

ENJOYMENT, BOREDOM, ANXIETY IN ELEMENTARY SCHOOLS

1 Enjoyment, Boredom, Anxiety in Elementary Schools in Two Domains: Relations with
2 Achievement

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1 doing homework, and taking tests). We focused on second and fourth-grade students to
2 investigate differences between early and later elementary school years, thus providing further
3 validation data of the Achievement Emotions Questionnaire-Elementary School (AEQ-ES:
4 Lichtenfeld et al., 2012) which originally considered only second and third-graders' emotions in
5 the domain of mathematics. Moreover, we looked at emotions and their differences both in
6 native language and mathematics to further extend the use of the instrument across different
7 domains.

8 In the Italian educational context, elementary students are taught native language and
9 mathematics as two distinct disciplines, with separate teachers and specific timetables for each
10 of the domain. As for the lessons, while mathematics instructions are unique from other subjects,
11 it is worth noting that native language teaching modalities refer to various activities, such as
12 silent and aloud reading, worksheets, spelling, etc., in accordance with national guidelines.
13 Characteristics of homework activities can vary by teacher, but they usually involve individual
14 work assigned every day with varying due dates (i.e. teachers assign homework every day,
15 sometimes for the day after or for the following days). Both domains are characterized by oral
16 and/or written tests, administered more frequently for older rather than younger students. As for
17 the contents of tests, teachers prepare them following national guidelines, but can vary
18 extensively from one institute to another, from one class to another, and are not uniform in
19 different schools. If tests are written, they can include open or closed-ended questions to assess
20 text comprehension for native language, or calculations for mathematics. Oral exams can consist
21 of reading a text or reciting a poetry for native language, or solving problems for mathematics.

22 **Grade, Gender, and Domain Differences in Achievement Emotions**

23 Research on factors explaining how and why young students experience different
24 achievement emotions across different domains is currently lacking. The empirical literature on

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1 emotions has documented the existence of some grade, gender, and domain differences, although
2 mainly among older students (for a review, see Pekrun & Stephens, 2012).

3 **Grades and achievement emotions.** Most of the previous studies examining
4 achievement emotions have been done with university or secondary school students (e.g., Goetz,
5 Nett, Martiny, Hall, & Pekrun, 2012; Goetz, Pekrun, Hall, & Haag, 2006; Niculescu, Tempelaar,
6 Dailey-Hebert, Segers, & Gijsselaers, 2016; Putwain, Larkin, & Sander, 2013) and only rarely
7 with elementary school students (Lichtenfeld et al., 2012; Raccanello et al., 2013). Many
8 researchers have focused on anxiety, suggesting increases over time, i.e. as grade level increases
9 (for a review, see Pekrun & Stephens, 2012). Raccanello et al. (2013) considered a wider variety
10 of achievement emotions to find fourth-graders, compared to seventh-graders, express higher
11 levels of positive emotions such as enjoyment, pride, relief, and relaxation, and lower levels of
12 negative emotions such as boredom and anger, while no differences in hope, anxiety, guilt, and
13 hopelessness were found. A recent study by Vierhaus, Lohaus, and Wild (2016), however, found
14 that this negative emotional trajectory can only be found in respect to class-related emotions, i.e.
15 those emotions emerging during lessons.

16 **Gender and achievement emotions.** Gender differences in achievement emotions have
17 also been investigated, although mainly with secondary school students and in the domain of
18 mathematics. Several studies found that girls reported more anxiety (Bieg, Goetz, Wolter, &
19 Hall, 2015; Else-Quest, Hyde, & Linn, 2010) as well as more hopelessness and shame (Frenzel,
20 Pekrun, & Goetz, 2007) than boys. Less is known on gender differences in elementary school
21 students and some contradictory results have been found. Most of the studies focused solely on
22 mathematics, confirming for example that in Germany not only older, but also elementary school
23 girls experience higher levels of math anxiety and boredom, and less enjoyment and pride as
24 compared to boys (Lichtenfeld et al., 2012; Lohbeck, Nitkowski, & Petermann, 2016). However,
25 in an American sample of boys and girls differed only in respect to boredom and not anxiety

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1 (Lichtenfeld et al., 2012). Likewise, a study by Harari, Vukovic, and Bailey (2013) with
2 American first-graders from high-minority schools found no gender differences for mathematics
3 anxiety. Given that most of the studies examining gender differences were in the mathematics
4 domain, their findings may be specific to math or the science, technology, engineering, and
5 mathematics (STEM) field, while other domains such as arts and language might produce
6 different results.

7 **Domain and setting in relation to achievement emotions.** Past research suggests a
8 need to consider domain (including native language and not only mathematics), beyond grade
9 (the span from first to fifth-grade—in the Italian context, elementary school is five years long—is
10 high) and gender as characterizing a range of emotions beyond anxiety. In addition, the focus of
11 our study was on native language and mathematics also because they are the two main subjects
12 for elementary school children. It is worth noting that the two domains differ on some aspects,
13 such as the skills necessary to tackle verbal and scientific tasks (Boekaerts, Otten & Voeten,
14 2003), the associated motivational constructs such as self-concept, self-efficacy, task-value, or
15 causal attributions, which differ to a greater extent as students' age increases (Goetz, Cronjaeger,
16 Frenzel, Lüdtke, & Hall, 2010; Wigfield & Eccles, 2000), and the corresponding stereotypical
17 beliefs, mirroring girls' superiority for language and boys' superiority for mathematics (Bieg et
18 al., 2015; Muzzatti & Agnoli, 2007).

19 Based on the control-value theory (Pekrun, 2006) and numerous supporting studies,
20 achievement emotions and their cognitive and motivational antecedents are organized in
21 domain-specific ways. Specifically, achievement emotions and their antecedents have been
22 found to differ across learning domains such as reading, writing, mathematics, and science (e.g.,
23 Gogol, Brunner, Preckel, Goetz, & Martin, 2016; Pekrun & Perry, 2014). For example,
24 secondary school students have been found to differentiate between domains when referring to
25 antecedents of emotions such as their self-efficacy, self-concepts, task-values, attributional

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1 beliefs, or achievement goals in English, Korean, mathematics, and science (Bong, 2001, 2004).
2 Likewise, students distinguish between emotions such as enjoyment, pride, boredom, anxiety,
3 and anger related to many different school subjects, such as Latin, German, English,
4 mathematics, and physics (Goetz, Frenzel, Lüdtke, & Hall, 2011; Goetz, Frenzel, Pekrun, & Hall,
5 2006; Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Goetz et al., 2012). In addition, Goetz et al.
6 (2012) found that eighth and eleventh-graders experience differing levels of enjoyment, pride,
7 boredom, anxiety, and anger when referring to different domains, but also when referring to
8 different classroom activities or homework, thus suggesting that it is important to assess
9 emotions separately in each setting as well as in different domains. However, prior studies did
10 not consider elementary school students, leaving open the question if younger students
11 distinguish between different school subjects as well as between different achievement settings
12 in these early years.

13 Among the few studies investigating elementary school students, Lichtenfeld et al.
14 (2012) found that second and third-graders reported more enjoyment, as well as less anxiety and
15 boredom. Students' emotional patterns were also more adaptive (i.e., more enjoyment, less
16 anxiety, less boredom) during lessons compared to during tests or homework, thus highlighting
17 the importance of considering the achievement setting in which emotions are measured. That
18 study, however, included only second and third-graders (not older elementary school students)
19 and only emotions related to mathematics. In addition, boredom was not assessed as a test
20 emotion and it was not assessed at all for second-graders. Other findings, considering a wider
21 variety of achievement emotions with elementary to secondary school students, found higher
22 levels of enjoyment and pride, and lower levels of guilt, boredom, and hopelessness for
23 mathematics compared to native language (Raccanello et al., 2013). Even if the authors
24 demonstrated that for students the distinction between domains is more salient compared to the
25 distinction between settings, their findings indicated that, also for elementary students,

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1 evaluative settings such as written and oral tests were associated with higher levels of hope,
2 anxiety, guilt, and hopelessness, while non-evaluative settings such as lessons and homework
3 were characterized by higher levels of enjoyment, relief, relaxation, and boredom. A limitation
4 of those results was the use of single-item measures. In addition, further studies indicated that,
5 even if between domain relations are weak in general, domain specificity increases with age
6 (Goetz et al., 2007). Therefore, it is still debatable if elementary school students can differentiate
7 between emotions across different subject domains and settings.

