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A Three-Body Problem: The effects of foreign language anxiety, enjoyment, and boredom on academic achievement

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Abstract

This study is part of a growing wave of interest in foreign language (FL) learners' emotions, their sources, and their effects. Previous studies have confirmed that there is a clear relationship between the emotions of *foreign language enjoyment* (FLE), *foreign language classroom anxiety* (FLCA), *foreign language boredom* (FLB), and foreign language performance. However, the relative importance of each emotion as a predictor of FL performance has yet to be examined, and as different teaching and learning strategies can elicit different emotions, it is difficult to determine whether FL teachers and learners should prioritize a specific emotion in course design and study. We, therefore, utilized structural equation modeling and latent dominance analysis on a sample of 502 Moroccan EFL learners in order to examine the relative importance of each emotion in predicting FL performance. We argue that it is crucial to use sophisticated statistical analyses and to collect samples from outside Western, educated, industrialized, rich, and democratic (WEIRD) countries. The latent dominance analysis revealed that FLCA had the strongest (negative) effect on English test scores. FLB had a significant—but slightly weaker—negative effect and FLE had a significant—but weaker still—positive effect. As such, it is vital that FL teachers and learners not underestimate the impact of anxiety on language learning.

Keywords: foreign language enjoyment; foreign language classroom anxiety; foreign language boredom; foreign language academic achievement; latent dominance analysis

In his gripping science fiction novel, *The Three-Body Problem*, Cixin Liu (2008) describes an alien civilization living on the planet Trisolaris in a star system four light-years from Earth that consists of three solar-type stars orbiting each other in an unstable three-body system. Civilization on Trisolaris is wiped out unexpectedly at irregular intervals as the planet is pulled in the orbits of the suns, resulting in extreme oscillation in temperatures. It takes many centuries for the inhabitants to realize that there are three suns and that their particular alignment can mean extinction as the result of extreme cold or extreme heat. An analogy could be made with learner emotions—with the difference, of course, that these are not life-threatening. Recent research into learner emotions shows that they are connected to personality and motivation and

form a dynamic system (Dewaele, Saito, et al., 2022). Their particular combinations in the classroom can silence and freeze learners or excite and warm them, which will affect the trajectory of their language-learning journey.

Applied linguists interested in learner emotions have traditionally focused on a single negative emotion: anxiety. It is not surprising that anxiety was the only emotion dimension to be included in different motivation constructs (Dörnyei, 2009; Gardner, 1985), and it is no coincidence that the current special issue focuses on anxiety. There are three main reasons for the enduring popularity of this "One-Body Problem." First, there is the ubiquity of anxiety in foreign language (FL) classrooms around the world. Second, there is the debilitating effects of anxiety, which on FL learners' performance and progress led to a realization among applied linguists that some strategy was needed to alleviate its effects. Third, the fact that Elaine Horwitz et al. (1986) provided the field with an excellent instrument to measure *foreign language classroom anxiety* (FLCA), allowing comparisons, adaptations, and replication studies (MacIntyre, 2017). In other words, FL learner anxiety is likely to remain a concern for teachers and a rich topic of investigation for researchers. In a break with more than forty years of tradition, in 2014, Dewaele and MacIntyre argued that it was time to expand the range of emotions and to consider a "Two-Body Problem" in learner emotions research, namely the relationship between the newly conceptualized *foreign language enjoyment* (FLE), reflecting a balance between challenge and skills in performing something difficult, and the established FLCA. Measuring FLE using their new 21-item scale, they found a moderate negative relationship between them, allowing them to claim that FLE and FLCA are separate and unique emotions rather than opposites on the same dimension—a claim that was confirmed by a recent meta-analysis of fifty-six studies (and ninety-six effect sizes) by Elouise Botes, Dewaele et al. (2022b), who found a moderate negative correlation of $r = -.31$ between FLE and FLCA. FLE was also found to be linked to FL performance. A large positive correlation ($r = .48$) existed between FLE and *willingness to communicate* (WTC), defined as the "readiness to enter into discourse at a particular time with a specific person or persons, using an L2" (MacIntyre et al., 1998, p. 547) and a moderate positive relationship emerged between FLE and FL academic achievement ($r = .30$). In a previous meta-analysis of sixty-seven studies (and ninety-nine effect sizes), Botes et al. (2020a) had found a moderate negative relationship between FLCA and FL academic achievement ($r = -.39$). Realizing that research had overwhelmingly used correlational, linear techniques to describe highly dynamic and nonlinear relationships, Botes, Dewaele et al. (2022a) used polynomial regression with response surface analysis in order to investigate the relationships between FLE, FLCA, and self-perceived proficiency. Using the database from Dewaele and MacIntyre (2014), they found nonlinear relationships. While a low level of FLCA and a high level of FLE were linked to a higher level of self-perceived proficiency, it turned out that the weight of FLCA on self-perceived proficiency of learners who experienced similar levels of FLCA and FLE was superior to that of FLE. In other words, FLCA had a stronger impact on perceived proficiency than FLE. The third "body," *foreign language boredom* (FLB), appeared on the scene a few years later (Kruk, 2016). Chengchen Li et al. (2023) and Li (2022) showed that this negative, low-arousal emotion also exerts a powerful influence on learner FL performance as it can cause disengagement. The logical next step was to investigate how the three emotions—FLE, FLCA and FLB—were connected and how they jointly affected performance and achievement (Dewaele, Albakistani, et al., 2022; Dewaele, Botes, et al., 2022; Li, 2022; Li & Han, 2022; Li & Wei, 2022). These studies answered calls for

