showed positive relationships between an educator-created empowering climate and need and novelty satisfaction, and negative relationships with need and novelty frustration. A disempowering climate was positively associated with need and novelty frustration, and negatively related to novelty satisfaction. Need satisfaction and novelty satisfaction were positively associated with academic self-concept, while need frustration and novelty frustration were associated negatively. The paths were invariant across the knowledge domains of STEM, social studies, language, and physical education. The results show that, regardless of the knowledge domain, the educator-created motivational climate represents a differential social-contextual factor explaining the need-based and novelty-based experiences, and academic self-concept of pre-service teachers throughout their initial teacher education programme.

CONTACT Rafael Burgueño ✉ rmburgueno@ual.es 📧 Carretera. Sacramento, s/n, La Cañada 04120, Almería, Spain
🐦 @BurguenoRafa

Introduction

In times of teacher shortages, it is crucial to improve the quality of new teacher recruitment and retention in initial teacher education programmes (Organisation for Economic Cooperation and Development [OECD], 2017). Nonetheless, the latest reports indicate that a large proportion of pre-service teachers leave their initial teacher education programme after only a short period due to their own sense of failure (OECD, 2018). One of the key determinants of academic achievement that helps pre-service teachers complete their initial teacher education programme successfully is academic self-concept (Granero-Gallegos et al., 2023). Although academic self-concept is widely understood to be constructed from experiences in the environment and interactions with others (Marsh et al., 1999; Shavelson et al., 1976; Shavelson & Bolus, 1982), no attention has been given to the specific way in which the teacher educator interacts with their teacher students, nor to how the delivery of the learning-related activity or lesson organisation (i.e. motivational climate) influence the academic self-concept of pre-service teachers.

Self-Determination Theory (SDT; Ryan & Deci, 2017) is a solid theoretical framework for exploring the role that teacher educators might play in pre-service teachers' academic self-concept through its dual motivational sequence (need-supportive/need-thwarting environment → need satisfaction/ frustration → outcomes). To thoroughly analyse the influences of the social environment, Duda (2013) advanced a hierarchical and fine-grained conceptualisation of motivational climates by incorporating the main social environmental dimensions highlighted in SDT (Ryan & Deci, 2017) and Achievement Goal Theory (Ames, 1992). This conceptualisation, which differentiates between an empowering and a disempowering climate, could shed light on how the teacher educator's role influences academic self-concept of pre-service teachers using the two specific motivational pathways described in SDT. Complementary to this, there is a need to gather evidence on the need for novelty in the specific context of initial teacher education and, consequently, to clarify the distinctive role that the satisfaction (or frustration) of this potential need within SDT might have on the interplay between the perceived educator-created motivational climate and pre-service teachers' academic self-concept. Hence, the present study seeks to expand on previous knowledge regarding initial teacher education by analysing the interplay between the pre-service teachers' perceptions of educator-created (dis-)empowering climates and their academic self-concept, including at the same time their need-based and novelty-based experiences.

Academic self-concept in initial teacher education

Self-concept is broadly conceptualised as a person's perception of self (Shavelson et al., 1976). In an attempt to translate the overall conceptualisation into something operational, Shavelson and Bolus (1982) defined self-concept as each person's perception of his/her ability in distinct domains, including in initial teacher education. Thus, academic self-concept in initial teacher education was exclusively defined as perceived ability in schoolwork (Brumariu et al., 2022). It is noteworthy that apart from the focus on ability when assessing academic self-concept, much research has also looked at the teacher students' willingness to work hard in their initial teacher education programme. It is tenable

that the teacher students' definition of academic self may rest significantly on the "effort" element of academic self-concept (Liu & Wang, 2005). Furthermore, the societal emphasis on effort in the pursuit of learning is likely to influence students' self-definitions. For these reasons, a growing body of studies has distinguished between ability (or competence) and effort (or affect) in regard to academic self-concept (Liu & Wang, 2005; Marsh et al., 1999; Matovu, 2014). Drawing on this differentiation, Liu and Wang (2005) operationalised academic self-concept in terms of academic confidence (i.e. a teacher student's feelings and perceptions about his/her ability and skill with regard to activities) and academic effort (i.e. a teacher student's commitment to, and involvement and interest in schoolwork).

Previous studies into initial teacher education have shown that academic self-concept of pre-service teachers could vary greatly depending on the specific knowledge domain (i.e. STEM, social studies, language, or physical education) to which they belong (Beudels et al., 2021; Trautwein et al., 2006). To illustrate this, a physical education pre-service teacher might have a strong academic self-concept toward physical education, but a weak one towards another knowledge domain given that (s)he sees herself/himself as highly capable of managing the classroom and teacher students subject-specific content in physical education, but (s)he might perceive herself/himself as incapable of guiding the students' learning in another knowledge domain such as language or STEM. A solid body of research theorises that the academic self-concept of pre-service teachers is shaped by experiences in the learning environment and interactions with their teacher educator (Pekrun & Stephens, 2015; Shavelson et al., 1976; Shavelson & Bolus, 1982). SDT maintains that the influence of perceived social environments on an individual's behaviour, cognition and wellness directly depends on their differentiated perception of basic psychological needs (Vansteenkiste et al., 2020).

Basic psychological needs and the need for novelty in initial teacher education

SDT postulates that individuals have basic psychological needs for autonomy, competence, and relatedness (Ryan & Deci, 2017), and that these act as psychological mediators between the social environment and human behaviour, cognition, and health (Vansteenkiste et al., 2020). SDT also postulates a dual-process model for explaining human functioning based on a clear distinction between need satisfaction and need frustration (Vansteenkiste & Ryan, 2013). Need satisfaction represents the core of humanity's bright side (i.e. need-supportive environments → need satisfaction → adaptive outcomes) given that it fosters an individual's personal development, self-actualisation, integration, and wellness (Vansteenkiste & Ryan, 2013). Autonomy satisfaction refers to experiences of volition and choice towards a desired behaviour. Competence satisfaction refers to experiences of mastery and efficacy towards goals. Relatedness satisfaction refers to experiences of interpersonal connection and caring. Conversely, SDT assumes that need frustration represents the core of humanity's dark side (i.e. need-thwarting environments → need frustration → maladaptive outcomes) as it contributes to maladaptive functioning patterns, passivity, fragmentation, and illness (Vansteenkiste & Ryan, 2013). Autonomy frustration includes experiences of coercion and pressure towards an undesired behaviour. Competence frustration includes experiences of inefficacy and failure in achieving expected goals. Relatedness frustration includes experiences of social

exclusion and solitariness. Apart from these three needs commonly accepted in the SDT literature, a growing body of research has gathered evidence in support of the need for novelty as the fourth basic psychological need (e.g. González-Cutre et al., 2016, 2020; López-García et al., 2023). Novelty satisfaction refers to experiences that differ from those comprising the everyday routine (González-Cutre et al., 2020), whereas novelty frustration concerns experiences of monotony in daily activities (González-Cutre et al., 2023).

SDT-based research has demonstrated that need satisfaction and need frustration can occur simultaneously in the same domain with both differentially contributing to specific outcomes (Burgueño et al., 2023). At the theoretical level, it is likely that when pre-service teachers perceive volition and choice in the learning-related activities, mastery in the task completion, and genuine connections to their teacher educator and classmates (i.e. need satisfaction), they would tend to feel higher academic confidence and effort involved in their initial teacher education programme (i.e. academic self-concept). This positive and direct relationship between need satisfaction and academic self-concept has been observed in previous research on pre-service teachers (Granero-Gallegos et al., 2023). Conversely, it is theoretically plausible that when pre-service teachers feel external and self-imposed pressures towards activity development, failure towards activity accomplishment, and exclusion from their teacher educators (need frustration), they tend to have a lower academic self-concept (i.e. a cross path). This direct but negative association has been reported in previous research (Granero-Gallegos et al., 2023). Although this research made a meaningful contribution to the field of initial teacher education, it did not consider the role that novelty satisfaction and novelty frustration might play in academic self-concept. Hence, there is a need to extend existing knowledge by exploring the distinctive roles that need-based and novelty-based experiences may have regarding academic self-concept in a sample of pre-service teachers from the knowledge domains of physical education, STEM, social studies, and language.

