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ZfE

SCHWERPUNKT

Who's bored in school?

The relationships between academic boredom, general cognitive ability, and intrinsic value in math and language classes in primary school children

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Abstract In the literature, general cognitive ability has been discussed as one critical factor that shapes students' boredom. In this study, we investigated the relationship between academic boredom and general cognitive ability in primary school students while also considering intrinsic value. We analyzed data from $N = 2849$ third graders from 188 German classrooms. We used structural equation models with latent variables to test for whether general cognitive ability and interest showed linear as well as nonlinear relationships with students' boredom. The results showed that the association between general cognitive ability and boredom was almost negligible after controlling for students' achievement as well as gender, age, and family background. However, both the linear and quadratic terms for students' intrinsic value were statistically significant, indicating that students with low and students with high interest reported more boredom in class than students with average interest. The findings are discussed in light of expectations based on control-value theory and the domain specificity and situational specificity of control and value appraisals.

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Keywords Academic boredom · General cognitive ability · Intrinsic value · Primary school

Wer langweilt sich in der Schule?

Die Beziehungen zwischen akademischer Langeweile, allgemeiner kognitiver Fähigkeit und intrinsischem Wert im Mathematik- und Deutschunterricht bei Grundschulkindern

Zusammenfassung In der Literatur wird die allgemeine kognitive Fähigkeit als ein entscheidender Faktor für die Entstehung von Langeweile bei Schülerinnen und Schülern diskutiert. In dieser Studie untersuchten wir den Zusammenhang zwischen akademischer Langeweile und allgemeiner kognitiver Fähigkeit bei Grundschulkindern unter Berücksichtigung des intrinsischen Werts eines Fachs. Wir analysierten Daten von N = 2849 Drittklässlern aus 188 deutschen Klassenzimmern. Mit Hilfe von Strukturgleichungsmodellen mit latenten Variablen testeten wir sowohl lineare als auch nichtlineare Zusammenhänge zwischen allgemeiner kognitiver Fähigkeit und intrinsischem Wert und der Langeweile von Schülerinnen und Schülern. Die Ergebnisse zeigten, dass der Zusammenhang zwischen allgemeiner kognitiver Fähigkeit und Langeweile nach Kontrolle der Schülerleistungen sowie des Geschlechts, des Alters und des familiären Hintergrunds nahezu vernachlässigbar war. Allerdings waren sowohl der lineare als auch der quadratische Term des intrinsischen Werts der Schülerinnen und Schüler statistisch signifikant, was darauf hindeutet, dass Schülerinnen und Schüler mit geringem und hohem Interesse für ein Fach mehr Langeweile im Unterricht berichteten als Schülerinnen und Schüler mit durchschnittlichem Interesse, kontrolliert für alle anderen Variablen. Die Ergebnisse werden vor dem Hintergrund der Kontroll-Wert-Theorie und der Domänenspezifität und Situationsabhängigkeit von Kontroll- und Wertbeurteilungen diskutiert.

Schlüsselwörter Langeweile · Allgemeine kognitive Fähigkeit · Intrinsischer Wert · Grundschule

1 Introduction

Studies have shown that students are bored between one third and up to nearly half of the time they spend in school lessons (Goetz et al. 2007a; Larson and Richards 1991; Nett et al. 2011; Schneider 2005). These numbers are alarming when considering the possible negative consequences of academic boredom for school achievement as well as intrinsic motivation (e.g., Pekrun et al. 2010; for a meta-analysis, see Tze et al. 2016).

In the literature, general cognitive ability has been discussed as a critical factor for students to be considered at risk of experiencing high levels of academic boredom (Plucker and McIntire 1996). There are findings indicating that both students with low intelligence and those with high intelligence are more bored in school than their peers of average intelligence (Feldhusen and Kroll 1991; Fogelman 1976; Kunkel et al. 1992). According to the control-value theory of achievement emotions, general cognitive ability is considered an important predictor of control appraisals, which may in turn cause boredom (Pekrun 2006; Pekrun et al. 2002). At the same time, the theory postulates that the subjective value (e.g., interest) of a task is another important antecedent of boredom. However, so far, the role of value appraisals in relation to intelligence and academic boredom has been neglected. Furthermore, most research on academic boredom has addressed secondary school-aged children or undergraduate students, even though academic boredom has also been claimed to be highly relevant at the very beginning of formal schooling (see Lohrmann 2022). A better understanding of the antecedents of boredom and their interplay, especially in primary school children, is therefore greatly warranted.