8 Limited current knowledge on emotions, such as focus on the mathematics domain, using
9 only single item measures, and contradictory prior results show a need for further empirical
10 investigations into achievement emotions. Comparing mathematics and native language domains
11 is particularly relevant in light of the fact that they can be associated with stereotypes related to
12 gender (Muzzatti & Agnoli, 2007). More knowledge on this issue could be highly applicable to
13 increasing accurate inferences on students' emotional experiences from one subject to the other.
14 Therefore, in this study we focused on three elementary student emotions (enjoyment, boredom,
15 and anxiety), in two domains (native language and mathematics), and across three settings
16 (lessons, homework, and tests), to assess differences between grades and genders, as well as
17 relations to academic achievement.

18 **Achievement Emotions and Achievement**

19 Achievement emotions may influence learning by having an impact on functional
20 mechanisms such as working memory capacity, information processing, and self-regulation (for
21 overviews see Pekrun, 2006; Pekrun & Perry, 2014). Reviews of empirical studies show
22 beneficial links for positive activating emotions, such as enjoyment, with achievement by
23 promoting affect-related memory effects, interest, deep attention, and flexible learning
24 strategies. Alternatively, the links with achievement are typically negative for negative
25 deactivating emotions such as boredom, which depletes attention, motivation on the task, and

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1 deep information processing. Inconsistent relations with achievement are typical for positive
2 deactivating emotions such as relief, which undermines focused attention and depth of
3 information processing. Similarly, negative activating emotions such as anxiety can reduce
4 cognitive resources but influences motivation in an ambiguous way.

5 Relations between emotions and achievement have been documented mainly in studies of
6 secondary school (Van der Beek, Van der Ven, Kroesbergen, & Leseman, 2017) and university
7 students (Ranellucci, Hall, & Goetz, 2015). Fewer studies examined the relations between
8 achievement emotions and achievement in elementary school children, and the results were
9 inconclusive. Goetz, Frenzel, Hall, and Pekrun (2008) reported that in fifth to tenth-graders
10 enjoyment and achievement were linked positively within domains (mathematics or verbal
11 language) and negatively across domains, so that performance in mathematics predicted
12 negatively enjoyment in language and performance in language predicted negatively enjoyment
13 in mathematics. A study by Mason and Stipek (1989) reported stability in the relations between
14 elementary school children achievement in reading and mathematics with emotions such as
15 feeling smart, proud, dumb, and nervous across one school year. However, they used single-item
16 measures, did not compare mean frequencies related to the two domains, and did not consider
17 two emotions frequently assessed in studies using Pekrun's (2006) control-value theory:
18 enjoyment and boredom.

19 Boredom—an unpleasant and low physiologically arousing emotion—has been only
20 recently been paid attention in the literature despite its potential relevance to dropout (for a
21 review see Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010), and reciprocal linkages with
22 achievement, at least in college students (Pekrun, Hall, Goetz, & Perry, 2014). Compared to
23 other emotions, boredom is also well suited for measurement scales that utilize drawings of
24 faces, as in the case of the AEQ-ES. Enjoyment is particularly relevant because, in comparison
25 with anxiety and boredom, empirical evidence shows it is highly domain-specific (Goetz,

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1 Frenzel, et al., 2006). Considering these emotions, Lichtenfeld et al. (2012) found that
2 elementary school students' mathematics-related enjoyment is linked positively, and boredom
3 and anxiety negatively, to their achievement. However, they considered only the mathematics
4 domain and boredom was not measured in all the considered settings (i.e., no items assessed it in
5 the 'taking tests' setting). This study aimed at adding to the research literature by investigating
6 elementary students' emotions both in the domain of the native language and in mathematics, as
7 well as by including test-related boredom.

8 **Measurement of Achievement Emotions in Elementary School Students**

9 Enjoyment, boredom, and anxiety are emotions measured in the AEQ-ES (Lichtenfeld et
10 al., 2012), which is a self-report questionnaire based on the Achievement Emotions
11 Questionnaire designed for older students (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011).
12 The AEQ-ES consists of 28 items covering affective, cognitive, motivational, and/or behavioral
13 components of emotions related to mathematics in elementary school children pertaining to
14 lesson, homework, and test settings. The questionnaire yielded good reliability and structural
15 validity in a sample of German second and third-graders in the domain of mathematics. It has
16 also been validated with American third-graders, showing its measurement invariance across
17 countries (Lichtenfeld et al., 2012).

18 However, researchers have yet to use the instrument to investigate if emotions and their
19 interrelations function in a similar manner across different domains, focusing on the invariance
20 of its structure according to factors such as different grades, gender, or domains. This could also
21 be due to the fact that the AEQ-ES is a relatively new instrument, and studies on translated
22 versions (beyond the German and the American versions related to mathematics, used with
23 second and third-graders) including data on invariance across countries have not been published
24 yet. Invariance analysis is a key step in the validation of an instrument to a new context (Kline,
25 2016; Ziegler & Bensch, 2013); specifically: "testing measurement invariance becomes an

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1 interesting and indispensable issue within the translation process” (Ziegler & Bensch, 2013, p.
2 82). Therefore, the current study tested invariance across country, including secondary data from
3 German and American samples (Lichtenfeld et al., 2012) and new data on Italian students
4 gathered through the present research. Documenting it is a key step in interpreting the
5 “psychometric soundness” of a translation (Ziegler & Bensch, 2013, p. 82).

6 Verifying measurement invariance is essential to make new findings more interpretable,
7 in order to check whether results are attributable to group differences or measurement issues
8 (Ziegler & Bensch, 2013). In other words, supporting the goodness of the measurement model of
9 a measure is essential before running possible further analyses to avoid construct bias (Kline,
10 2016). Thus, when examining grade, gender, and domain differences in achievement emotions, it
11 becomes relevant to investigate the invariance across these factors of the instrument deputed to
12 measure them.

13 **Research Questions and Hypotheses**

14 The first aim of this work was to further test the AEQ-ES by examining its structural
15 invariance across countries, grades, gender, and domains (Research Question 1). We also
16 examined how much enjoyment, boredom, and anxiety second and fourth-graders feel in two
17 domains of native language learning and mathematics (Research Question 2). Moreover,
18 relations between emotions and achievement within and across domains were examined
19 (Research Question 3).

20 **Research Question 1.** Our first research question was about the validity of the AEQ-ES.
21 Lichtenfeld et al. (2012) confirmed its psychometric properties with German and American
22 third-graders considering only one domain: mathematics. The first aim of this study was to
23 extend those results by considering also fourth-graders’ emotions in both native language
24 learning and mathematics. In line with the original AEQ-ES findings (Lichtenfeld et al., 2012), a
25 second-order hierarchical model that distinguishes between different settings (attending class,

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1 doing homework, and taking tests) each emotion (enjoyment, boredom, and anxiety) was
2 hypothesized to best represent the structure of the data for both the native language as well as the
3 mathematics domain (Hypothesis 1a). The hierarchical model was expected to yield a better fit
4 to the data as compared to two alternative models, in which valence (i.e., with positive and
5 negative items loading on two separate latent factors) or emotion type (i.e., with enjoyment,
6 boredom, and anxiety items loading on three separate latent factors) were included. Additionally,
7 we expected the original AEQ-ES structure to be equivalent across three countries, namely Italy,
8 Germany, and the US; finally, invariance was expected across grades and gender for the native
9 language and mathematics, as well as across domains (Hypothesis 1b).