(Dis-)empowering motivational climates in initial teacher education

SDT-based research argues that the basic psychological needs of pre-service teachers will be perceived as either satisfied or frustrated, depending on their interpretation of the classroom social environment (Vansteenkiste et al., 2020). To study the classroom social environment in more detail, Duda and Appleton (2016) outlined a conceptualisation for motivational climate based on a hierarchical, integrative, and multidimensional approach, incorporating the main social environmental dimensions underscored within SDT (i.e. autonomy support, control, and social support) and Achievement Goal Theory (i.e. task-involving and ego-involving climates). According to Duda and Appleton (2016), a teacher educator creates an empowering climate when he/she provides pre-service teachers with opportunities to choose, gives meaningful rationales for activities, acknowledges their preferences and opinions (i.e. autonomy support), establishes intrapersonal criteria for success based on effort, cooperative learning, skills development, and hard work (i.e. a task-involving climate), and makes them feel valued and cared for as people (i.e. social support). In contrast, a teacher educator creates a disempowering climate when he/she uses pressuring tactics to make pre-service teachers think, behave, and feel in a prescribed way (control), and establishes interpersonal success criteria based on the display of superiority, rivalry, and differential treatment towards

students depending on their performance levels, as well as the use of rewards for achievements and punishments for mistakes (i.e. an ego-involving climate).

By incorporating the main social environmental elements of SDT and Achievement Goal Theory, Duda and Appleton (2016) theorised that (dis-)empowering climates would be differentially associated with need-based experiences. Since empowering climates incorporate need-supportive practices, they would primarily tend to support need satisfaction. Therefore, empowering climates are theoretically believed to act as social antecedents to the bright side (empowering climates → need satisfaction → outcomes) outlined in SDT (Vansteenkiste & Ryan, 2013, page 265). In addition, Duda and Appleton (2016) theorised that empowering climates might act secondarily as a buffer against experiences of need frustration. In contrast, disempowering climates, which integrate need-thwarting practices, would strongly tend to facilitate need frustration. Thereby, disempowering climates are theoretically believed to act as social antecedents to the dark side (disempowering climates → need frustration → outcomes) as described in SDT (Vansteenkiste & Ryan, 2013, page 265). Furthermore, Duda and Appleton (2016) theorised that disempowering climates might act secondarily to undermine experiences of need satisfaction.

Even though the notion of educator-created (dis-)empowering climates has recently been incorporated into the agenda of researchers analysing the learning environment in teacher education, very little is currently known about how educator-created (dis-)empowering climates contribute to the need-based and novelty-based experiences of pre-service teachers in their initial teacher education programme. The only SDT-grounded study found to date revealed a positive relationship between a perceived educator-created empowering climate and need satisfaction, and between a perceived educator-created disempowering climate and need frustration in pre-service physical education and language teachers (Granero-Gallegos et al., 2023). Additionally, a perceived educator-created empowering climate was negatively associated with need frustration, whereas a perceived disempowering climate was unrelated to need satisfaction in the two samples of pre-service teachers studied (Granero-Gallegos et al., 2023). Although this study did manage to shed a little light on the impact of the pre-service teachers' perception of educator-created (dis-)empowering climates on their need-based experiences, one must note that the influence of perceived (dis-)empowering climates on academic self-concept (when considering both the role of need and novelty satisfaction and of need and novelty frustration) remains to be investigated in the context of initial teacher education. This research also sought to provide evidence of the need for novelty as the fourth basic psychological need in the specific context of initial teacher education. Such research contributes to gathering evidence that will help researchers and teacher educators obtain better insight into the differentiated effects of pre-service teachers' perceptions of educator-created (dis-)empowering climates on their need-based and novelty-based experiences and academic self-concept, taking into account the specific knowledge domain to which they belong. In addition, it will provide information for teacher educators to implement instructional and motivational strategies for creating motivational climates that not only promote adaptive psychological experiences and learning-related consequences, but also avoid maladaptive experiences throughout initial teacher education programmes.

The present research

Guided by the bright and dark side outlined by SDT, and incorporating Duda and Appleton's (2016) conceptualisation of (dis-)empowering climates as social environmental antecedents, the main objective of this research was to test the simultaneous predictive relationships of the pre-service teachers' perception of educator-created (dis-)empowering climates on their academic self-concept, considering the mediating role of need-based and novelty-based experiences. As the pre-service teachers' academic self-concept could additionally vary depending on the knowledge domain to which they belong, a secondary objective was to analyse the invariant nature of the predictive model to be tested across the four knowledge domains (i.e. STEM, social studies and humanities, language, and physical education). In line with the SDT assumptions (Ryan & Deci, 2017; Vansteenkiste et al., 2020) and previous research into initial teacher education (Granero-Gallegos et al., 2023; Granero-Gallegos et al., 2023; López-García et al., 2023), we hypothesise that: an empowering climate would positively and primarily predict need satisfaction (H1) and novelty satisfaction (H2); an empowering motivational climate would negatively and secondarily predict need frustration (H3) and novelty frustration (H4); a disempowering climate would positively and primarily predict need frustration (H5) and novelty frustration (H6); a disempowering climate would negatively and secondarily predict need satisfaction (H7) and novelty satisfaction (H8); need and novelty satisfaction would positively predict academic self-concept (H9 and H10); need and novelty frustration would negatively predict academic self-concept (H11 and H12); need and novelty satisfaction would positively mediate the relationship between an empowering climate and self-concept, in the same way as they would negatively mediate the relationship between a disempowering climate and academic self-concept (H13 and H14); and need and novelty frustration would negatively mediate the association of a disempowering climate with academic self-concept, just as they would positively mediate the association of an empowering climate with academic self-concept (H15 and H16) (see Figure 1). Given the lack of previous research, we did not make hypotheses on the invariant character of the predictive model to be tested.

Method

Participants and setting

Prior to recruiting and selecting the participants, we used the *Free Statistics Calculator* v.4.0 (Soper, 2022) software to determine the minimum sample size for the trustworthiness of the results. This revealed that at least 1,371 individuals would be needed to detect the effect sizes (i.e. $f^2 = .15$) with a statistical power level of .99 and a statistical significance level of $\alpha = .05$ (Soper, 2022).