In this study, we investigated the relationship between academic boredom in mathematics and German classes and students' intelligence—as one important factor linked to control appraisals—as well as the relationship between boredom and subject-specific value in a sample of 2849 third-grade students in primary school. The aim was to better understand the association between intelligence and subject-specific boredom while considering students' subject-specific value and controlling for their academic achievement, age, gender, and family background. Therefore, we tested linear as well as nonlinear relationships between these variables. To the best of our knowledge, this is the first study to investigate the relationship between academic boredom and intelligence while considering value appraisals in such a young sample.

2 Theoretical background

Academic boredom is considered to be a negative, deactivating emotion that is focused on certain academic activities, such as listening to the teacher or studying for a test (Pekrun et al. 2002, 2014). Academic boredom can occur for different reasons and signals mental or behavioral escape from unpleasant situations in the classroom, such as through mind-wandering (Goetz et al. 2018, 2019; Pekrun 2018; Pekrun et al. 2002; Titz 2001). This is a reason for concern, as a learner who is mind-wandering is not cognitively engaged in the learning activities (Pekrun et al. 2010). Learning may thus become superficial as the learning material is not actively elaborated. Consequently, new ideas may become detached from the learner's prior knowledge and may subsequently be poorly understood.

Students often experience boredom in learning activities that are either too difficult or too easy (too low or too high control) and that they consider uninteresting or of little relevance to them (low intrinsic value, Pekrun et al. 2010). Empirical studies on boredom have often focused on over- and underchallenge as reasons for academic boredom (Acee et al. 2010; Conrad 1997; Daschmann et al. 2011; Goetz and Frenzel 2006; Krannich et al. 2019; Larson and Richards 1991; Titz 2001; Tze et al. 2016). Overchallenge is defined as a learning situation in which the demands are too high in comparison with the student's abilities, and underchallenge—the opposite situation—is defined as a learning situation in which the demands are too low compared with the student's abilities (Pekrun et al. 2002). Boredom is seen as a consequence of a mismatch between individuals' mental capabilities and the cognitive demands of the learning environment, with both understimulation and overstimulation expected to result in higher boredom (e.g., Krannich et al. 2019; Westgate and Wilson 2018). Furthermore, learners may find it harder to motivate themselves to do their homework, yielding a downward spiral of negative emotions and low achievement (Pekrun et al. 2014; Tze et al. 2016).

Almost all of the studies that have empirically investigated the relationship between academic achievement and boredom to date have found a negative association between boredom and achievement (Ahmed 2013; Frenzel et al. 2007; Goetz et al. 2007b; Goetz et al. 2010; Larson and Richards 1991; Pekrun and Perry 2014; Putwain et al. 2018; Raccanello et al. 2019). The meta-analysis by Tze et al. (2016) revealed an average effect size of $r=0.24$. This means that high boredom goes along with low achievement and vice versa. Even though achievement is usually conceptualized as an outcome rather than a predictor of boredom, achievement and boredom may affect each other reciprocally in a feedback loop over time through students' control and value appraisals (see Fig. 1 in Pekrun et al. 2007, 2014, 2017; Putwain et al. 2018). This means that achievement and boredom can become self-sustaining processes over time (Pekrun et al. 2017).

2.1 Academic boredom and general cognitive ability

General cognitive ability has been considered an important predictor of academic boredom. Students who are overchallenged are frequently mentioned as being at risk of experiencing high boredom (e.g., Bieg et al. 2013; Pekrun et al. 2010) because they perceive that their control over their schoolwork is too *low* in relation to their cognitive abilities. Roseman (1975), for example, found that middle school students with IQ scores below 95 reported that they were "frequently bored." This finding was supported by Fogelman (1976), who found that 11-year-olds who reported that they were "often bored" had lower cognitive abilities than their peers who reported being bored less often. Thus, it can be assumed that children with low levels of cognitive ability are more bored than children with average to high cognitive ability levels.