increased diversity in the range of emotions, in methodological approaches, in the use of sophisticated statistical methods, and in language learning populations (Dewaele & Li, 2020; In'nami et al., 2022; MacIntyre et al., 2019). However, even though FLCA, FLE, and FLB have been directly and indirectly linked to academic achievement in language classrooms (Dewaele, Botes, et al., 2022), previous studies have seemed to show that FLCA has a powerful negative effect on learning and proficiency outcomes (Botes, Dewaele et al., 2022a), but is not yet clear how it compares with the effects of FLE and FLB. As such, the current study aims to address this issue via a latent dominance analysis on 502 English Foreign Language (EFL) learners in Morocco. We therefore aim to expand our understanding of this complex "Three-Body Problem" and to determine whether one or the other of the "bodies" may be relatively more important. In other words, which of the three FL learner emotions has the strongest impact on their academic performance?

Literature Review

Research on Learner Emotions

Dewaele and MacIntyre (2016) argued that FLE is more than superficial pleasure because it has a cognitive dimension that needs to be engaged for FLE to occur:

> [FLE is] a complex emotion, capturing interacting dimensions of the challenge and perceived ability that reflect the human drive for success in the face of difficult tasks [...] enjoyment occurs when people not only meet their needs, but exceed them to accomplish something new or even unexpected. (pp. 216–217)

Dewaele and MacIntyre (2016) revisited their original 2014 database to investigate the factor structure of FLE and FLCA. A Principal Component Analysis (PCA) confirmed that anxiety items loaded on a single dimension, whereas the FLE items loaded on two separate dimensions: personal and social enjoyment. Botes et al. (2021) used the database on which Dewaele and MacIntyre (2014) was based to investigate the factor structure in more detail, in order to construct a Short Foreign Language Enjoyment Scale (S-FLES). Botes et al. (2021) identified a three-factor hierarchical model with a higher-order FLE factor. The first factor referred to FL learners' appreciation of their FL teacher, the second factor reflected their purely personal enjoyment related to being in the FL class, and the third factor reflected the good relationships with peers and was labeled social enjoyment.

FLCA, in turn, was originally defined by Horwitz et al. (1986) as a "distinct complex of self-perceptions, beliefs, feelings, and behaviors related to classroom language learning arising from the uniqueness of the language learning process" (p. 128) and measured through a 33-item FLCA Scale, which is context-specific and captures a FL learner's tendency to feel anxious (referring to a *trait*) when using or learning a FL (referring to a *state*). Dewaele and MacIntyre (2014, 2016) used an eight-item version of the scale, which was psychometrically validated in Botes, van der Westhuizen et al. (2022). We estimate that around thirty studies have been carried out on the relationship between FLE and FL performance. One of the difficulties in researching the link between learner emotions and proficiency or learning is that causal pathways can be bidirectional (Botes et al., 2020b). High FLE and low FLCA might strengthen a learner's self-confidence leading to stronger engagement and motivation, which could ultimately result in better performance in various tests. The comparison of