Considering the estimated sample size, 1410 pre-service secondary teachers (40.3% men, 59.6% women, 0.1 no gender data; age: $M = 23.85$, $SD = 5.13$, range = 18–60 years) enrolled in the professional master's programme in education at different Spanish universities participated in the present cross-sectional research. Since initial secondary teacher education in Spain is organised into a consecutive five-year model (a four-year, full-time degree programme in a specific subject followed by a one-year, full-time master's in education programme), the teacher candidates came from different degree programmes
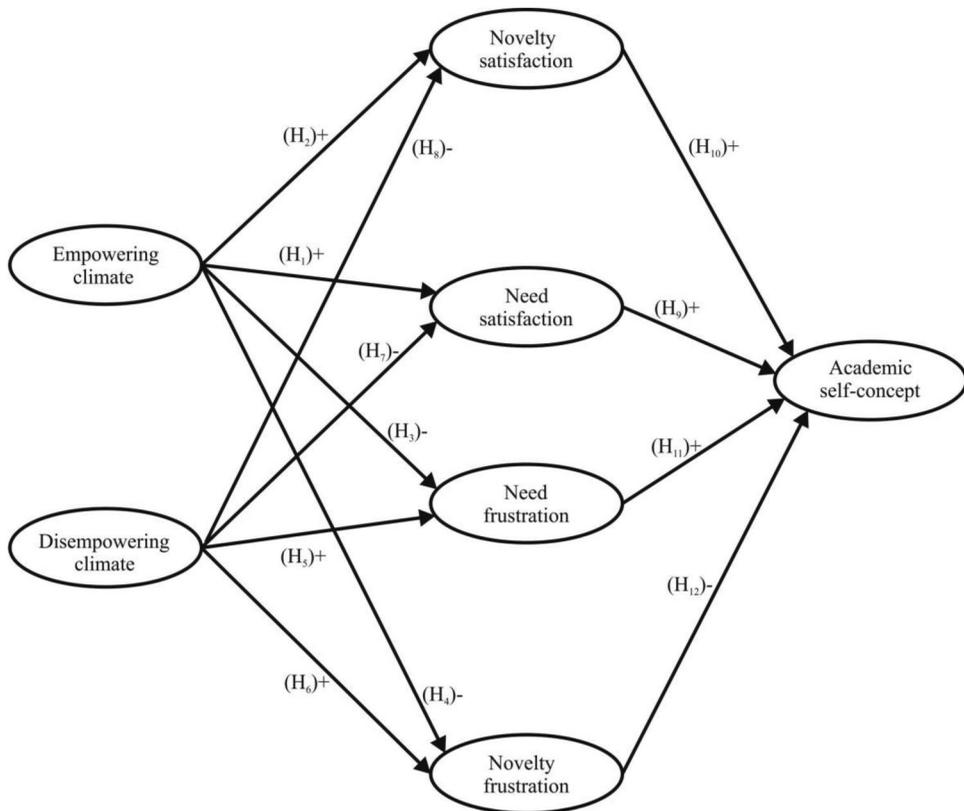
Figure 1. Theoretical hypothesised model. Note: The plus sign (+) indicates a positive relationship between variables while the negative sign (−) indicates a negative association.

related to STEM, social studies and humanities, language, and physical education. Specifically, 327 (23.2%) pre-service teachers were enrolled in the STEM domain, 350 (24.8) in the social studies and humanities domain, 430 (30.5%) in the language domain, and 303 (21.4%) in the physical education domain. The participants were recruited and selected using a convenience sampling method with blinding between the participants and the researchers responsible for the data analysis treatment.

Measures

Educator-created (dis-)empowering motivational climates

Grounded in the theoretical assumptions of SDT and Achievement Goal Theory, and the prior research of Mastagli et al. (2021), various items were taken from the Interpersonal Teaching Style in Higher Education Scale (Authors, aaaa), the Motivational Climate in Education Scale (Authors, bbbb), and items adapted from the Social Support Questionnaire by Appleton et al. (2016) to measure the different climate dimensions. Assessment of the perceived empowering motivational climate was carried out using three subscales: autonomy support (five items, e.g. "My educator gave students choices and options"), task-involving climate (four items, e.g. "The teacher expects us to learn new skills and acquire new knowledge), and social support (three items, e.g. My educator listened

openly and did not judge the students' personal feelings"). The measure for the perceived disempowering motivational climate included two subscales: an ego-involving climate (three items, e.g. "Students are encouraged to outperform one another") and controlling style (six items, e.g. "My teacher paid less attention to pupils if they displeased him or her"). Items were scored on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Basic psychological need satisfaction

We used the Spanish version, adapted to education (León et al., 2011), of the *Échelle de Satisfaction des Besoins Psychologiques* (Gillet et al., 2008). The instrument is preceded by the stem "In my classes … ", and includes 15 items that, grouped into 5 items per dimension, measure satisfaction of the need for autonomy (e.g. "I feel free to make my own choices"), competence (e.g. "I feel I am good at what I do"), and relatedness (e.g. "I feel I get along with the people around me"). Items were scored on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). In this study, the hierarchical one-factor model obtained a good fit to the observed data: χ^2 ($df = 86$) = 336.720, $p < .001$, $\chi^2/df =$ 3.915; CFI = .968; TLI = .961; SRMR = .037; RMSEA = .045 (90%CI = .039–.050).

Novelty satisfaction

We used the novelty-satisfaction subscale adapted to education (González-Cutre et al., 2020). It is preceded by the stem "In my classes … " and followed by 5 items to measure novelty satisfaction (e.g. "I frequently feel there are novelties for me"). Items were scored on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). In this study, the one-factor model obtained a suitable fit to the observed data: χ^2 ($df = 5$) = 7.341, $p < .001$, $\chi^2/df = 4.033$; CFI = .999; TLI = .998; SRMR = .007; RMSEA = .018 (90%CI = .001–.044).

Basic psychological need frustration

We used the Spanish version, adapted to education (Cuevas et al., 2015), of the Psychological Need Thwarting Scale (Bartholomew et al., 2011). The instrument is headed by the stem "In my classes … " and followed by 12 items that, grouped into four items per dimension, measure frustration of the need for autonomy (e.g. "I feel pushed to behave in certain ways"), competence (e.g. "Situations occur in which I am made to feel incapable"), and relatedness (e.g. "I feel I am rejected by those around me"). Items were scored on a Likert scale from 1 (strongly disagree) to 7 (strongly agree). In this research, the hierarchical one-factor model obtained a good fit to the observed data: χ^2 ($df = 51$) = 233.746, $p < .001$, $\chi^2/df = 4.583$; CFI = .970; TLI = .962; SRMR = .028; RMSEA = .050 (90% CI = .044–.057).

Novelty frustration

We used the novelty-frustration subscale adapted to education (González-Cutre et al., 2020). This is preceded by the stem "In my classes … " and followed by 5 items measuring novelty frustration (e.g. "I feel monotony"). Items were scored on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). In this study, the one-factor model obtained a suitable fit to the observed data: χ^2 ($df = 5$) = 20.166, $p < .001$, $\chi^2/df = 4.033$; CFI = .992; TLI = .984; SRMR = .012; RMSEA = .053 (90%CI = .034–.075).

Academic self-concept

We used the Spanish version (Authors, cccc) of the Academic Self-Concept Scale (Matovu, 2014). The instrument includes six items which measure academic confidence (three items, e.g. "I can follow the classes easily") and academic effort (three items, e.g. "I study hard for my tests"). Items were scored on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). In this study, the hierarchical one-factor model had a good fit to the observed data: χ^2 ($df = 12$) = 33.120, $p < .001$, $\chi^2/df = 2.760$; CFI = .976; TLI = .954; SRMR = .029; RMSEA = .072 (90%CI = .056–.088)

Procedure

The entities in charge of coordinating the MPE in each university, together with the teaching staff from the different Schools of Education, were contacted beforehand to request their collaboration and inform them of the study objective. The researchers invited all pre-service secondary teachers ($N = 3653$ according to governmental data) via email to participate in the study. The instrument was administered at the end of the second semester of the 2020/2021 academic year. It was completed in a classroom environment in each of the participating universities, where the researchers provided the potential participants with a link to Google Forms via a QR code. Since the Google Form was configured in such a way that it required a response to each question, there were no missing data. Prior to the online questionnaire being administered, the researchers gave the potential survey respondents a brief explanation of the importance of the research, the voluntary nature of their participation, the anonymity of their responses, and explained that there would be no effects on their grades and that they could cease participation at any time. Furthermore, the researchers were available to resolve any doubt during the questionnaire's completion process. Except for two people who decided not to participate in the research, all the participants gave their informed consent prior to undertaking the study. This research was approved by the Bioethics Committee of the University (masked for review process) and conducted in accordance with the Helsinki Declaration.