10 **Research Question 2.** The second research question was, are there mean differences for
11 enjoyment, boredom, and anxiety related to grade (second and fourth), gender, and domain
12 (native language and mathematics)? In line with previous findings, we expected second-graders
13 to report higher levels of enjoyment and lower levels of boredom and anxiety compared to
14 fourth-graders (Hypothesis 2a). We also expected girls, compared to boys, to experience more
15 enjoyment and less boredom and anxiety in native language learning and to the mathematics
16 domain (Hypothesis 2b).

17 **Research Question 3.** With our third research question we asked, do enjoyment,
18 boredom, and anxiety relate to achievement? In both the native language and mathematics
19 domains, we hypothesized enjoyment to be positively related to achievement, and boredom and
20 anxiety to be negatively related (Hypothesis 3a). Moreover, based on previous findings on
21 domain specificity of emotions, we expected relations between emotions and achievement to be
22 stronger within a domain than between emotions in one domain and achievement in the other
23 domain (Hypothesis 3b).

24 **Method**

25 **Participants**

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1 The sample included 767 elementary school students attending grade 2 ($n = 370$) or grade
2 4 ($n = 397$) in 60 classes at 19 schools in Northern Italy, representing a wide variety of socio-
3 economic backgrounds. Mean age was 7.08 years ($SD = 2.10$) for grade 2 (55% girls), and 8.86
4 years ($SD = 2.78$) for grade 4 (53% girls). Students had written parental consent to participate
5 and were guaranteed anonymity. The data concerning emotions was gathered at the beginning of
6 the second term of the school year, and those concerning achievement at the end of the second
7 term. Reference data for testing invariance across countries were kindly made available by the
8 authors of the AEQ-ES (Lichtenfeld et al., 2012). The data included 595 German students
9 attending grade 3 (mean age = 10.10 years; $SD = 0.72$; 49% girls) and 163 US students attending
10 grade 3 (mean age = 8.69 years; $SD = 0.42$; 58% girls).

11 Measures

12 **Achievement emotions.** We developed an Italian version of the AEQ-ES (Lichtenfeld et
13 al., 2012) by means of a back-translation procedure, from English to Italian and back from
14 Italian to English. The Italian adaptation included all the existing 28 items on enjoyment (nine
15 items), anxiety (12 items), and boredom (seven items), referring to the three settings of attending
16 class (class-related), doing homework (homework-related), and taking tests (test-related). In
17 addition, we added four items about boredom during tests by adapting existing AEQ-ES items,
18 which were not included in the original version, to measure the intensity of the same three
19 emotions in all three settings. Given that the original version considered only the domain of
20 mathematics, we added the native language domain by adjusting the items accordingly.

21 The Italian version of the AEQ-ES, therefore, was comprised of 32 items for each
22 domain (64 items total), of which nine related to enjoyment (four items for lessons, e.g., *I enjoy*
23 *math class*; two items for homework, e.g., *When I do math homework, I am in a good mood*; and
24 three items for tests, e.g., *I look forward to math tests*), 11 to boredom (four items for lessons,
25 e.g., *I find math class so boring that I would rather do something else*; three items for

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1 homework, e.g., *When I do math homework, I get tired quickly because I am bored*; and four
2 items for tests, e.g., *Math tests bore me*), and 12 to anxiety (four items for lessons, e.g., *During*
3 *math class, I worry that everything is too difficult for me*; three items for homework, e.g., *Math*
4 *homework scares me so much that I don't want to start doing it*; and five items for tests, e.g., *I*
5 *get nervous during math tests*). For each item, intensity of emotions was rated on a 5-point
6 Likert scale (1 = *not at all* and 5 = *very much*), supported by drawings of faces corresponding to
7 increasing levels of intensity (Lichtenfeld et al., 2012). All verbal labels and pictorial materials
8 were matched to children's gender, with a different version for boys and girls, to ensure that
9 children could identify themselves with the faces. Items were grouped to enhance item salience
10 to each domain and setting; specifically, for each domain we first presented class-related items,
11 then homework-related items, and finally test-related items. Every section of the questionnaire
12 was preceded by a written label specifying the domain and setting, and a drawing depicting a
13 cartoon character busy within one of the three settings; namely, a dragon standing with a
14 worksheet in one hand for lessons, a mouse laying staring at a book for homework, and a duck
15 sitting at a desk with a pen and a sheet of paper for tests. It took about 45 minutes for the
16 students to complete the questionnaire. Given that the length of the questionnaire could have
17 been associated to fatigue for the participants, we gave them the possibility to stop whether they
18 requested it, and then to begin to answer again after a brief pause.

19 Reliability of each factor was determined by calculating Omega as these analyses do not
20 require tau-equivalence (i.e., that each indicator variable contributes equally to the factor) or
21 uncorrelated error variances. Omega values ranged from .61 to .93, and from .68 to .93, for the
22 three emotions in the native language and mathematics domains, respectively (see Table 1).

23 **Achievement.** We asked teachers to report students' grades separately for native
24 language and mathematics as included in their final report card, assigned at the end of the second

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1 term of the school year. In the Italian education system, grades range from 1 (very poor) to 10
2 (excellent).

3 Procedure

4 The Local Ethical Committee for Psychological Research of the University of Padova (n.
5 1613) approved the research project. Among the children whose parents agreed to their
6 participation, two investigators led students in completing the AEQ-ES on three consecutive
7 weeks, once a week, in classroom sessions lasting about one hour each. Like in the original
8 study of the AEQ-ES, all items were read aloud and children were told that there were no right
9 or wrong answers and to respond honestly. To ensure that the students understood how to
10 respond to the questionnaire items, we added a familiarization phase for each emotion (e.g.,
11 *Hiking in the mountains bores me*), which were outside the school context to avoid interferences.
12 After completing the examples, the students were asked to share their answers to solve possible
13 misunderstandings concerning how to respond to the items. Order of the domain (native
14 language, mathematics) was counterbalanced across classes. At the end of the study, each child
15 received a diploma as a gift for his/her participation. Students were tested during school time on
16 two consecutive days. The data considered here were only from the second session during which
17 students responded to the AEQ-ES.

18 Reference data for testing invariance across countries referred to a first study for the
19 German sample and to a second study for the US sample published by Lichtenfeld et al. (2012).

20 Data Analysis

21 We used Mplus version 6.11 (Muthén & Muthén, 1998–2011) to run Confirmatory
22 Factor Analyses (CFA), tests of Measurement Invariance (MI), and Path Analyses (PA),
23 controlling for biases due to a clustering effect given that children were grouped by class. The
24 nested nature of the data was taken into account by utilizing the `<type=complex>` option in
25 Mplus (Muthén & Muthén, 1998–2011), which uses maximum likelihood estimation with robust

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1 standard errors (MLR) to estimate model parameters. This syntax is quite demanding in the
2 estimation process. We used one-tailed tests for the PA given that the hypotheses were mono-
3 directional (level of significance: $p < .10$). Before conducting the PA, we checked the adequacy
4 of the sample size. It is worth noting that we had the permission to gather achievement data for
5 only for 424 Italian students. According to Kline (2016) the minimum ratio between numbers of
6 observations and numbers of parameters should be 5:1 or more, and preferably 10:1. A
7 preliminary analysis, however, showed that the minimum ratio requested to run Structural
8 Equation Models (SEM) was not met: The first two general models required 112 parameters to
9 be estimated resulting in a ratio of only 3.79 cases for each parameter. The models also had
10 many factors and in one case a first order factor with less than three items (larger samples are
11 recommended under these conditions; Kline, 2016). Therefore, we applied PA for the first two
12 general models examining the three emotions together, separated by domain. Then, the same
13 analyses focusing on each emotion separately in the different settings were calculated to permit a
14 coherent comparison with the two overall models, separated by domain (see Figure 2a for the
15 overall models and Figure 2b for the models separated by domain).