one's performance with peers in the classroom might also affect one's emotions. Disappointing test or learning results might weaken FLE and increase FLCA and could simultaneously undermine learners' self-confidence, motivation, and enthusiasm, leading to reduced investment in the learning process and creating a negative vicious circle. Moreover, local contextual factors might affect learners' emotions, for example, having to perform in front of others, the seating arrangement in the classroom, a dislike for a replacement teacher, or feeling disengaged when called on by the teacher (Dewaele & Pavelescu, 2021). *Foreign language boredom* (FLB) is one of the emotions that has been introduced recently as an interesting topic for study in SLA research (Kruk, 2016). Li et al. (2023) for example defined FLB as: "a negative emotion with an extremely low degree of activation/arousal that arises from ongoing activities […] (that) are typically over-challenging or under-challenging" (p. 12). Li (2022) found that FLB is more likely to occur among learners who do not feel very competent and dislike their FL classes. Recent research has shown that FLE, FLCA, and FLB are interconnected. Dewaele, Botes, et al. (2022) used structural equation modeling with data collected from an international sample of 332 FL learners to investigate the relationships between the three emotions, to locate their sources and to measure their effects on academic achievement. Higher levels of FLE were found to be correlated with significantly lower FLCA and FLB levels. Higher levels of FLCA were linked with higher levels of FLB. Looking into the sources of the three emotions, the researchers found that the frequency of use of the FL in class by the teacher boosted FLE but did not affect FLB or FLCA. Teachers who did not follow set routines in class had students with higher FLE and lower FLB, but it was not linked to their FLCA. FLE and FLB had no effect on FL performance, but FLCA had a significant negative effect. Using a mediation analysis to understand the direct and indirect effects of the classroom environment, FLE, FLCA, and FLB on WTC, Li et al. (2022) collected data from 2,268 university EFL learners in China. The authors found that FLE was negatively related to both FLCA and FLB, which were positively correlated with each other (with small to medium effect sizes). FLE was found to be the strongest positive predictor of WTC, while FLB was a much stronger negative predictor of WTC than FLCA. The three emotions accounted for close to two-thirds of the total effect of the classroom environment on WTC, thus the three emotions partially mediated the relationship between classroom environment and WTC. Looking into levels of FLE, FLCA, and FLB among 168 Arab and Kurdish English EFL learners in both in-person and emergency remote teaching classes, Dewaele, Albakistani and Kamal Ahmed (2022) found relatively high levels of FLE in both conditions, lower levels of FLCA and very low levels of FLB. A separate study on the same database showed a significant positive correlation between FLCA and FLB ($r = .49$) and significant negative relationships between FLE and both FLCA and FLB ($r = -.17$ and $r = -.40$, respectively). No relationship was found between FLE, FLB, and English academic achievement in in-person classes, but FLCA had a significant negative relationship with English academic achievement ($r = -.29$). None of the three emotions were connected with English academic achievement in the online condition. Li and Han (2022) reported similar patterns for a group of 348 Chinese EFL learners. A positive relationship existed between FLCA and FLB, and both variables were negatively correlated with FLE. Regression analyses showed that FLCA was a significant negative predictor of English test scores. FLE and FLB had no effect on test scores, but they were significant positive predictors of perceived English achievement. Further investigation with 954 junior secondary EFL learners in rural China showed that FLE, FLCA, and FLB affected their EFL performance (Li & Wei, 2022). The

longitudinal study revealed that the three emotions at Time 1 predicted learners' English achievement at Time 2. FLE emerged as the strongest and most enduring predictor over time, while FLCA was only a negative predictor at Times 2 and 3. The initial negative effect of FLB disappeared completely by Time 3. To sum up, the effects of FLCA, FLB, and FLE on academic achievement have been investigated, and, while the direction has been constant (negative for FLCA and FLB, positive for FLE), their strength has varied across studies and across time in some longitudinal studies.

Awareness of Context in Positive Psychology and the Implications for Applied Linguistics

The studies mentioned above were all inspired by *positive psychology* (PP), which was introduced in the field of applied linguistics by MacIntyre and Gregersen (2012). It offered researchers a new theoretical basis and a new perspective to study learner emotions (Dewaele et al., 2019; MacIntyre et al., 2019). The basic tenet of the PP approach is to move away from an exclusive focus on the negative aspects of life (and a deficit perspective in FL learning; see Dewaele & Saito, 2022). For FL research, PP means focusing on optimal functioning and adopting a broader, holistic perspective that includes positive emotions. PP also promoted attention to learners' well-being in education. The founders of PP insisted that adopting a PP perspective did not imply using nonscientific methods or looking at reality through rose-colored glasses:

> Positive psychology does not rely on wishful thinking, faith, self-deception, fads, or hand waving; it tries to adapt what is best in the scientific method to the unique problems that human behavior presents to those who wish to understand it in all its complexity. (Seligman & Csikszentmihalyi, 2000, p. 7)

However, Ciarrochi et al. (2016) have complained that PP, and more specifically PP interventions in education, "is guilty of a […] pernicious set of errors" (p. 11). These include the fact that "interventions are decontextualized and coercive (reducing students' autonomy)" (p. 2) and that it is both misguided and ineffective to try to get rid of negative experiences as they form part of a "meaningful life" (p. 4). Finally, they argue that the pursuit of happiness may have some unintended negative consequences, making people more selfish. In the context of FL education, our own belief is that enthusiasm for the positive should not draw attention away from the negative. The benefits of PP in applied linguistics far outweigh its potential limitations and biases. MacIntyre et al. (2019) point out that PP can be seen as a useful metatheory rather than a unified theory and that it allows educators to move away from a deficit perspective: "balance between positive and negative processes is essential to move the field beyond simplistic notions of good and bad, motivated and demotivated, successful and unsuccessful learners" (p. 8). MacIntyre et al. (2019) argue that PP offers applied linguists a useful theoretical, epistemological, and methodological toolbox. It allows the development of intervention studies that use an "appropriately balanced and context-sensitive approach" (p. 2). For example, FL learners who suffer from high anxiety, low self-confidence, and a feeling of lack of authenticity would benefit from teachers focusing on their "grit and perseverance, strengths, hope, optimism, courage" (p. 4). MacIntyre et al.'s (2019) call for more diversity in the field extends to statistical methods. The next section thus presents dominance analysis, which—to our knowledge—has not yet been used in applied linguistics.