Data analysis

Preliminary data analysis

Firstly, no missing values were found. Secondly, given that there is no validity evidence for the empowering and disempowering motivational climates measure, three alternative models were tested; these relied on the distinction between empowering and disempowering climates proposed by Duda and Appleton (2016). Specifically, a first-order, two-factor model (i.e. empowering and disempowering) was tested using a confirmatory factor analysis (CFA) approach. A hierarchical two-factor CFA model (H-CFA) was also tested by specifying each item as a factor loading on a target first-order factor and, in turn, every first-order factor was permitted to load on one or various hierarchical factors (Rindskopf & Rose, 1988). In this case, each first-order factor was specified according to the initial theoretical model: an empowering climate was specified in terms of a task-involving climate, autonomy support, and social support; a disempowering climate was specified in terms of an ego-involving climate and a controlling style. Finally, and following the proposal by Appleton et al. (2016), a bifactor CFA model (two-B-CFA) was also

tested. The bifactor model assumes the existence of one or more global factors (i.e. empowering and disempowering) that explains the covariance of every observed measure and, simultaneously, presents several first-order factors (i.e. task-involving climate, autonomy support, social support, ego-involving climate, and controlling style), measuring and explaining a part of the same items (Brown, 2015).

The assessment of each factor model was performed using Mplus v.8 (version 8.4; Muthén & Muthén, 1998–2017). The models were estimated using the maximum likelihood robust (MLR) estimator, which offers robust fit-indices and standard errors in the case of non-normality and performs well with variables that are measured with a minimum of five response categories (Muthén & Muthén, 1998–2017). The goodness of fit was evaluated by a combination of fit indices: the coefficient between χ^2 and degrees of freedom (df), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Standardised Root Mean Square Residual (SRMR), the Root Mean Square Error of Approximation (RMSEA) accompanied by a 90% confidence interval (90%CI), and the Akaike Information Criterion (AIC). Values up to 3 and 5 for the χ^2/df coefficient, and higher than .90 or .95 for the CFI and TLI, in conjunction with scores lower than .06 or .08 for the SRMR and RMSEA, respectively, would indicate an excellent or adequate fit to the data (Kline, 2016). The AIC is used to select amongst competing factor models, with the model having the smallest AIC value being the best fit and, therefore, the one chosen to replicate (Kline, 2016). As the goodness-of-fit measures tend to favour bifactor models (Gignac, 2016), additional statistical indices were used to assess the robustness of the two global factors: Hierarchical omega (ω_h, Zinbarg et al., 2006), coefficient H (Hancock & Mueller, 2001), Explained Common Variance (ECV; Stucky & Edelen, 2015), Percentage of Uncontaminated Correlations (PUC; Reise et al., 2013), and Item-Explained Common Variance (I-ECV; Stucky et al., 2013). The robustness of the global factor is confirmed by values higher than .80 for ω_h and coefficient H, together with ECV and PUC values over .70, and I-ECV scores above .80 (Reise et al., 2013; Stucky et al., 2013; Stucky & Edelen, 2015).

Main data analysis

Descriptive statistics and latent correlations from the structural equation modelling (SEM) were computed for each variable under study. To analyse the relationships between (dis-)empowering climates, need-based and novelty-based experiences, and academic self-concept in pre-service teachers, the SEM was run following the two-step approach (Kline, 2016). As the first step, the measurement model examined the bidirectional relationships between all the variables, while the second step analysed the predictive effects of (dis-)empowering climates on need and novelty satisfaction and need and novelty frustration, and academic self-concept. Indirect effects from the pre-service teachers' perception of educator-created (dis)empowering climates on their academic self-concept, via need-based and novelty-based experiences, were also examined using Hayes (2017) methods of multiple mediation. According to Hayes (2017), an indirect effect is significant ($p < .05$) when its 95% confidence interval (95% CI) does not contain zero.

To test the invariance of the predictive model across the four knowledge domains (i.e. STEM, social studies and humanities, language, and physical education), we followed the methodological approach of Milfont and Fischer (2010). This tests a series

of progressively constrained models that analyse: a) configural invariance (i.e. the freely estimated model); b) weak invariance (i.e. equality constraints in item factor loadings); c) strong invariance (i.e. equality constraints in item factor loadings and intercepts); d) strict invariance (i.e. equality constraints in item factor loadings, intercepts and error variances), e) structural weight invariance (i.e. equality constraints in item factor loadings, intercepts and error variances, and direct paths between factors), f) factor residual invariance (i.e. equality constraints in item factor loadings, intercepts and error variances, direct paths between factors, and factor residual variances) and g) factor covariance invariance (i.e. equality constraints in item factor loadings, intercepts and error variances, direct paths between factors, factor residual variances, and factor covariances). Differences of up to .010 in the CFI and as high as .015 in the RMSEA between two progressive models would support the invariance assumption (Milfont & Fischer, 2010).

Results

Preliminary results

Table 1 shows the goodness-of-fit measures for each factor model tested on pre-service teachers. Although all three factor models showed minimally acceptable values for each goodness-of-fit measure, the H-CFA and Two-B-CFA models seemed to better represent the observed data, according to the improvement in the fit indices.

Although the Two-B-CFA model (i.e. the bifactor model) showed a better fit, items from autonomy support, task-involving climate, and social support failed to load on the global empowering-climate factor with λ ranging from −.20–.18 (see Table 2). In addition, the results for the global empowering climate factor's robustness presented scores of .01 for ω_h, .26 for coefficient H, .06 for ECV and .71 for PUC. The global disempowering climate factor presented values of .76 for ω_h, .88 for coefficient *H*, .54 for ECV and .50 for PUC. At the item level (I-ECV), no items from the global empowering and disempowering climate factors reached .80 as a minimally acceptable value. However, these results suggest that the two global factors cannot be considered unidimensional.

Regarding the H-CFA model (i.e. the hierarchical two-factor model), suitable factor loadings were obtained with values over .802 and .625 in the hierarchical empowering and disempowering factors, respectively; and standardised regression weights were higher than .36 for the different first-order factors (see Appendix A). Thus, the absence of misspecifications in the internal structure and the good fit to the observed data suggest to us that the H-CFA model should be used for the subsequent analyses.

Table 1. Goodness-of-fit measures for the factor models estimated on the Empowering-Disempowering Scale.

	$\chi^2(df)$	χ^2/df	CFI	TLI	SRMR	RMSEA(90%CI)	AIC
CFA	1030.016(187)	5.508	.920	.911	.059	.057(.053–.060)	79306.810
H-CFA	611.060(182)	3.357	.965	.956	.052	.041(.037–.044)	78911.235
Two-B-CFA	457.035(157)	2.911	.972	.962	.023	.037(.033–.041)	78704.023

Note: CFA = First-order confirmatory factor analysis; H-CFA = Hierarchical confirmatory factor analysis; Two-B-CFA = Two-bifactor confirmatory factor analysis model.

Table 2. Descriptive statistics, reliability coefficients and latent correlations between variables.

	Range	M(SD)	γ_1	γ_2	ω	1	2	3	4	5	6	7
1. Empowering climate	1–5	3.69(0.74)	−0.28	−0.22	.89	—	−.37***	.56***	.44***	−.24***	−.21***	.62***
2. Disempowering climate	1–5	2.38(0.85)	0.41	−0.26	.87		—	−.10***	−.07**	.36***	.30***	−.29***
3. Need satisfaction	1–5	3.85(0.64)	−0.21	−0.22	.92			—	.39***	−.26***	−.27***	.74***
4. Novelty satisfaction	1–5	3.39(0.96)	−0.11	0.06	.92				—	−.23***	−.63	.42***
5. Need frustration	1–5	2.25(0.87)	0.58	−0.29	.97					—	−.24***	−.40***
6. Novelty frustration	1–5	2.66(1.03)	0.07	−0.69	.90						—	−.33***
7. Academic self-concept	1–7	5.44(0.98)	−0.44	−0.30	.87							—

Note: γ_1 = Skewness; γ_2 = Kurtosis; α = Cronbach's alpha; ω = McDonald's omega. ***$p < .001$, **$p < .01$, *$p < .05$

Main results

Descriptive statistics, reliability coefficients, and latent correlations between variables

Table 2 shows that educator-created empowering climates, need satisfaction, novelty satisfaction, and academic self-concept obtained mean scores above the mid-point of the measurement scale, whereas educator-created disempowering climates, need frustration, and novelty frustration presented mean values below the mid-point. The McDonald's omega scores were between .87 and .97, indicating a good level of reliability for every variable under study. Positive latent correlations were found between academic self-concept and an empowering climate, need satisfaction, and novelty satisfaction, while there were negative latent correlations between academic self-concept and a disempowering climate, need frustration, and novelty frustration.