16 We used the R version 3.3.2 (R Core Team, 2016) to run Linear Mixed Models (LMM;
17 for similar applications see Raccanello, Burro, Brondino, & Pasini, 2017), to investigate
18 differences in emotions based on grade (second-graders, fourth-graders), gender (males,
19 females), and domain (native language, mathematics). We utilized the lmer function in the lme4
20 package (Bates, Mächler, Bolker, & Walker, 2015). We performed Mixed Model ANOVA
21 Tables via likelihood ratio tests (afex package; Singmann, Bolker, Westfall, & Aust, 2016) and
22 reported effect sizes as conditional R^2 (MuMIn package; Barton, 2016; Nakagawa & Schielzeth,
23 2013). We utilized Gaussian family and identity link-function. For post-hoc tests we used the
24 Bonferroni correction with the Satterthwaite's approximation for degrees of freedom (lsmeans
25 package; Lenth, 2016). Participants and class were used as random effects. The level of

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1 significance was $p < .05$. Preliminary analyses (LMM) revealed no significant effects of grade,
2 gender, or domain on achievement.

3 **Results**

4 **Preliminary Analyses**

5 We verified that skewness (range: 0.03-2.80, mean value 1.10) and kurtosis (range: 0.00-
6 7.32, mean value 1.35) values for each item did not exceed 2.0 and 7.0 (except one item),
7 respectively, supporting normality assumptions (Curran, West, & Finch, 1996). We also
8 analyzed missing values in the data, which revealed the maximum percent of missing values for
9 items was 3%, and only 11% of the cases registered any missing values. Little's MCAR test
10 indicated that data were missing at random, $\chi^2(2962) = 4217.30, p < .001$.

11 Descriptive statistics appear in Table 1, which includes intercorrelations, number of
12 items, possible range, observed range, means, and standard deviations for grade, gender,
13 achievement emotions by setting, and achievement, separated by domain (native language and
14 mathematics). The emotions felt in the three settings and two domains inter-correlated, and
15 many relations were found with achievement, mainly in mathematics and in the native language
16 as for anxiety.

17 **Validation of the AEQ-ES in the two Domains and Measurement Invariance (MI)**

18 We ran two separate CFAs, one for each domain, to test the goodness of fit of the
19 hypothesized structure, considering the class to which children belonged as the clustering
20 variable. We tested a hierarchical second-order model distinguishing between the three settings
21 for each emotion (Figure 1). To investigate goodness of fit, we used the comparative fit index
22 (CFI), the root-mean-square error of approximation (RMSEA), and the standardized root mean
23 square residual (SRMR), with $CFI \geq .90$, $RMSEA \leq .08$, and $SRMR \leq .10$ as threshold values
24 (Kline, 2016). The results of the CFAs supported the hypothesized structure. All factor loadings
25 were positive and statistically significant (larger than .58 and .60, respectively for the native

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1 language and mathematics) and the goodness of fit indexes were acceptable (native
2 language/mathematics: $\chi^2(452/453) = 1572.34/1410.20$, CFI = .93/.93, RMSEA = .06/.05,
3 SRMR = .06/.05), supporting Hypothesis 1a.

4 We compared goodness of fit of the hierarchical model to that of two alternative models.
5 First, a two-factor model in which positive items loaded on a latent positive emotion factor and
6 negative items loaded on a latent negative emotion factor (native language/mathematics:
7 $\chi^2(463/463) = 4445.25/3257.10$, CFI = .74/.79, RMSEA = .11/.09, SRMR = .10/.08). Second, a
8 three-factor model in which enjoyment, boredom, and anxiety items loaded on three different
9 latent factors, respectively (native language/mathematics: $\chi^2(461/461) = 3013.03/2454.41$, CFI =
10 .83/.85, RMSEA = .08/.08, SRMR = .07/.06; see also Lichtenfeld et al., 2012 for this approach).
11 None of these models showed acceptable fit to the data, thus supporting the hypothesized
12 hierarchical structure, further supporting Hypothesis 1a.

13 For each domain, MI analyses examined hypotheses on the invariance of the factorial
14 structure across countries, grades, and gender. In addition, we checked for the invariance across
15 domains, splitting our dataset randomly (balancing both grade and gender). We performed
16 multigroup CFAs by testing separate nested CFA models, including: (1) the configural
17 invariance model, allowing all the parameters to be freely estimated; (2) the metric invariance
18 model, requiring invariant factor loadings; and (3) the scalar invariance model, additionally
19 requiring invariant intercepts. Comparisons among models were based on differences in CFI,
20 RMSEA, and SRMR: Support for invariance requires a change in CFI less or equal than .010, a
21 change in RMSEA less or equal than .015, and a change in SRMR less or equal to .030 for
22 testing metric invariance and less or equal to .010 for testing scalar invariance. We reported the
23 three indexes (see Table 2) but, as suggested by Chen (2007), we considered the change in CFI
24 as the main criterion.

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1 To test invariance across countries, we ran separate analyses comparing the Italian
 2 sample with the German and US samples only for the mathematics domain, given that the
 3 original data referred to that domain. The covariance matrix was negatively defined due to the
 4 small negative variance of homework-related anxiety, so the variance of this factor was
 5 restricted to .001. The results of the sequence of gradually more restrictive tests of MI supported
 6 configural, metric, and scalar invariance across all countries. It is worth noting that the scalar
 7 invariance was met only when freeing the intercept of one anxiety item. We conducted the same
 8 analyses across grades, gender, and domains and the findings suggested invariance (configural,
 9 metric, and scalar invariance) across all groups. The hypothesized measurement model was thus
 10 found to be invariant and generalizable for emotions across countries for mathematics, across
 11 grades and genders both for the native language and mathematics, and across domains
 12 (Hypothesis 1b).

13 **Grade, Gender, and Domain Differences in Emotions**

14 For each domain, responses to items on the same emotion and setting were averaged
 15 together, thus forming nine variables. We ran three LMM, separately for each emotion, with
 16 grade (second-graders, fourth-graders), gender (males, females), and domain (native language,
 17 mathematics) as fixed effects and emotions as dependent variables (enjoyment: $R^2_c = .35$;
 18 boredom: $R^2_c = .32$; anxiety: $R^2_c = .38$). See Figure 3 for mean values and standard errors.

19 Regarding enjoyment, we found significant effects for grade, $X^2(1) = 29.40, p < .001$, and
 20 domain, $X^2(1) = 32.04, p < .001$. Specifically, second-graders ($M = 3.59, SD = 0.94$) reported
 21 higher levels of enjoyment than fourth-graders ($M = 2.98, SD = 0.93$), and students reported
 22 lower levels of enjoyment in the native language learning ($M = 3.13, SD = 1.21$) compared to
 23 mathematics ($M = 3.41, SD = 1.21$). However, results yielded two significant two-way
 24 interactions, grade x domain, $X^2(1) = 16.70, p < .001$, and gender x domain, $X^2(1) = 14.12, p <$
 25 $.001$, as well as a significant grade x gender x domain, $X^2(1) = 4.21, p = .040$, three-way

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1 interaction. The post-hoc tests related to the three-way interaction revealed that, concerning
 2 grade differences, both second-grade boys, $t(182.60) = 5.96, p < .001$, and girls, $t(151.31) =$
 3 $5.13, p < .001$, reported higher levels of enjoyment for native language compared to fourth-
 4 graders, whereas only second-grade girls, $t(153.48) = 3.57, p = .013$, reported higher levels of
 5 enjoyment in mathematics as compared to fourth-grader girls. As for domain differences,
 6 enjoyment was lower in native language as compared to mathematics only for boys, $t(754.25) =$
 7 $-7.81, p < .001$, and girls, $t(174.82) = -4.92, p < .001$, in fourth-grade.