The Potential of Dominance Analysis in Research on FL Learner Emotions

As detailed above, numerous previous studies have examined FLCA, FLE, and FLB as predictors of FL proficiency, albeit as proxies in the form of self-perceived proficiency or academic achievement in the form of grades, test scores, or general indications of their level of proficiency (ranging from beginner to advanced) (Botes et al., 2022a, 2022b; Dewaele & MacIntyre, 2014). The majority of these studies have found a larger effect size between academic achievement and FLCA in comparison to FLE (Botes et al., 2020a, 2022b). For example, in the Dewaele, Botes et al. (2022) study, FLCA demonstrated the largest effect size in relation to academic achievement ($r = -.186$; $p < .001$), followed by FLB ($r = -.170$; $p < .001$), and lastly FLE ($r = .118$; $p < .01$). Much has been made of this effect size difference, with Botes, Dewaele, et al. (2022a) remarking that "the negative effective effect of FLCA may to some extent 'overpower' any positive effects of FLE" (p. 25). The only exception to this pattern is Dewaele and Alfwazan (2018), where a positive effect of FLE on proficiency and academic achievement of Saudi EFL students and British secondary school FL learners was stronger than a negative effect of FLCA.

However, even though the consistent finding of larger effect sizes of FLCA in predicting proficiency in the form of academic achievement may be indicative of the relative importance of FLCA in comparison to the emotions of FLE and FLB, it is not a statistical certainty. In order to clearly determine dominance, there is a need to examine the relative importance of predictors via a dominance analysis (Budescu, 1993). Traditional effect size metrics, especially when predictors are correlated, can be flawed indicators of dominance since the metrics do not necessarily partition variance in order of relative importance (Tonidandel & LeBreton, 2011). In addition, contrasting results have also been found, indicating that FLCA may not yield the largest effect size (Li, 2022; Li & Wei, 2022). Therefore, it is not a given that FLCA is the most dominant variable in predicting FL academic achievement, nor whether FLE or FLB is more dominant. This issue of relative importance can be overcome through the method of dominance analysis (Budescu, 1993; Mizumoto, 2022), which "approaches the problem of relative importance by examining the change in R^2 resulting from adding a predictor to all possible subset regression models" (Tonidandel & LeBreton, 2011, p. 3). Thus, a predictor is seen as more important or more dominant than another if it is chosen over all other competing predictors in all possible subset models (Azen & Budescu, 2003). The dominance analysis method was originally proposed by Budescu (1993), elaborated by Azen and Budescu (2003), and recently further expanded by Gu (2022) to include latent predictors (for an overview on dominance analysis in applied linguistics research, see Mizumoto, 2022). By examining the relative importance of predictors as latent variables, the added benefits of structural equation modeling can be included in the dominance analysis, such as the assessment of measurement error and the possibility of examining complex, higher-order variables (Kline, 2015). As such, the relative importance of FLCA, FLE, and FLB with regard to predicting academic achievement will be examined in the current study through the use of dominance analysis. The following research question will therefore be explored: In predicting academic achievement in the EFL classroom, which emotion variable is the most dominant in a latent model?

Methods

Participants

Participants were 502 Moroccan EFL learners from various secondary schools, universities, and language centers in different parts of the country. The average age

was 22.37 years (*SD* = 7 and ranging from age fourteen to sixty) with 228 male and 269 female participants (five did not disclose their gender). Participants were at different stages of their EFL learning journey, with eighty-five beginner learners, 147 lower intermediate learners, 175 upper intermediate learners, and ninety-five advanced learners. The third author translated the instrument from English into Arabic and then asked an English/Arabic teacher to check the translation, with minor differences in translation resolved. Questions and items were presented both in English and Arabic in order to ensure a full understanding by the respondents. All participants were multilingual. This is unsurprising given the high levels of multilingualism found in the Moroccan population (Ennaji, 2005). Participants consisted of 111 bilinguals, 233 trilinguals, 127 quadrilinguals, and twenty-six pentalinguals. They all knew Arabic and were studying English. Additional languages in the repertoires of participants included French (*n* = 415), Amazigh (*n* = 146), Spanish (*n* = 39), Turkish (*n* = 14), and German (*n* = 12).

Approval for this study was obtained from the ethics committee at the first and third author's research institution. A snowball sampling strategy was adopted. A call for participation was issued on professional networks and social media (LinkedIn, Facebook, Instagram, and blogs). Personal contacts were used to reach a wide range of Moroccan EFL learners in different institutions in Morocco. The questionnaire was posted online using Google Forms and remained accessible throughout the month of June in 2022, when all teaching had reverted to in-person instruction. Participants' individual consent was obtained at the start of the survey. The anonymity of participants, their rights, and the confidentiality of their information was explained and guaranteed at the start of the questionnaire.