Paths from educator-created (dis-)empowering climates to academic self-concept via need-based and novelty-based experiences

Once the robustness of the measurement model was verified (χ^2 ($df = 204$) = 914.132; χ^2/df = 4.481; CFI = .956; TLI = .945; SRMR = .047; RMSEA = .050 (90%CI = .046–.053)), the hypothesised model was tested, and an appropriate fit to the observed data was found: χ^2 ($df = 241$) = 1203.191; χ^2/df = 4.993; CFI = .944; TLI = .930; SRMR = .062; RMSEA = .053 (90%CI = .050–.056). Figure 2 shows that the total variance explained was 66% for academic self-concept, 35% for need satisfaction, 21% for novelty satisfaction and need frustration, and 17% for novelty frustration.
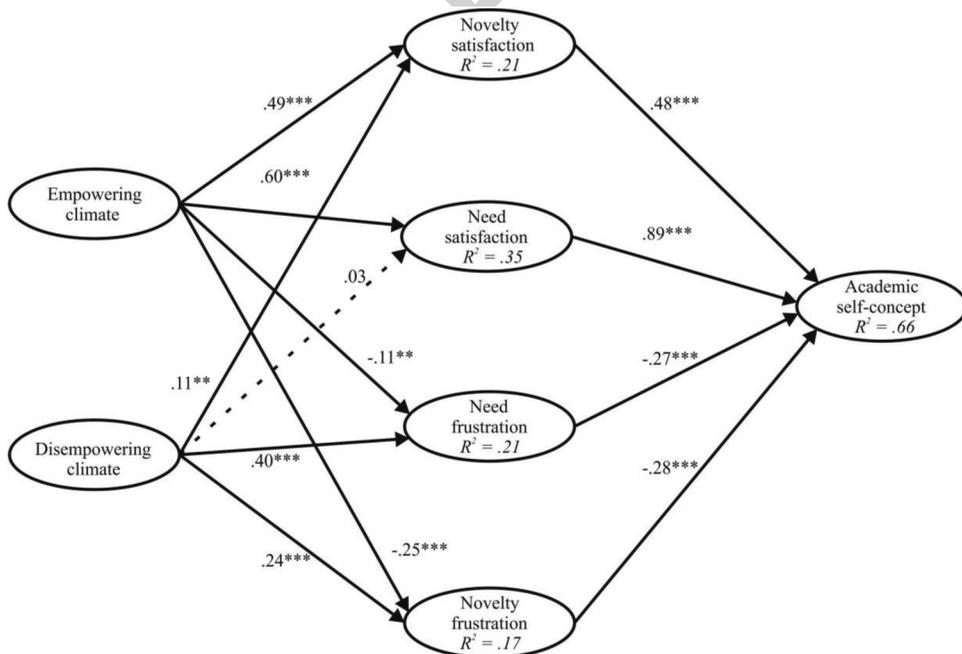

Figure 2. Direct paths from educator-created (dis-)empowering climates to academic self-concept via need-based and novelty-based experiences in pre-service teachers. Note: Dotted arrows represent non-significant paths. **$p<$ .001; **$p<$ .01, *$p<$ .05.

Figure 2 shows the direct relationships between educator-created (dis-)empowering climates, and need-based and novelty-based experiences, with academic self-concept. Specifically, an empowering climate positively predicted need satisfaction and novelty satisfaction, while it negatively predicted need and novelty frustration. A disempowering climate positively predicted need frustration and novelty frustration, whereas it negatively predicted novelty satisfaction. In turn, both need satisfaction and novelty satisfaction positively predicted academic self-concept, while need and novelty frustration did so negatively. Regarding the indirect effects (Table 3), need and novelty satisfaction significantly mediated the relationship between an empowering climate and academic self-concept. Similarly, need and novelty frustration significantly mediated the association between a disempowering climate and academic self-concept.

Invariance of the structural model across knowledge domains

Table 4 shows differences of −.004 between the configural and weak invariance, −.005 between the weak and strong invariance, −.007 between the strong and strict invariance, −.001 between the strict and structural weights invariance, −.003 between the structural weights and factor residuals invariance, and −.002 between the factor residuals and factor covariance invariance for the CFI value. In addition, differences of −.004 were found between the configural and weak invariance, −.005 between the weak and strong invariance, −.007 between the strong and strict invariance, −.001 between the strict and structural weights invariance, −.003 between the structural weights and factor residuals invariance, and −.002 between the factor residuals and factor covariance invariance for the CFI value. Furthermore, differences of .000 were found between the configural and weak invariance, .001 between the weak and strong invariance, and .000 between each of the two progressively constrained models in the RMSEA values. Taken together, the results indicate that the invariance assumption for the predictive model could not be rejected.

Discussion

This research aimed to examine the interplay between pre-service teachers' perceptions of educator-created (dis-)empowering climates and their academic self-concept, considering the mediating role of need-based and novelty-based experiences. The main results showed a positive and direct path from a perceived educator-created empowering climate to need

Table 3. Indirect paths from educator-created (dis-)empowering climates to their academic self-concept via need-based and novelty-based experiences in pre-service teachers

	$\beta(SE)$	p-value	95%CI
Indirect effects from educator-created empowering climate to academic self-concept			
Specific need satisfaction	.54(.11)	<.001	.35, .75
Specific novelty satisfaction	.23(.08)	.002	.11, .35
Specific need frustration	.03(.01)	.003	.01, .05
Specific novelty frustration	.07(.01)	<.001	.06, .09
Indirect effects from perceived disempowering climate to academic self-concept			
Specific need satisfaction	.02(.02)	.271	−.01, .06
Specific novelty satisfaction	.05(.03)	.088	−.11, .01
Specific need frustration	−.11(.01)	<.001	.09, .13
Specific novelty frustration	−.07(.01)	<.001	.04, .09

Note. 95%CI = Confidence interval at 95%

Table 4. Invariance across knowledge domains for the structural equation modelling tested

	χ^2(df)	CFI	RMSEA(90%CI)	Model comparisons	$\Delta\chi^2$(Δdf)	ΔCFI	ΔRMSEA
1. Configural invariance	1860.16(836)	.909	.040(.038–.043)	–	–	–	–
2. Weak invariance	1943.35(884)	.905	.040(.037–.042)	2 versus 1	83.19(48)***	−.004	.000
3. Strong invariance	2182.17(953)	.890	.041(.039–.044)	3 versus 2	239.27(69)***	−.005	.001
4. Strict invariance	2324.11(1022)	.883	.041(.039–.043)	4 versus 3	150.34(69)***	−.007	.000
5. Paths invariance	2383.99(1064)	.882	041(.038–.043)	5 versus 4	59.88(42)*	−.001	.000
6. Factor residuals invariance	2434.92(1079)	.879	041(.039–.043)	6 versus 5	50.93(15)***	−.003	.000
7. Factor covariance invariance	2483.38(1106)	.877	041(.039–.043)	7 versus 6	48.46(27)**	−.002	.000

Note: ***$p < .001$, *$p < .05$

and novelty satisfaction, and from a perceived educator-created disempowering climate to need and novelty frustration, and novelty satisfaction. Negative and cross paths were found from a perceived educator-created empowering climate to need and novelty frustration. In addition, need and novelty satisfaction were positively associated with academic self-concept while need and novelty frustration were associated negatively.