8 In respect to boredom, we found significant differences according to student grade, $X^2(1)$
 9 $= 16.28, p < .001$, gender, $X^2(1) = 4.80, p = .028$, and domain, $X^2(1) = 16.04, p < .001$. Second-
 10 grade students reported lower levels of boredom ($M = 1.79, SD = 0.89$) compared to fourth-
 11 graders ($M = 2.27, SD = 0.93$), and students reported more boredom in the native language ($M =$
 12 $2.14, SD = 1.19$) compared to mathematics ($M = 1.95, SD = 1.15$). Again, results yielded two
 13 significant two-way interactions, grade x domain, $X^2(1) = 18.56, p < .001$, and gender x domain,
 14 $X^2(1) = 7.44, p = .006$. Analyses of the post-hoc tests indicated grade differences only for
 15 boredom relating to the native language, $t(82.41) = -5.39, p < .001$ (second-graders: $M = 1.78,$
 16 $SD = 1.03$, fourth-graders: $M = 2.48, SD = 1.23$). Gender differences also emerged, with boys
 17 reporting more boredom ($M = 2.10, SD = 0.94$) than girls ($M = 1.99, SD = 0.93$), but again this
 18 effect was limited to native language, $t(1411.90) = 3.41, p = .004$ (boys: $M = 2.27, SD = 1.23;$
 19 girls: $M = 2.03, SD = 1.15$). Domain differences were found only considering fourth-graders,
 20 $t(754.42) = 6.04, p < .001$ (native language: $M = 2.48, SD = 1.23$, mathematics: $M = 2.07, SD =$
 21 1.17), and boys, $t(761.93) = 4.53, p < .001$ (native language: $M = 2.27, SD = 1.23;$ mathematics:
 22 $M = 1.93, SD = 1.18$), with boredom higher for native language.

23 For anxiety, we found a significant main effect of grade, $X^2(1) = 10.88, p < .001$: Second-
 24 graders ($M = 1.64, SD = 0.65$) were less anxious compared to fourth-graders ($M = 1.85, SD =$
 25 0.68). Moreover, the two-way interactions of grade x domain, $X^2(1) = 9.89, p = .002$, and gender

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1 x domain, $X^2(1) = 10.33, p = .001$, were significant. Finally, results yielded a three-way
 2 interaction of grade x gender x domain, $X^2(1) = 4.64, p = .031$. On the whole, grade differences
 3 were only found for boys in respect to the native language-related anxiety, $t(243.03) = -3.89, p =$
 4 $.004$. Also domain differences emerged: More anxiety was reported for the native language
 5 compared to mathematics, $t(752.51) = 4.55, p < .001$. But this was only the case for fourth-
 6 graders boys.

7 To sum up, our data supported Hypothesis 2a on grade differences, and partially
 8 Hypothesis 2b on gender and domain differences.

9 **Achievement Emotions and Achievement**

10 We first conducted a PA to examine if the three emotions related to achievement,
 11 considering the two domains in the same model (Figure 2a), for the subsample of the 424 Italian
 12 students. Anxiety in native language learning ($\beta = -.11, p = .022$) and mathematics ($\beta = -.29, p =$
 13 $.006$) was negatively linked to achievement in the native language, with 10% of the variance
 14 explained. Enjoyment in mathematics ($\beta = .20, p = .047$) was positively linked to achievement in
 15 mathematics, and anxiety in mathematics ($\beta = -.27, p = .011$) and in the native language ($\beta = -$
 16 $.14, p = .010$) was negatively linked to achievement in mathematics, with 14% of explained
 17 variance. In sum, anxiety negatively related to achievement in both domains while enjoyment
 18 positively related to achievement in mathematics only, partially supporting Hypothesis 3a.
 19 Moreover, anxiety in the native language negatively related to achievement in mathematics and
 20 anxiety in mathematics negatively related to achievement in the native language, suggesting that
 21 anxiety is a rather pervasive emotion affecting achievement beyond the domain it is felt in
 22 (differently from what expected according to Hypothesis 3b).

23 Additionally, to further investigate the set of relations within domains (Hypothesis 3a),
 24 we carried out six PAs for each setting and each domain (Figure 2b). For enjoyment and
 25 boredom, only test-related emotions were statistically significant in relation to achievement, and

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1 only for mathematics: Test-related enjoyment ($\beta = .14, p = .086$) was positively related with
 2 achievement, while test-related boredom ($\beta = -.22, p = .064$) was negatively related, with 3%
 3 and 6% of explained variance respectively. Alternatively, anxiety was linked to achievement in
 4 both domains. In native language learning, class-related anxiety ($\beta = -.18, p = .002$) and test-
 5 related anxiety ($\beta = -.25, p = .003$) negatively related with achievement, while homework-related
 6 anxiety ($\beta = .15, p = .024$) positively related to achievement, in total explaining 8% of the
 7 variance. In mathematics, only test-related anxiety was statistically significant in relation with
 8 achievement ($\beta = -.36, p < .001$), with 11% of the variance explained.

Discussion

10 In the current study, we investigated elementary school students' enjoyment, boredom,
 11 and anxiety during lessons, homework, and tests, as well as the relations of the emotions with
 12 achievement in native language learning and mathematics. The results extended the AEQ-ES
 13 (Lichtenfeld et al., 2012) to a domain beyond mathematics, specifically native language
 14 learning, examined more grade differences (i.e. fourth-graders), and added boredom-related
 15 items pertaining to the test setting. Below we discuss the main results, and their implications for
 16 theory and practice.

17 Measuring Emotions in Elementary School Students

18 Our first research question focused on examining the psychometric properties of the
 19 AEQ-ES to test its validity in a new context and for a new domain. The results supported the
 20 proposed hierarchical model of achievement emotions. Invariance tests further revealed that the
 21 AEQ-ES can be used to assess enjoyment, boredom, and anxiety of elementary school students
 22 in both domains of native language and mathematics, in different grades and among different
 23 genders. Extending the findings of the original study in which elementary school students'
 24 emotions were found to be invariant across German and US samples (Lichtenfeld et al., 2012),
 25 our data revealed measurement invariance in mathematics across three different countries (Italy,

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1 Germany, and US), thus suggesting that the structure of achievement emotions is comparable
2 across these different countries. This further supports the proposition of the control-value theory
3 (Pekrun, 2006) that the fundamental structures as well as the underlying mechanisms of
4 emotions are based on general nomothetic principles, whereas contents, frequency, and intensity
5 of emotions were found to differ across cultures, genders, and individuals.

6 **Grade, Gender, and Domain Differences in Achievement Emotions**

7 Regarding student emotion differences across grades, the present study found mean level
8 differences in students' enjoyment, boredom, and anxiety. In line with previous research (e.g.,
9 Raccanello et al., 2013) results showed younger students generally reported higher levels of
10 enjoyment and lower levels of boredom and anxiety as compared to older elementary students,
11 with some exceptions. Changes in academic tasks and classroom organization, psychological
12 development concurrent to physiological modifications, and changes in peer relationships may
13 be responsible for the fact that older students experience less enjoyment and more boredom and
14 anxiety towards different school subjects (Eccles & Roeser, 2011). These results are in line with
15 results from longitudinal research showing a decline in motivation and related affective
16 dispositions in the transition from elementary to high school (e.g., Bong, 2009; Paulick,
17 Watermann, & Nückles, 2013; Raccanello & Brondino, 2016; Wigfield & Eccles, 2002).

18 These findings urge significant adults like teachers, psychologists, and parents to reflect
19 on practical ways to prevent downward emotional trajectories in students such as reduced
20 enjoyment and increased boredom and anxiety that characterize learning environments. Both
21 parents and teachers should foster a positive emotional climate associated with learning tasks to
22 reduce this maladaptive trend. Moè (2016), who found teachers' enthusiasm about their teaching
23 affected both students' motivation and recall, demonstrated the relevance of such attention
24 within classes. Also important to student emotions is parents displaying high levels of positive

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1 affect in the homework context (Pomerantz, Wang, & Ng, 2005) and transmitting intrinsic
2 motivation (Katz, Kaplan, & Buzukashvili, 2011).