Awareness of Context in Psychological and Applied Linguistics Research

Henrich et al. (2010) caused a storm when they argued that behavioral scientists seemed to wrongly assume that there is little variation in people around the world when publishing broad claims about human psychology and behavior "based on samples drawn entirely from Western, Educated, Industrialized, Rich, and Democratic (WEIRD) societies" (p. 2). They pointed out that "members of WEIRD societies, including young children, are among the least representative populations one could find for generalizing about humans" (p. 2).

The field of FL learning emotions may have largely avoided this bias because its researchers work in multilingual and multicultural contexts in different parts of the world, but it is good to be reminded that more research is needed from non-WEIRD societies. The first study to look at FLE and FLCA by Dewaele and MacIntyre (2014) was based on a sample of 1,742 foreign language learners from all over the world, but a large majority (86%) came from WEIRD countries. As such, we answer the call issued by Andringa and Godfroid (2020) to further the non-WEIRD research focus in applied linguistics with the current sample of 502 Moroccan EFL learners.

English in the Moroccan Education System

English as a foreign language (EFL) is taught in both Moroccan public and private schools for different purposes and in different ways. Studying a FL is compulsory in Moroccan public high schools (English, Spanish, or German depending on the region). Learners start the first year of English in middle school around the age of thirteen (two hours a week) and take it for the next three years of high school (three, four, or five hours a week, depending on the stream).

The purpose and organization of teaching English at private schools varies considerably, depending on the type of school and curriculum adopted (American Language Centers, British Council courses, etc.). The curriculum of EFL in public high schools, as explained in the English language guidelines for secondary schools (Ministry of National Education, 2007), is a standards-based approach that targets "what learners must know and be able to do with English" (p. 5). According to these guidelines, the focus is on teaching key competencies and the four skills with the aim of developing learners' communicative competence. Learners at the end of the fourth year of learning the EFL at high school take a high-stakes summative written national exam (Baccalaureate), testing a level of proficiency ranging from lower-intermediate to upper-intermediate.

Instruments
The following section details the instruments used in this study.

Short-form Foreign Language Classroom Anxiety Scale ($\omega = .815$; $\alpha = .809$).
The unidimensional eight-item measure is a shortened form of the original Foreign Language Classroom Anxiety Scale designed by Horwitz et al. (1986), shortened in Dewaele and MacIntyre (2014), and recently validated by Botes, van der Westhuizen, et al. (2022). Items included "It embarrasses me to volunteer answers" and "Even if I am well prepared for English, I feel anxious about it." Items were measured on a five-point Likert scale from *strongly disagree* to *strongly agree*.

Short-form Foreign Language Enjoyment Scale ($\omega = .926$; $\alpha = .925$).
The multidimensional nine-item scale was developed by Botes et al. (2021) and is a shortened version of the 21-item Foreign Language Enjoyment Scale (Dewaele & MacIntyre, 2014). The measure was designed with a higher-order factor of FLE, which consisted of three lower-order factors, namely *personal enjoyment* (three items, e.g., "I enjoy my English class"), *social enjoyment* (three items, e.g., "There is a good atmosphere in my English classroom"), and *teacher appreciation* (three items, e.g., "My teacher is supportive"). Items were measured on a five-point Likert scale from *strongly disagree* to *strongly agree*.

Foreign Language Classroom Boredom Scale ($\omega = .948$; $\alpha = .948$).
FLB was measured through the eight-item unidimensional scale measuring boredom in the EFL classroom. The measure is a subscale of the broader Foreign Language Boredom Scale (Li et al., 2021), with the subscale specifically examining boredom within the EFL classroom and, as such, is equivalent in context to the scales used to measure FLCA and FLE. Items included were "It is difficult for me to concentrate in the EFL class" and "My mind begins to wander in the EFL class." Items were measured on a five-point Likert scale from *strongly disagree* to *strongly agree*.

Academic Achievement
EFL academic achievement was measured through a single item asking participants to report their last exam mark in percentage. This result could be the mark of a general

exam, a test, or a term grade. Participants were asked to convert their results scored out of twenty marks (a scoring system widely used in Moroccan schools) to a score out of 100%, and an example was given in the item. Participants reported high average scores ($M = 75.4$ %, $SD = 16.2$), which suggested that they were "good" students and not necessarily a representative sample of the Moroccan EFL population. This self-selection bias is inevitable in online questionnaires (Dörnyei & Dewaele, 2023).

Data Analysis

Descriptive statistics, correlations, and reliability coefficients were calculated in JASP (version 0.11.1: JASP Team, 2019). The structural equation model was analyzed through Lavaan in RStudio (Rosseel, 2012).