Our results are consistent with previous research into initial teacher education (Granero-Gallegos et al., 2023), which states that exposure to empowering climates was primarily associated with need and novelty satisfaction in pre-service teachers. A plausible explanation would be that when a teacher educator creates an empowering climate, providing pre-service teachers with opportunities to choose and a meaningful rationale for activities (i.e. autonomy support), establishing self-referenced criteria (i.e. task-involving) and showing emotional support and caring (i.e. social support), pre-service teachers tend to feel they have initiative and choice, mastery towards tasks, and a genuine connection to the educator and the other classmates. In accordance with the research of Aibar et al. (2021) indicating that autonomy-supportive and social-supportive teaching practices were positively related to novelty satisfaction in secondary physical education students, our results suggest that when pre-service teachers perceive that their teacher educator is providing them with opportunities to choose, and different alternatives for undertaking activities while creating new and close connections with them, they are more likely to feel novelty satisfaction. This is because they feel supported by their classmates and teacher educator in their quest for new possibilities when negotiating learning activities.

Consistent with prior research (Granero-Gallegos et al., 2023), our results also show that exposure to these types of motivational climates was negatively and secondarily related to the pre-service teachers' need and novelty frustration. A possible reason for this is that, when pre-service teachers perceive their teacher educator as using autonomy-supportive, task-involving, and social-supportive practices, the students will tend not only to minimise any perceived experiences of coercion, incompetence, and active rejection from the teacher educator and/or classmates, but they will also perceive a break with the classroom routine and monotony. In accordance with SDT (Vansteenkiste et al., 2020), these findings suggest that empowering climates play an energising role in supporting need and novelty satisfaction while acting as a buffer against need and novelty frustration.

In accordance with our hypotheses, and in line with previous studies on pre-service teachers (Granero-Gallegos et al., 2023; López-García et al., 2023), our results show that exposure to disempowering climates is primarily associated with need and novelty

frustration. A possible explanation would be that, when pre-service teachers perceive that their teacher educator is creating a disempowering climate by providing them with normative comparison criteria for tasks (i.e. ego-involving) and using coercive language in the classroom (i.e. control), they will probably feel more pressure to participate in lessons, more incompetence toward the tasks, and more socially excluded by their classmates. Moreover, for the first time, our study sheds light on the positive relationship between a disempowering climate and novelty frustration in initial teacher education. It is likely that when the teacher educator overly limits the space for undertaking an activity, and assesses it with normative criteria, the activity in question becomes monotonous and routine in the eyes of pre-service teachers. This is because the activity must be completed in the educator-prescribed way if they want to succeed.

Contrary to our hypotheses, yet in line with previous research (Granero-Gallegos et al., 2023), our findings reveal that an educator-created disempowering climate was unrelated to need satisfaction in pre-service teachers. This would suggest that exposure to a variety of controlling and ego-involving practices from the teacher educator during the lesson does not undermine pre-service teachers' need satisfaction. Indeed, previous research argues that the presence of supportive, empowering-climate characteristics might compensate for the detrimental effects of thwarting, disempowering-climate elements on need satisfaction among pre-service teachers (Authors, bbbb). On the other hand, our results somewhat surprisingly revealed a positive yet weak path from a disempowering climate to novelty satisfaction among pre-service teachers. This contrasts with one of the hypotheses and with the small body of evidence on the need for novelty in other contexts (González-Cutre et al., 2020). A plausible rationale would be that, to support pre-service teachers' novelty satisfaction, it is more important that they experience something new (e.g. new activities, a change to the usual classroom management) in the lesson, even though this may involve the teacher educator using strict commands and controlling language to make clear what they must do.

The results support two of the research hypotheses and are in accordance with prior studies on initial teacher education (Granero-Gallegos et al., 2023; Granero-Gallegos & Carrasco-Poyatos, 2023), in that pre-service teachers' need satisfaction and novelty satisfaction were positively related to their academic self-concept. This could be because when pre-service teachers perceive that they can show initiative, choose tasks, gain mastery, and foster genuine connections with their classmates and the teacher educator, while also being exposed to different activities from usual, they tended to develop a strong sense of academic self-concept and to strengthen their belief in their own abilities and effort to successfully complete the activities undertaken in the initial teacher education programme. On the other hand, the findings also revealed that pre-service teachers' need frustration and novelty frustration were negatively associated with their academic self-concept. An explanation for this might be that when pre-service teachers perceive social and self-imposed pressures, feel clumsy undertaking an activity, excluded by their teacher educator while, at the same time, perceiving the classroom routine as monotonous, they were prone to feeling less competent and exerting less effort on the academic work of their initial teacher education programme. Considering the growing amount of SDT-based research into novelty (González-Cutre et al., 2016,

2020), the results of the present study add to the evidence on recognising novelty as the fourth basic psychological need in the specific context of initial teacher education.

The results from the invariance tests revealed that the predictive model was invariant across the four knowledge domains. This suggests that, irrespective of the particular characteristics of teaching in each knowledge domain, pre-service teachers interpreted the influence of perceived classroom learning environments on their academic self-concept in a similar way. Indeed, the findings suggest that the development of pre-service teachers' academic self-concept might equally be promoted, either directly or indirectly, through empowering climates created by their teacher educators via need satisfaction and novelty satisfaction. Similarly, pre-service teachers from the four knowledge domains commonly felt lower academic self-concept if their teacher educators created disempowering climates when managing the class during their initial teacher education programme. To the best of our knowledge, this is the first research to provide evidence indicating that the associations between the pre-service teachers' perception of classroom learning environments and their academic self-concept are invariant across the STEM, social studies and humanities, language, and physical education knowledge domains.

Implications for initial teacher education

The results from this research underline the importance of considering educator-created motivational climates in the development of academic self-concept among pre-service teachers throughout their initial teacher education programme, regardless of the knowledge domain to which they belong. Indeed, these findings provide evidence recommending that teacher educators create empowering motivational climates as an appropriate instructional strategy to enhance pre-service teachers' psychological experiences. Therefore, teacher educators should be educated in how to create empowering motivational climates in initial teacher education programmes and be sensitised to how this type of motivational climate can have adaptive, cognitive, affective, and behavioural consequences for pre-service teachers through them experiencing need and novelty satisfaction. Similarly, it is important to make teacher educators aware of the detrimental effects of disempowering climates on pre-service teachers' need-based and novelty-based experiences, and on their cognitive outcomes, in order to reduce or avoid these types of motivational climates.

Limitations

The present research has a series of limitations that should be mentioned. Firstly, the convenience sampling method followed to select and recruit participants means that the results should be interpreted with caution and should not be generalised to the population as a whole. Additional research is required to analyse whether the associations of empowering and disempowering educator-created climates on pre-service teachers' academic concept would vary in different educational settings, and in different social and cultural contexts. Secondly, self-reported questionnaires were administrated to assess the empowering and disempowering educator-created climates.

Hence, further studies using complementary observational instruments are needed to obtain a better understanding of the effects of both types of motivational climate on pre-service teachers' need-based and novelty-based experiences, and their academic self-concept. Thirdly, although the structural model tested relied on the SDT and Achievement Goal Theory, the adoption of a cross-sectional design did not allow us to establish cause–effect relationships between the variables under study. Additional longitudinal and experimental studies are required to verify the directions of causality between the variables considered in this research.

Conclusions

This is the first study to gather evidence of the differentiated effects of empowering and disempowering climates on need-based and novelty-based experiences and academic self-concept in initial teacher education, irrespective of the knowledge domain to which the pre-service teachers belong. An empowering educator-created climate tends to support need and novelty satisfaction and academic self-concept among pre-service teachers, while a disempowering educator-created climate contributes to need and novelty frustration. Accordingly, these results lead us to recommend that teacher educators create empowering motivational climates to develop a strong sense of academic self-concept in STEM, social studies, language, and physical education pre-service teachers throughout their initial teacher education programme. In addition, this research provides evidence on the distinctive role played by novelty satisfaction and novelty frustration in the context of initial teacher education.

Disclosure statement

Q3 No potential conflict of interest was reported by the author(s).