In addition, students who are underchallenged are also considered at risk of experiencing boredom in school. This notion resonates well with the common assumption in giftedness research and practice that academically gifted children are more bored in regular classes than children with average abilities because gifted children tend to be underchallenged (Csikszentmihalyi 1975; Krannich et al. 2019; Malmberg and Little 2007). This *boredom hypothesis* is highly accepted in practice and often mentioned as a justification for ability grouping (Feldhusen and Kroll 1991; Preckel et al. 2010). However, although theoretically sound, empirical studies that tested this claim have produced ambiguous findings. There are findings that have supported the assumption that gifted students are bored in school (Feldhusen and Kroll 1985; Galbraith 1985; Kunkel et al. 1992) and that they indeed report being underchallenged (Gallagher et al. 1997; Kanevsky and Keighley 2003). Most recently, Feuchter and Preckel (2022) found evidence that ability grouping reduces academic boredom in gifted secondary school students. In other studies, however, gifted individuals were not found to be more bored than their peers but instead experienced teaching as more repetitive (Feldhusen and Kroll 1991; Freeman 1991; Preckel et al. 2010). Goetz et al. (2007a) investigated the emotional profiles of Grade 6 students depending on their cognitive abilities. They found no differences in mean boredom levels between low, average, and high ability students. Gjesme (1977) even found that students with high problem-solving skills were less bored than students with average or low problem-solving skills.

2.2 Control-value theory

General cognitive ability has been used as an indicator of general over- (low general cognitive ability) and underchallenge (high general cognitive ability) in school, which should in turn result in higher levels of academic boredom. However, according to the control-value theory of achievement emotions (Pekrun et al. 2002, 2007; Pekrun 2006; Pekrun and Perry 2014), students' cognitive resources for accomplishing a task are not sufficient for explaining achievement emotions such as boredom. This is because control-value theory assumes that achievement emotions result from perceived control, subjective values, and the interaction between these appraisals in a certain domain. The theory is built on the assumption that appraisals of *control* (high vs. low) and *value* (positive vs. negative) are proximal factors for academic emotions that determine which emotion is elicited. Control appraisals comprise students' perceived control over achievement activities and their outcomes, for example, subjective control over learning and the outcome of earning high grades. According to the theory, control appraisals that are too high or too low may cause academic boredom (but see Pekrun et al. 2010, 2014; Shao et al. 2020). Value appraisals, on the other hand, comprise the intrinsic values that students assign to a task and its outcome. Specifically, it is assumed that boredom arises when there is a mismatch between individuals' valued goals and their current activities. Control and value appraisals are in turn influenced by more distal factors, such as individual student characteristics. These characteristics include cognitive ability, self-efficacy, self-concept, and achievement goals (Goetz et al. 2006a; Marsh and Craven 2002; Marsh and O'Mara 2008; Wigfield and Eccles 2000). In addition to individual characteristics, control and value beliefs are also shaped by the environment (Pekrun et al. 2007).

Control-value theory can be used to explain links between general cognitive ability and academic boredom. General cognitive ability has been linked to very low and high perceived control (Brunner et al. 2008), which in turn affects academic boredom. For instance, students exhibiting low general cognitive ability perceive themselves as being less able to solve tasks in class (and thus perceive low control) and report higher levels of academic boredom compared with students with average-level general cognitive skills. Whereas there is research on the link between general cognitive ability and academic boredom (see above), to date, value appraisals have been neglected in this line of research. However, previous research has shown that students who value a task for intrinsic (e.g., interest) or extrinsic reasons (e.g., extrinsic rewards) are less likely to feel bored (e.g., Putwain et al. 2018; Raccanello et al. 2022).

Whereas learners' cognitive abilities refer to a general ability to master a task, value appraisals typically refer to domain-specific perceptions. Previous research has revealed that achievement emotions need to be considered domain-specific constructs (Goetz et al. 2006b, c, 2010; Goetz et al. 2007b). Students' achievement emotions differ to a greater extent between learning domains as they grow older and move from primary to secondary school. For instance, findings by Goetz et al. (2006b) revealed that the interrelationships among students' emotional experiences in six subjects were generally weak, indicating that boredom must be investigated in a specific learning domain. For this reason, previous research has used domain-specific values, such as learners' interest in mathematics or German language arts, to predict subject-specific boredom (e.g., Shao et al. 2020; Tanaka and Murayama 2014).