3 In addition to differences across grades, the current findings also revealed differences in
4 emotions across gender. However, gender differences only emerged for the native language
5 domain, for which boys reported to be more bored than girls. A potential underlying mechanism
6 explaining these differences is the extent to which children endorse gender-stereotypical beliefs
7 that expect girls to be better in verbal tasks and boys in mathematics, or adults'—parents or
8 teachers'—beliefs about gender specificity of mathematics vs. language, which we did not
9 measure. In other terms, on the bases of the control-value theory we can assume that
10 expectations of being better—even expectations due to stereotypical beliefs of adults significant
11 for children—led to differences in emotions, with control appraisals responsible for that as
12 central antecedents of emotions. Practitioners could work on reducing stereotypic beliefs,
13 especially for boys in native language, or enhancing control appraisals.

14 Finally, we found that children felt differently in respect to the different school domains,
15 thereby filling gaps in the literature which has neglected this issue. Native language learning was
16 found to be less enjoyable for fourth-graders, more boring both for fourth-graders and boys, and
17 more anxiety provoking only for fourth-grade boys. Results on enjoyment and boredom parallel
18 previous findings on native language and mathematics with older students (Raccanello et al.,
19 2013). The finding that, overall, mathematics resulted in better emotions than native language
20 could be related to different factors, among which the way teachers talk about these content
21 areas. Often teachers know the importance of convincing young kids of the importance of STEM
22 and thus focus on trying to generate excitement, engagement, and rationales for mathematics,
23 and maybe this could not be the case for native language. In addition, utility value may be
24 highlighted more in mathematics compared to native language—and value beliefs are key
25 appraisals for achievement emotions. Basing on our findings, interventions focused on

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1 promoting utility value (e.g., Rozek, Svoboda, Harackiewicz, Hulleman, & Hyde, 2017) could
2 foster positive emotions and discourage negative ones in the native language domain. Future
3 studies should disambiguate whether this effect is particular to the Italian context or can be
4 generalized to other countries. On the whole, our findings suggest that taking into account
5 situational characteristics is essential to adequately describe psychological processes associated
6 with learning, and specifically emotional processes.

7 Documenting how different emotions vary their intensity according to the kind of domain
8 could also give specific indications at an applied level. It could encourage professionals such as
9 teachers, psychologists, or educators to acknowledge that, although the structure of emotions in
10 different domains is the same, intensity with which emotions are felt in different domains can
11 vary extensively from one student to another.

12 **Relations Between Emotions and Achievement**

13 Finally, a central aim of the study was to examine the relations of enjoyment, boredom,
14 and anxiety with achievement. We first examined within-domain relations. In line with the
15 theoretical model (Pekrun, 2006; Pekrun & Perry, 2014) and previous research with elementary
16 school children in mathematics (Lichtenfeld et al., 2012), the current study results showed
17 anxiety correlated negatively while enjoyment positively correlated with achievement, while in
18 the native language domain only anxiety was negatively linked to achievement. We found no
19 significant relations between boredom and achievement in this study. Interestingly, the results
20 yielded across-domain relations between students' anxiety and achievement: Anxiety
21 experienced in the native language was negatively linked to achievement in mathematics, and
22 anxiety felt in mathematics negatively related with the level of achievement in the native
23 language. This indicates that anxiety may be a very pervasive emotion that spreads to different
24 domains, thereby negatively influencing performance.

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1 Beyond supporting findings from the vast literature on the role of anxiety for school
2 performance (e.g., Pekrun & Stephens, 2012), our findings extended it taking into account the
3 role of settings. As expected, class-related and test-related anxiety were negatively linked to
4 achievement. Surprisingly, the present study yielded positive relations between homework-
5 related anxiety and achievement, suggesting that worries activated in a non-evaluative setting
6 during homework (different from the evaluative setting in which grades are obtained), in which
7 the social component is less salient, differ in respect to their consequences in performance
8 outcomes. A plausible mechanism that may account for this difference, could be that anxiety
9 experienced in a non-evaluative setting may be functional in enhancing students' extrinsic
10 motivation and thereby enhancing students' effort invested. During homework students reported
11 boredom more than anxiety and more than doing tests or attending lessons. Therefore, anxiety
12 felt in this boring setting of homework time could be functional towards a display of effort and
13 prevents lack of accomplishment or giving up early. Relations between achievement and the
14 other two emotions, namely enjoyment and boredom, were quite weak and only were significant
15 in the test setting.

16 Overall, teachers and parents may interpret these data as encouragement to make children
17 anxious during homework despite the subsequent negative effects during test taking. However,
18 fear appeals have been experimentally demonstrated as teaching strategies damaging for learning
19 (e.g., Putwain & Best, 2011). We also highlight that the mean level of anxiety was quite low.
20 These are not highly anxious children, which is encouraging, but also cautions teachers and
21 parents against making children highly anxious because these results are based on low levels of
22 anxiety in the first place.

23 In summary, our findings suggest that anxiety plays a complex role in students'
24 achievement. Our results highlight the relevance of considering both domain-specificity as well

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1 as different school settings when measuring emotions, especially in view of future intervention
2 studies aimed at favoring more adaptive emotional patterns.

3 **Limitations, Implications, and Future Directions**

4 A primary limitation of the present research is the use of self-report measures, which
5 could have favored social desirability effects. Future work should extend these findings by
6 assessing emotions considering other indicators such as facial expressions, by videotaping
7 lessons, or taking into account other-reports such as from parents or teachers. A further
8 limitation is that there was only one measurement point in time for each construct, namely,
9 emotions and achievement; in other words, we used a cross-sectional rather than a longitudinal
10 research design. This aspect relates to the assumption of construct stability, given that we
11 measured achievement emotions during the term and data on achievement were gathered at the
12 end of the term. Together with taking into account the young age of our participants, these issues
13 further solicit the importance of caution in the interpretation of construct representativeness and
14 stability. Future longitudinal studies should include more measurement points to assess
15 reciprocal relations between students' emotions and their achievement going beyond these
16 limitations. Another limitation is that classroom related factors were not included in the study.
17 These factors, like characteristics of teaching (e.g., displayed enthusiasm, students'
18 involvement), teachers' motivations (e.g., self-efficacy, self-determined motivation), as well as
19 the capabilities the team of teachers has, may be important antecedents of emotions and foster
20 students positive affect and intrinsic motivation. This study also utilized path analyses with
21 single indicators, which usually have poor psychometric properties and assume error free
22 measurement of the variables. This is especially problematic in respect to independent variables
23 being affected by measurement error as it biases the parameter estimates. Further limitations of
24 path analyses in general regard issues related to the underlying assumptions (e.g., the absence of
25 correlations between residuals and preceding variables, or the interval scale of the variables) or

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1 to the meaning of the model fit (e.g., significant paths do not demonstrate the causal nature of
2 relations), and, for our specific path analyses, the limited number of manifest variables per latent
3 variable (Jeon, 2015). Finally, relations between emotions and achievement were only analyzed
4 for a sub-sample due to missing achievement data for part of the sample. Thus, future studies
5 would be well advised to include larger samples to replicate these findings.

6 **Conclusions**

7 At any school level, students experience different emotions in their school subjects and
8 the different achievement settings they are facing. For elementary school students, emotions
9 were assessed using the AEQ-ES, a self-report instrument whose hierarchical structure has been
10 demonstrated as invariant across three countries, different grades and gender, and across
11 domains. Anxiety was found to be linked both to achievement in the same domain as well as to
12 achievement in another domain, while both enjoyment and boredom showed few linkages with
13 performance. Older students were found to show a more maladaptive emotional pattern than
14 younger students, marked by lower enjoyment as well as higher boredom and anxiety. Focusing
15 on students' emotions and developing instruments to assess them in reliable ways is a very
16 important step, which can provide innovative contributions to our knowledge of the emotional
17 factors that are important in specific school contexts. In addition, research in this area enable a
18 deepening understanding about how young students experience their emotions differently
19 according to grade, gender, and domains. Finally, these results could help teachers, practitioners,
20 and parents to verify the efficacy of their teaching methods or ways of supporting them, in order
21 to ascertain whether they have a positive impact on students' emotions in the academic setting.