Q2

ORCID

Antonio Granero-Galleros (iD) http://orcid.org/0000-0002-1385-8386
Rafael Burgueño (iD) http://orcid.org/0000-0003-2354-0037

Q4 References

Aibar, A., Abós, Á., García-González, L., González-Cutre, D., & Sevil-Serrano, J. (2021). Understanding students' novelty satisfaction in physical education: Associations with need-supportive teaching style and physical activity intention. *European Physical Education Review*, *27*(4), 779–797. https://doi.org/10.1177/1356336X21992791

Ames, C. (1992). Achievement goals and the classroom motivational climate. In *Student perceptions in the classroom* (pp. 327–348). Lawrence Erlbaum Associates, Inc.

Appleton, P. R., Ntoumanis, N., Quested, E., Viladrich, C., & Duda, J. L. (2016). Initial validation of the coach-created empowering and disempowering motivational climate questionnaire (EDMCQ-C). *Psychology of Sport and Exercise*, *22*, 53–65. https://doi.org/10.1016/j.psychsport.2015.05.008

Bartholomew, K. J., Ntoumanis, N., Ryan, R. M., & Thøgersen-Ntoumani, C. (2011). Psychological need thwarting in the sport context: Assessing the darker side of athletic experience. *Journal of Sport and Exercise Psychology*, *33*(1), 75–102. https://doi.org/10.1123/jsep.33.1.75

Beudels, M. M., Damerau, K., & Preisfeld, A. (2021). Effects of an interdisciplinary course on pre-service primary teachers' content knowledge and academic self-concepts in science and technology–a quantitative longitudinal study. *Education Sciences*, *11*(11), https://doi.org/10.3390/educsci11110744

Brown, T. A. (2015). *Confirmatory factor analysis for applied research*. Guilford publications.

Brumariu, L. E., Waslin, S. M., Gastelle, M., Kochendorfer, L. B., & Kerns, K. A. (2022). Anxiety, academic achievement, and academic self-concept: Meta-analytic syntheses of their relations across developmental periods. *Development and Psychopathology*, 1597–1613. https://doi.org/10.1017/S0954579422000323

Burgueño, R., García-González, L., Abós, Á., & Sevil-Serrano, J. (2023). Students' need satisfaction and frustration profiles: Differences in outcomes in physical education and physical activity-related variables. *European Physical Education Review*, 563–581. https://doi.org/10.1177/1356336X231165229

Cuevas, R., Sánchez-Oliva, D., Bartholomew, K. J., Ntoumanis, N., & García-Calvo, T. (2015). Adaptation and validation of the psychological need thwarting scale in Spanish physical education teachers. *The Spanish Journal of Psychology*, *18*(e53), 1–9. https://doi.org/10.1017/sjp.2015.56

Duda, J. L. (2013). The conceptual and empirical foundations of empowering coaching™: Setting the stage for the PAPA project. *International Journal of Sport and Exercise Psychology*, *11*(4), 311–318. https://doi.org/10.1080/1612197X.2013.839414

Duda, J. L., & Appleton, P. R. (2016). Empowering and disempowering coaching climates: Conceptualization, measurement considerations, and intervention implications. In M. Raab, P. Wylleman, R. Seiler, A.-M. Elbe, & A. Hatzigeorgiadis (Eds.), *Sport and exercise psychology research* (pp. 373–388). Academic Press.

Gignac, G. E. (2016). The higher-order model imposes a proportionality constraint: That is why the bifactor model tends to fit better. *Intelligence*, *55*, 57–68. https://doi.org/10.1016/j.intell.2016.01.006

Gillet, N., Rosnet, E., & Vallerand, R. J. (2008). Development of a scale of satisfaction of the fundamental requirements in sporting context. *Canadian Journal of Behavioural Science*, *40*(4), 230–237. https://doi.org/10.1037/a0013201

González-Cutre, D., Brugarolas-Navarro, M., Beltrán-Carrillo, V. J., & Jiménez-Loaisa, A. (2023). The frustration of novelty and basic psychological needs as predictors of maladaptive outcomes in physical education. *Physical Education and Sport Pedagogy*, 1–14. https://doi.org/10.1080/17408989.2023.2167969

González-Cutre, D., Romero-Elías, M., Jiménez-Loaisa, A., Beltrán-Carrillo, V. J., & Hagger, M. S. (2020). Testing the need for novelty as a candidate need in basic psychological needs theory. *Motivation and Emotion*, *44*(2), 295–314. https://doi.org/10.1007/s11031-019-09812-7

González-Cutre, D., Sicilia, Á, Sierra, A. C., Ferriz, R., & Hagger, M. S. (2016). Understanding the need for novelty from the perspective of self-determination theory. *Personality and Individual Differences*, *102*, 159–169. https://doi.org/10.1016/j.paid.2016.06.036

Granero-Gallegos, A., Baena-Extremera, A., Escaravajal, J. C., & Baños, R. (2021). Validation of the academic self-concept scale in the Spanish university context. *Education Sciences*, *11*(10), 653. https://doi.org/10.3390/educsci11100653

Granero-Gallegos, A., Hortigüela-Alcalá, D., Hernando-Garijo, A., & Carrasco-Poyatos, M. (2021). Teaching style and competence in higher education: The motivational climate mediation. *Educacion XX1*, *24*(2), 43–64. https://doi.org/10.5944/educxx1.28172

Granero-Gallegos, A., López-García, G. D., Baena-Extremera, A., & Baños, R. (2023). Relationship between psychological needs and academic self-concept in physical education pre-service teachers: A mediation analysis. *Sustainability*, *15*(5), 4052. https://doi.org/10.3390/su15054052

Granero-Gallegos, A., Phan, H. P., & Ngu, B. H. (2023). Advancing the study of levels of best practice pre-service teacher education students from Spain: Associations with both positive and negative achievement-related experiences. *PLoS One*, *18*(6), e0287916–23. https://doi.org/10.1371/journal.pone.0287916

Granero-Gallegos, A., & Carrasco-Poyatos, M. (2020). Spanish adaptation of motivational climate in education scale with university students. *Education Sciences*, *10*(6), 157–115. https://doi.org/10.3390/educsci10060157

Granero-Gallegos, A., López-García, G. D., & Burgueño, R. (2023). Are educator-created (dis)empowering climates equally associated with motivational experiences in physical education pre-service teachers as in foreign language pre-service teachers? *Porta Linguarum*, *76*(VII), 75–94. https://doi.org/10.30827/portalin.viVII.29163

Hancock, G. R., & Mueller, R. O. (2001). Rethinking construct reliability within latent variable systems. In R. Cudeck, S. du Toit, & D. Sörbom (Eds.), *Structural equation modeling: Present and future* (pp. 195–216).

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford publications.

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

León, J., Domínguez, E., Núñez, J. L., Pérez, A., & Martín-Albo, J. (2011). Translation and validation of the Spanish version of the échelle de satisfaction des besoins psychologiques in academic context. *Anales de Psicología*, *27*(2), 405–411.

Liu, W. C., & Wang, C. K. J. (2005). Academic self-concept: A cross-sectional study of grade and gender differences in a Singapore secondary school. *Asia Pacific Education Review*, *6*(1), 20–27. https://doi.org/10.1007/BF03024964

López-García, G. D., Carrasco-Poyatos, M., Burgueño, R., & Granero-gallegos, A. (2023). Relationships between needs satisfaction and the quality of motivation with academic engagement in pre-service physical education teachers. *SAGE Open*, *13*(3), 1–11. https://doi.org/10.1177/21582440231197507

López-García, G. D., Granero-Gallegos, A., Carrasco-Poyatos, M., & Burgueño, R. (2023). Detrimental effects of disempowering climates on teaching intention in (physical education) initial teacher education. *International Journal of Environmental Research and Public Health*, *20*(1), 878, 8–14. https://doi.org/10.3390/ijerph20010878

Marsh, H. W., Craven, R., & Debus, R. (1999). Separation of competency and affect components of multiple dimensions of academic self-concept: A developmental perspective. *Merril-Palmer Quarterly*, *45*(4), 567–601.