FLCA and FLB were both specified as unidimensional latent variables. In turn, FLE was specified as a multidimensional measurement model with a higher/order FLE latent variable indicated by the three lower latent variables of personal enjoyment, social enjoyment, and teacher appreciation. In addition, academic achievement was measured by a single item and, as such, was captured and specified as an observed variable in the structural equation model. The model was tested utilizing maximum likelihood estimation with standard error. Model fit recommendations set by Kenny (2020) were used to determine model fit, specifically by examining the Root Mean Square Error of Approximation ($RMSEA \leq .08$), the Standardized Root Mean Square Residual ($SRMR \leq .08$), the Comparative Fit Index ($CFI \geq .90$), and the Tucker-Lewis Index ($TLI \geq .90$).

Dominance analysis was carried out in RStudio using the lavaan, gtools, bain, and MASS packages. The three-step procedure proposed by Gu (2022) was followed. First, the general dominance estimate of each predictor (FLCA, FLE, and FLB) was calculated based on the latent correlation matrix generated through the proposed structural equation model. Second, the confidence intervals, Wald test z and p-values were calculated after generating bootstrap samples (5000) for each predictor (Gu, 2022). Lastly, based on the general dominance estimates, hypotheses of relative importance were formulated, where the order of dominance of the predictors was tested. The order of dominance was established through bootstrap sampling (5000) in order to examine "how often each of the hypotheses is supported by the bootstrap samples of the general dominance measures" (Gu, 2022, p. 580). Furthermore, the order-constrained hypotheses were examined via Bayes factors that determined the ratio of the likelihood of one hypothesis vs. the likelihood of another hypothesis (Kass & Raftery, 1995). For the R code utilized and further information on the latent dominance analysis carried out in this study, see Gu (2022). The general dominance estimates, confidence intervals, and Wald test significance were used to establish the relative dominance of the predictors. Furthermore, the sequential order of dominance was established through Bayes factors.

Results

Descriptive Statistics and Correlation Coefficients

Descriptive statistics for the variables included in this study can be found in Table 1.

Structural Equation Model

The model is visually depicted in Figure 1. The model achieved close fit ($\chi2$ (290) = 896.97; $p < .001$), with the *RMSEA* (.065) and the *SRMR* (.074) both below the cut-off

Table 1. Descriptive Statistics

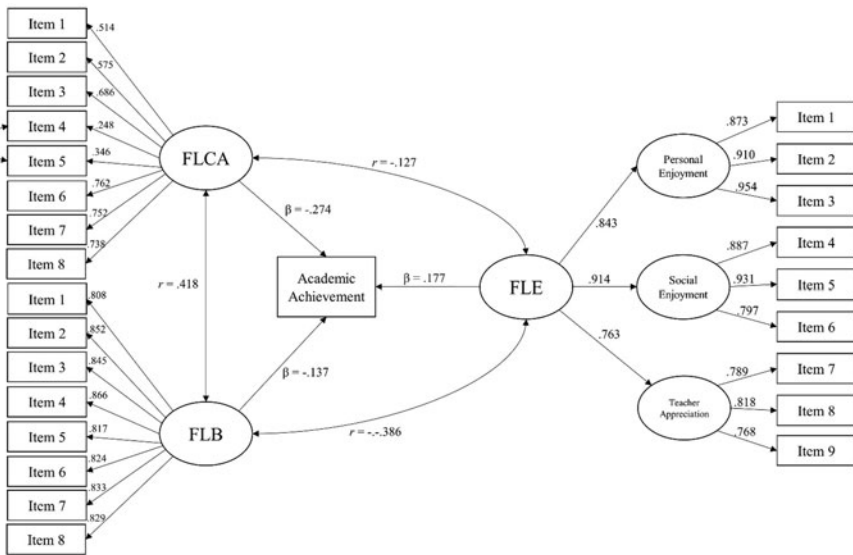|	M	SD	Min	Max
FLCA	2.546	.805	1	5
FLB	1.903	.840	1	5
FLE	3.924	.853	1	5
Academic achievement	75.398	16.238	10	100

Figure 1. Structural Equation Model.
Note: All effect sizes are significant at *p* < .01.

of .08 suggested by Kenny (2020). Furthermore, the *CFI* (.931) and *TLI* (.922) were both above the needed threshold of .90 and thus indicated good fit (Kenny, 2020). Furthermore, the factor loadings were generally acceptable (see Figure 1), with the exception of Item 4 (.248) and Item 5 (.346) of the S-FLCAS. As Items 4 and 5 of the S-FLCAS were both negatively worded (e.g., "I don't worry about making mistakes in the English class"), the lower factor loadings are, to some extent, expected. Negatively worded items regularly lead to atypical response patterns (Carlson et al., 2011), which can have a negative impact on model fit (Conrad et al., 2004).