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Table 1

Intercorrelations, Number of Items, Possible Range, Observed Range, Means (M), Standard Deviations (SD), and Omega Values for Age, Gender, Achievement Emotions by Setting (Class, Homework, Test), and Achievement, for each Domain (Native Language, Mathematics)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Age in months	--																					
2. Gender	.04	--																				
3. Class-related enjoyment – Native language	-.14***	.10**	--																			
4. Homework-related enjoyment – Native language	-.13***	.12***	.78***	--																		
5. Test-related enjoyment – Native language	-.12***	.04	.69***	.73***	--																	
6. Class-related boredom – Native language	.11**	-.10**	-.84***	-.65***	-.54***	--																
7. Homework-related boredom – Native language	.11**	-.11**	-.71***	-.76***	-.57***	.80***	--															
8. Test-related boredom – Native language	.14***	-.08*	-.67***	-.66***	-.65***	.76***	.81***	--														
9. Class-related anxiety – Native language	.03	-.03	-.44***	-.33***	-.35***	.53***	.47***	.46***	--													
10. Homework-related anxiety – Native language	-.02	-.07	-.36***	-.41***	-.37***	.43***	.53***	.49***	.69***	--												
11. Test-related anxiety – Native language	.09**	.00	-.36***	-.36***	-.52***	.39***	.45***	.52***	.64***	.68***	--											
12. Achievement – Native language	-.05	.15**	.04	.00	.06	-.11*	-.07	-.09	-.21***	-.12*	-.25***	--										
13. Class-related enjoyment – Mathematics	-.08*	-.04	.15***	.21***	.20***	-.08*	-.13***	-.10**	.00	-.05	-.09*	.11*	--									
14. Homework-related enjoyment – Mathematics	-.12***	-.03	.26***	.38***	.32***	-.18***	-.26***	-.24***	-.03	-.09**	-.11**	.11*	.77***	--								
15. Test-related enjoyment – Mathematics	-.09*	-.11**	.15***	.24***	.39***	-.07	-.12***	-.19***	-.02	-.07*	-.20***	.19***	.71***	.70***	--							
16. Class-related boredom – Mathematics	.09*	.01	-.13***	-.17***	-.13***	.17***	.20***	.19***	.12**	.13***	.14***	-.15**	-.85***	-.64***	-.58***	--						
17. Homework-related boredom – Mathematics	.09*	-.01	-.15***	-.23***	-.18***	.21***	.30***	.32***	.15***	.20***	.20***	-.18***	-.72***	-.74***	-.59***	-.79***	--					
18. Test-related boredom – Mathematics	.11**	.05	-.11**	-.18***	-.19***	.18***	.27***	.34***	.18***	.22***	.28***	-.21***	-.68***	-.63***	-.69***	.76***	.81***	--				
19. Class-related anxiety – Mathematics	.03	.09*	.04	.02	-.03	.03	.06	.07	.29***	.23***	.28***	-.22***	-.55***	-.40***	-.44***	.65***	.56***	.59***	--			
20. Homework-related anxiety – Mathematics	.03	.06	.05	-.03	-.03	.02	.10**	.13***	.22***	.34***	.31***	-.21***	-.52***	-.49***	-.48***	.60***	.65***	.65***	.72***	--		
21. Test-related anxiety – Mathematics	.10**	.11**	.06	.00	-.11**	.02	.07	.15***	.23***	.26***	.41***	-.32***	-.53***	-.45***	-.64***	.57***	.60***	.73***	.72***	.75***	--	
22. Achievement – Mathematics	-.04	.09	.00	.01	.08	-.07	-.06	-.07	-.20***	-.10*	-.25***	.84***	.19***	.15***	.27***	-.21***	-.22**	-.26***	-.28***	-.22***	-.37***	--
Number of items	--	--	4	2	3	5	3	4	3	3	5	--	4	2	3	5	3	4	3	3	5	--
Possible range	--	0-1	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-10	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-10
Observed range	83-131	0-1	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	6-10	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	6-10
M	96.02	--	3.40	2.95	3.04	2.03	2.23	2.16	1.54	1.68	2.06	8.37	3.73	3.18	3.32	1.81	2.06	1.96	1.53	1.65	2.05	8.50

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<i>SD</i>	31.50	--	1.34	1.40	1.26	1.23	1.33	1.29	0.75	0.90	0.98	1.18	1.29	1.43	1.3	1.15	1.29	1.26	0.8	0.93	1.09	1.21
<i>Omega</i>	--	--	.93	.80	.82	.93	.89	.92	.72	.61	.79	--	.92	.76	.85	.91	.89	.93	.73	.68	.84	--

Note. $N = 767$, with the exception of intercorrelations with achievement, for which $N = 424$. Achievement was measured according to Italian grades.

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

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Table 2

Results of Invariance Analyses across Country (Italy, Germany, US) for Mathematics, across Grade (Second, Fourth-Graders) and Gender (Boys, Girls) for Native Language/Mathematics, and across Domain

Groups	Model	χ^2	df	<i>p</i>	CFI	RMSEA	SRMR	Δ CFI	Δ RMSEA	Δ SRMR
Country	Italy (n = 767)	1529.09	453	.001	.928	.056	.065	–	–	–
	US/Germany (n =163/595)	554.07/842.93	339/339	.001/.001	.923/.927	.063/.050	.060/.055	–	–	–
	Configural invariance	1361.17/1529.09	680/680	.001/.001	.932/.931	.060/.056	.058/.065	–	–	–
	Metric invariance	1430.09/1645.32	700/699	.001/.001	.928/.927	.061/.054	.064/.061	.004	.000	.006/.005
	Scalar invariance	1510.00/1880.30	728/727	.001/.001	.922/.918	.062/.057	.068/.064	.009	.003	.004/.003
Grade	Second-graders (n = 370)	886.65/977.00	453/452	.001/.001	.925/.911	.051/.057	.061/.059	–	–	–
	Fourth-graders (n = 397)	1230.96/1078.20	453/453	.001/.001	.915/.931	.066/.059	.079/.058	–	–	–
	Configural invariance	2142.02/2039.80	907/906	.001/.001	.918/.918	.060/.057	.072/.059	–	–	–
	Metric invariance	2138.82/2131.44	929/929	.001/.001	.919/.921	.058/.059	.072/.062	.001/.003	.002/.002	.000/.003
	Scalar invariance	2301.74/2212.42	961/961	.001/.001	.911/.917	.060/.059	.098/.067	.008/.004	.002/.000	.005/.026
Gender	Boys (n = 353)	864.08/1017.41	451/452	.001/.001	.945/.925	.051/.059	.065/.068	–	–	–
	Girls (n = 414)	954.07/1654.24	452/453	.001/.001	.938/.902	.052/.081	.064/.060	–	–	–
	Configural invariance	2176.36/1967.02	907/906	.001/.001	.917/.923	.060/.056	.070/.058	–	–	–
	Metric invariance	2144.97/1983.16	927/929	.001/.001	.922/.924	.059/.055	.069/.059	.005/.001	.001/.001	.001/.001
	Scalar invariance	2197.31/2054.73	961/961	.001/.001	.921/.921	.058/.055	.072/.061	.001/.003	.001/.000	.003/.002
Domain	Native language (n = 386)	1211.51	453	.001	.906	.068	.072	–	–	–
	Mathematics (n = 376)	1009.65	453	.001	.920	.057	.058	–	–	–
	Configural invariance	2202.86	907	.001	.913	.061	.066	–	–	–
	Metric invariance	2219.79	929	.001	.914	.060	.067	.001	.001	.001
	Scalar invariance	2281.94	961	.001	.912	.060	.070	.002	.000	.003

Note. df = degrees of freedom; CFI = comparative fit index; RMSEA = root-mean-square error of approximation; SRMR = standardized root mean square residual; Δ CFI/RMSEA/SRMR = change in CFI/RMSEA/SRMR.

Figure 1. Factorial structure of the hierarchical model, in which the nine first-order factors are the three emotions (enjoyment, boredom, and anxiety) evaluated in the three settings (class, homework, test), and the second-order factors are the three emotions. We did not report the exact number of items per factor (see Table 1 for the exact number of items). E = enjoyment, B = boredom, A = anxiety.