Mastagli, M., Van Hoye, A., Hainaut, J.-P., & Bolmont, B. (2021). The role of an empowering motivational climate on pupils' concentration and distraction in physical education. *Journal of Teaching in Physical Education*, 311–321. https://doi.org/10.1123/jtpe.2020-0252

Matovu, M. (2014). A structural equation modelling of the academic self-concept scale. *International Electronic Journal of Elementary Education*, *6*(2), 185–197.

Milfont, T. L., & Fischer, R. (2010). Testing measurement invariance across groups: Applications in cross-cultural research. *International Journal of Psychological Research*, *3*(1), 111–130. https://doi.org/10.21500/20112084.857

Muthén, L. K., & Muthén, B. O. (1998–2017). *Mplus user's guide* (8th ed.). Muthén & Muthén.

OECD. (2017). *Do new teachers feel prepared for teaching?* (Issue 17) OECD Publishing.

OECD. (2018). *Teaching in focus #22. Who wants to become a teacher and why?*

Pekrun, R., & Stephens, E. J. (2015). International encyclopedia of the social & behavioral sciences. *International Encyclopedia of the Social & Behavioral Sciences: Second Edition*, 469–474. https://doi.org/10.1016/B978-0-08-097086-8.92018-X

Reise, S. P., Scheines, R., Widaman, K. F., & Haviland, M. G. (2013). Multidimensionality and structural coefficient bias in structural equation modeling. *Educational and Psychological Measurement*, *73*(1), 5–26. https://doi.org/10.1177/0013164412449831

Rindskopf, D., & Rose, T. (1988). Some theory and applications of confirmatory second-order factor analysis. *Multivariate Behavioral Research*, *23*(1), 51–67. https://doi.org/10.1207/s15327906mbr2301_3

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory. Basic psychological needs in motivation, development and wellness*. Guilford Press.

Shavelson, R. J., & Bolus, R. (1982). Self concept: The interplay of theory and methods. *Journal of Educational Psychology*, *74*(1), 3–17. https://doi.org/10.1037/0022-0663.74.1.3

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research*, *46*(3), 407–441. https://doi.org/10.3102/00346543046003407

Soper, D. S. (2022). *Effect size calculator for multiple regression* (Software). https://bit.ly/3C68OLW.

Stucky, B. D., & Edelen, M. O. (2015). Using hierarchical IRT models to create unidimensional measures from multidimensional data. In *Handbook of item response theory modeling: Applications to typical performance assessment* (pp. 183–206). Routledge.

Stucky, B. D., Thissen, D., & Edelen, M. O. (2013). Using logistic approximations of marginal trace lines to develop short assessments. *Applied Psychological Measurement*, *37*(1), 41–57. https://doi.org/10.1177/0146621612462759

Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2006). Self-esteem, academic self-concept, and achievement: How the learning environment moderates the dynamics of self-concept. *Journal of Personality and Social Psychology*, *90*(2), 334–349. https://doi.org/10.1037/0022-3514.90.2.334

Vansteenkiste, M., & Ryan, R. M. (2013). On psychological growth and vulnerability: Basic psychological need satisfaction and need frustration as a unifying principle. *Journal of Psychotherapy Integration*, *23*(3), 263–280. https://doi.org/10.1037/a0032359

Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. *Motivation and Emotion*, *44*(1), 1–31. https://doi.org/10.1007/s11031-019-09818-1

Zinbarg, R. E., Yovel, I., Revelle, W., & McDonald, R. P. (2006). Estimating generalizability to a latent variable common to all of a scale's indicators: A comparison of estimators for ω h. *Applied Psychological Measurement*, *30*(2), 121–144. https://doi.org/10.1177/0146621605278814

Appendix A

Standardised factor loadings for first-order CFA (two factors), H-CFA, and two-bifactor-CFA solutions of the Empowering-Disempowering Scale.

Item	CFA		H-CFA					Two-B-CFA							GF	
	Emp	Dis	AS	T	SS	C	E	Emp	Dis	AS	T	SS	C	E	Emp	Dis
AS								.92***								
EIDES2	.62***		.63***							.63***					−.07	
EIDES3	.66***		.67***							.66***					−.10	
EIDES6	.70***		.71***							.73***					.17	
EIDES9	.73***		.74***							.74***					−.20	
EIDES11	.66***		.68***							.66***					−.20	
T								.83***								
CMES1	.63***			.71***							.71***				.03	
CMES3	.68***			.81***							.82***				.11	
CMES5	.62***			.70***							.70***				−.11	
CMES7	.44***			.50***							.50***				.02	
SS								.93***								
SOC1	.75***				.77***							.80***			.18	
SOC2	.62***				.64***							.64***			−.13	
SOC3	.63***				.64***							.64***			−.09	
C									.93***							
EIDES1		.70***				.70***							.56**			.42***
EIDES4		.78***				.78***							.61**			.48***
EIDES5		.85***				.85***							.73**			.46***
EIDES7		.81***				.82***							−.67**			.87***
EIDES8		.70***				.70***							.55**			.44***
EIDES10		.55***				.55***							.42**			.35***
E									.64***							
CMES2		.57***					.81***							.40***		.70***
CMES4		.62***					.85***							.48***		.71***
CMES6		.25***					.36***							−.41***		.68***

Note: Emp = Empowering; Dis = Disempowering; CFA = first-order confirmatory factor analysis; H-CFA = Higher-order CFA; Two-B-CFA = Two-bifactor CFA; GF = General factor; AS = Autonomy support; T = Task-involving; SS = Social support; E = Ego-involving; C = Controlling. ***$p < .001$.

Appendix B

Invariance test across gender, age, and knowledge domains for the H-CFA model ($N = 1410$).

	χ^2(df)	CFI	RMSEA(90%CI)	Model comparisons	$\Delta\chi^2$(Δdf)	ΔCFI	ΔRMSEA
Invariance across gender							
1. Configural invariance	1341.31(366)	.955	.043(.041–.046)	–	–	–	–
2. Weak invariance	1362.84(382)	.955	.042(.040–.045)	2 *versus* 1	21.53(16)	.000	.001
3. Strong invariance	1368.95(403)	.955	.042(.040–.045)	3 *versus* 2	6.11(21)	.000	.000
4. Strict invariance	1400.74(424)	.954	.039(.039–.043)	4 *versus* 3	31.79(21)*	−.001	.003
Invariance across age							
	χ^2(df)	CFI	RMSEA(90%CI)	Models' comparisons	$\Delta\chi^2$(Δdf)	ΔCFI	ΔRMSEA
1. Configural invariance	1073.08(366)	.946	.037(.034–.040)	–	–	–	–
2. Weak invariance	1096.21(382)	.945	.036(.034–.039)	2 *versus* 1	23.13(16)	.001	.001
3. Strong invariance	1226.44(403)	.937	.038(.036–.041)	3 *versus* 2	130.23(21)***	−.008	−.002
4. Strict invariance	1308.94(424)	.932	.039(.036–.041)	4 *versus* 3	82.50(21)***	−.005	.001
Invariance across knowledge domains							
	χ^2(df)	CFI	RMSEA(90%CI)	Models' comparisons	$\Delta\chi^2$(Δdf)	ΔCFI	ΔRMSEA
1. Configural invariance	1485.36(870)	.943	.030(.028–.033)	–	–	–	–
2. Weak invariance	1502.70(886)	.943	.031(.028–.034)	2 *versus* 1	17.34(16)	.000	.001
3. Strong invariance	1564.89(907)	.937	.030(.028–.033)	3 *versus* 2	62.19(21)***	−.005	−.001
4. Strict invariance	1603.44(928)	.935	.031(.029–.034)	4 *versus* 3	38.55(21)**	−.002	.000

Note:***$p < .001$, **$p < .01$, *$p < .05$