Overall, the model indicated that all three emotions significantly predicted EFL academic achievement (FLCA: $\beta = -.274$; FLE: $\beta = .177$; FLB: $\beta = -.137$; $p < .01$), with FLCA having the largest effect size, followed by FLE and FLB. However, the β regression coefficients do not necessarily imply an order of dominance, as the contribution of an individual predictor "may be hidden by the other predictors already in the model" (Gu, 2022, p. 572). As such, in order to fully explore the research question at the center of this study, a dominance analysis was carried out.

Table 2. Latent Correlation Coefficient Matrix

	1.	2.	3.	4.
1. Academic achievement	–	−.354	.264	−.320
2. FLCA		–	−.127	.418
3. FLE			–	−.386
4. FLB				–

***$p < .001$ **$p < .01$

Latent Dominance Analysis

The latent correlation matrix generated by the structural equation model can be found in Table 2. The latent correlation matrix was utilized to conduct the latent dominance analysis.

The results of the latent dominance analysis can be found in Table 3. FLCA had the largest dominance estimate ($d_{FLCA} = .092$), followed by FLB ($d_{FLB} = .056$), and lastly, FLE ($d_{FLE} = .036$). Furthermore, the Wald test z and p-values determined that the general dominance measures were statistically significant ($p < .05$). Interestingly, even though FLE had a larger regression coefficient than FLB in the latent model (FLE: $\beta = .177$; FLB: $\beta = −.137$), the dominance analysis indicated that FLB had a larger dominance estimate.

Based on the general dominance estimates, three hypotheses regarding the ordering of importance of the predictors were formulated. Hypothesis 1 specifically examined the order of importance based on the general dominance estimates (see Table 3).

$$H_1: d_{FLCA} > d_{FLB} > d_{FLE}$$

Given that the general dominance estimates of FLE ($d_{FLE} = .036$) and FLB ($d_{FLB} = .056$) were rather close in value and that FLE had the larger regression coefficient in the latent model, Hypothesis 2 was formulated to specifically examine whether the larger estimate of FLB was a statistical artifact and whether FLE might be a more important predictor.

$$H_2: d_{FLCA} > d_{FLE} > d_{FLB}$$

Lastly, Hypothesis 3 was formulated to specifically examine the extent to which positive emotions may be the most important predictor and to fully establish the order of

Table 3. Dominance Analysis Results

	d_j	SE	CI_s	CI_b	Z	p-value
FLCA	.092	.028	[.045; .155]	[.044; .154]	3.271	<.001
FLE	.036	.020	[.009; .087]	[.009; .088]	1.775	<.05
FLB	.056	.020	[.024; .101]	[.024; .010]	2.828	<.01

Note: Where d_j = dominance estimate, SE = standard error, CI_s = bootstrap sampling confidence interval, CI_b = bias-corrected bootstrap confidence interval, z = Wald test estimate, p-value = significance of the Wald test

Table 4. Dominance Ordering Hypotheses Results

Hypotheses	Bayes Factors
H_1 vs. H_a	$BF_{1a} = 2.879$
H_2 vs. H_a	$BF_{2a} = 1.378$
H_3 vs. H_a	$BF_{3a} = 0.271$
H_1 vs. H_2	$BF_{12} = 2.089$
H_1 vs. H_3	$BF_{13} = 10.636$
H_2 vs. H_3	$BF_{23} = 5.091$

importance between the oft-examined FLE and its negative emotion counterpart of FLCA (Dewaele & MacIntyre, 2014).

$$H_3: d_{FLE} > d_{FLCA} > d_{FLB}$$

The Bayes factor results can be found in Table 4. Hypothesis 1 had the largest Bayes factor ($BF_{1a} = 2.879$) in comparison to the alternative H_a and, as such, received the most support from the data. In turn, Hypothesis 3 ($BF_{3a} = .271$) received the least support and was rejected in the dataset with a Bayes factor of less than one. However, it should be noted that both the Bayes factors for H_1 and H_2 fell in the range of 1–3 and, as such, can be regarded as rather small (Lee & Wagenmaker, 2014). In the comparisons between the hypotheses, the support for H_1 was 2.089 times larger than the support for H_2. In turn, BF_{13} (10.636) and BF_{23} (5.091) both confirmed the rejection of Hypothesis 3 in favor of Hypothesis 1 and 2.

As such, the analysis showed that FLCA had the largest general dominance estimate of all predictors, and the most important predictors of EFL academic achievement in order was FLCA, followed by FLB, and lastly, FLE.

Discussion

The aim of the present paper was to establish which learner emotion variables—FLCA, FLE, or FLB—were dominant in predicting academic achievement in Moroccan EFL classrooms. Along the way, we established that FLE was negatively linked to both FLCA and FLB, which were positively correlated with each other. These patterns correspond to the ones uncovered in previous research on both WEIRD and non-WEIRD populations (Dewaele, Botes, et al., 2022; Dewaele, Albakistani, et al., 2022; Li, 2022; Li & Han, 2022; Li et al., 2022).