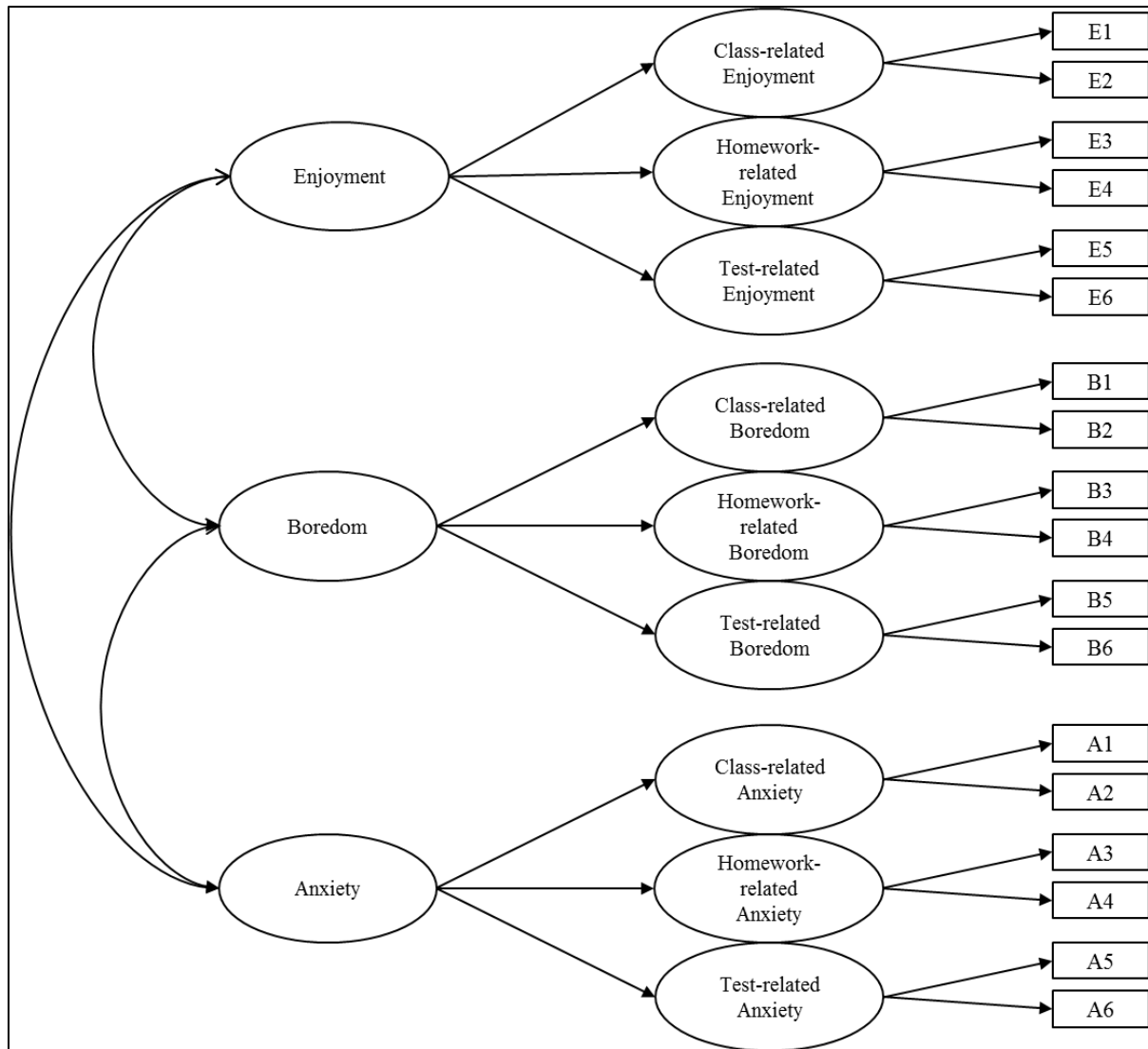


Figure 2. Path analyses for relations of achievement emotions with achievement: overall (Figure 2a) and separated by domain (native language/mathematics) and setting (Figure 2b). We reported explained variances next to each dependent variable.

$^{\circ}p < 0.10$, $*p < .05$, $**p < .01$, $***p < .001$.

Figure 2a

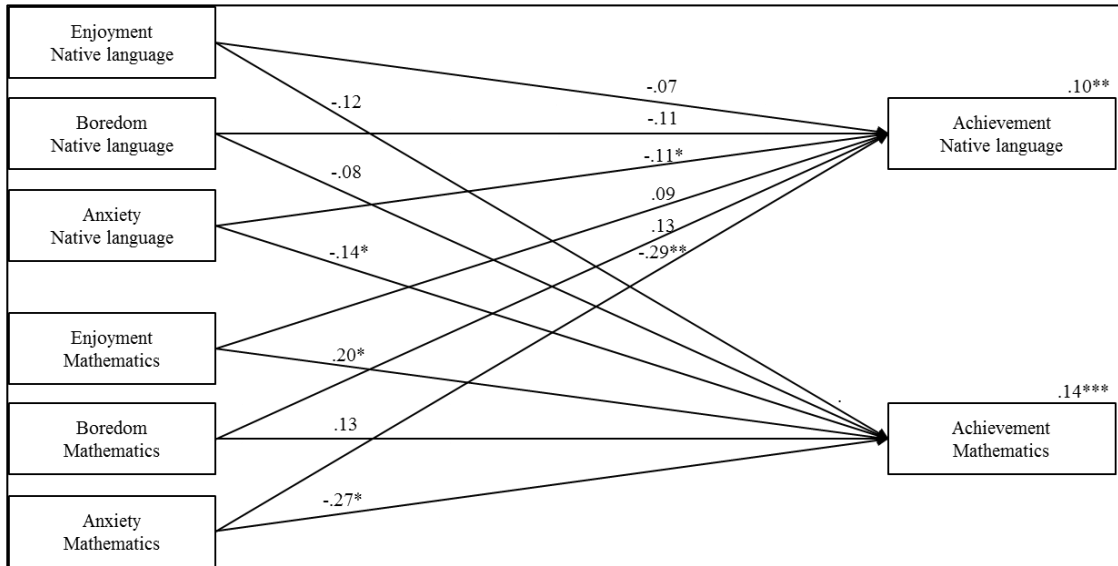


Figure 2b

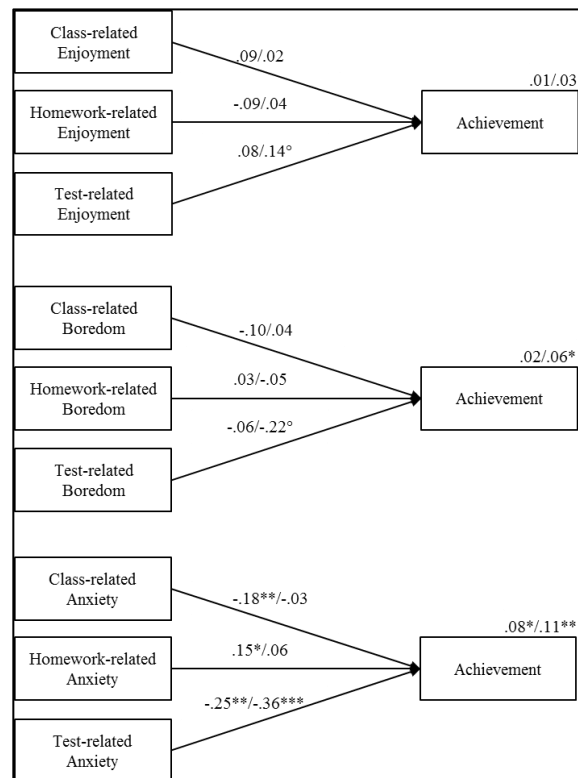


Figure 3. Means of enjoyment, boredom, and anxiety by grade (second-graders, fourth-graders), gender (boys, girls), and domains (native language, mathematics). The bars are standard errors.