FLCA turned out to be the emotion that had the strongest effect on the English academic achievement of Moroccan EFL learners, followed by FLB and FLE. In other words, more anxiety and boredom combined with lower enjoyment led to weaker achievement. These patterns reflect previous meta-analyses that found stronger negative effects for FLCA than for FLE on achievement (Botes et al., 2020a, 2022b). It partly confirms the finding in Dewaele, Kamal Ahmed, et al. (2022) that FLCA in in-person classes had the strongest effect on English academic achievement but that FLE and FLB had no effect. The present results diverge from the findings in Li and Wei (2022), where FLE had the strongest effect on academic achievement at Time 1, followed by FLB and,

lastly, FLCA. Our results also differ from Li (2022), who found a stronger relationship between proficiency and FLE than between proficiency and FLB. It is possible that some of the variation in results across the literature is linked to the nature of the dependent variable and its operationalization. The dependent variable of academic achievement, as operationalized by test results does not necessarily reflect proficiency or learning. It is also likely that tests and exams affect FLCA more than FLE and FLB. Students who suffer from FLCA in regular classes probably experience spikes of FLCA when completing tests, and the paralyzing effect of FLCA may impair their performance at that moment in time. FLE and FLB are less likely to have a direct effect on test performance, as tests are usually relatively short, perceived as necessary but not particularly enjoyable. Indeed, none of the descriptions of enjoyable episodes in Dewaele and MacIntyre (2014) included mentions of test or exam performance. We speculate that usual levels of FLE and FLB are less likely than FLCA to fluctuate wildly during test or exam performance, and are also less likely to affect the performance itself. MacIntyre and Gardner (1994) pointed out that anxiety can separately affect input, processing, and output of the FL. We would argue that FLCA can hamper academic achievement in the moment but also in the medium and longer term. An anxious student might avoid speaking up in class, develop avoidance strategies that could limit the development of the FL, and test anxiety might distract and impair the student.

Limitations

A number of limitations need to be considered regarding the findings of this study. The first is the underlying assumption modeled in the SEM that emotions predict academic achievement. We cannot exclude the possibility of spiral effects and nonlinear relationships between emotions and academic achievement. However, the modeling of possible spiral effects given the current cross-sectional dataset was not possible. As such, our second limitation is the use of cross-sectional data. Our study, therefore, only provides a snapshot of a complex, ever-evolving system (Dewaele & Pavelescu, 2021; Dewaele, Saito, et al., 2022; Elahi Shirvan, et al., 2020; Kruk et al., 2022). As such, we are aware that there are limits to the analogy with the Three-Body Problem as it implies multiple observations of a dynamic system. Despite its limitations, the design did allow us to establish which emotion had a dominant effect on the FL academic achievement at the end of the academic year for Moroccan EFL students at different stages in their EFL learning journey. Third, the operationalization of academic achievement was limited in that it consisted of self-reported grades and test results as opposed to standardized achievements. In addition, it should be noted that some participants reported grade averages while others reported test scores; this undoubtedly created error in the measurement.

While a strength of the paper is the focus on a relatively homogeneous non-WEIRD population (Henrich et al., 2010), namely EFL learners in Morocco, which allowed us to keep the education system constant and the language profiles relatively similar, it is unclear whether the results of the study can be generalized to other non-WEIRD and WEIRD samples. We strongly recommend further research regarding the dominance of various emotions in FL learning across different contexts, as different educational systems may result in differing emotions dominating the language learning outcome variable. In addition, measurement invariance testing of the variables across WEIRD and non-WEIRD samples is needed for fruitful comparisons to be made. Invariance testing allows researchers "to establish that the scale items are understood

similarly by all study participants deemed to be part of the "same" population being examined, regardless of their group membership" (Sudina, 2021, p. 1154).The dominance analysis allowed us to establish that the debilitating effects of FLCA were the strongest of the three emotions considered. It also underlines the fact that FLB can undermine FL performance in the longer term (Li, 2022). Although FLE had more modest effects on English academic achievement, we feel that FLE—together with FLB—are the crucial variables that teachers can manipulate to boost learners' performance and progress in the FL.

Conclusion

We began our paper by referring to Cixin Liu's novel *The Three-Body Problem*, developing an analogy between celestial dynamics and learner emotion dynamics. As we conclude the paper, after conducting this study, we still believe that the celestial Three-Body Problem that refers to the effects of three solar-type stars orbiting each other on an inhabited planet can—with a little poetic license—be compared with the three FL learner emotions affecting learners' FL academic achievement. Our findings suggest that while all three emotions exert an influence on academic achievement, FLCA dominates, followed by FLB, and finally by FLE. The dominance of one emotion impacting this particular dependent variable should not obscure the fact that, in a Three-Body Problem, the two remaining bodies/emotions may well determine the complete trajectory that will lead to the final outcome.

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