Control-value theory predicts that achievement emotions arise from a combination of what learners are able to do and what they want to do. However, research has not addressed the combination of students' general cognitive ability and their domain-specific value appraisals. Instead, it has addressed the associations between academic boredom and students' cognitive abilities and values in separate streams of research. Thus, investigating the intrinsic value of a certain subject in combination with general cognitive ability—as an antecedent of perceived control—should provide more detailed insights into the relationship between intelligence and academic boredom.

Thereby, not only should the linear associations of general cognitive ability and value appraisals with boredom be investigated, but also the interaction between these variables, which might also be relevant in predicting academic boredom (see, e.g., Bieg et al. 2013; Putwain et al. 2018). In addition, quadratic associations between students' cognitive abilities and boredom as well as quadratic associations between value and boredom should be examined. As reviewed above, both low and high general cognitive ability have been associated with academic boredom (Feldhusen and Kroll 1985; Roseman 1975), but a potential quadratic relationship between these variables has not yet been empirically tested (for control appraisals, see Pekrun et al. 2010, 2014). Quadratic relationships for students' interest have also not been tested empirically. However, a quadratic relationship is also plausible here because activities might lead to academic boredom due to a learner's lower interest in the activity or because the activity does not fully satiate the learner's high interest. The latter might be particularly true for the school context in which tasks can hardly be restructured by the learner to better fit individual goals.

2.3 Academic boredom in primary school

Children's first years in school are commonly characterized by high levels of joy for classes and academic tasks. This trend might suggest that academic boredom is not a problem in primary school. However, almost one fourth of primary school students already report being bored in school (Schneider 2005; Valtin et al. 2005), and low-achieving students report being bored more often than high-achieving students (Sparfeldt et al. 2009; Valtin et al. 2010). Cross-sectional results have provided evidence of an increase in boredom over time (Raccanello et al. 2019). Furthermore, initial longitudinal results have shown a slight increase in boredom between Grades 2 and 5 (Vierhaus et al. 2016), thus suggesting that this topic becomes more relevant as students progress in school (for an increase in boredom in Grades 5 to 8, see Feuchter and Preckel 2022). Boredom can also be experienced during children's first years in school. Reasons for academic boredom in primary school that have frequently been mentioned in the literature are a lack of fit between students' capabilities and the demands of the class (Lohrmann 2008a, b; Sparfeldt et al. 2009), characteristics of the teaching, such as monotony in teaching methods or inappropriate classroom management (for an overview, see Lohrmann 2008a, b; Lohrmann et al. 2011).

Although the beginning of formal schooling is enormously important for students' emotional experience of learning and schooling, empirical research that has investigated academic boredom, its causes, and its consequences during primary school is still scarce (Lohrmann 2022). The assumptions of control-value theory concerning the importance of control and value appraisals for academic boredom should be as relevant in primary school as previously demonstrated for older samples (see, e.g., Putwain et al. 2021; Raccanello et al. 2022). Already in primary-school-aged children, boredom has been found to be negatively associated with intrinsic value and control appraisals (Putwain et al. 2021) as well as academic achievement (Raccanello et al. 2019). However, no significant interaction between control and value appraisals has been found in primary school children (for math, Putwain et al. 2021), and quadratic relationships have not been investigated so far. It is important to understand which variables are associated with boredom already at this young age in order to prevent the negative consequences associated with boredom later on, such as low achievement, low motivation (see Tze et al. 2016), or greater intentions to drop out (see Respondek et al. 2017). Furthermore, Wigfield et al. (1997) demonstrated that value and control beliefs become more stable during primary school; thus, it is important to investigate boredom and its antecedents as early in students' school careers as possible.[1]

2.4 Present study

The available evidence suggests that boredom is highly relevant for primary school students, but this question has not been systematically investigated so far (Goetz et al. 2019; Lohrmann 2022). A serious weakness of existing studies is that the majority have addressed boredom in secondary education and have often considered achievement or intelligence in isolation. These shortcomings raise the question of how intelligence, intrinsic value, and academic achievement are related to each other in predicting academic boredom in primary-school-aged children.

In this study, we investigated the relationship between domain-specific academic boredom (German and math classes) and general cognitive ability as well as subject-specific intrinsic value in German primary school children. In German primary schools, class composition is more heterogeneous compared with secondary school because there is no tracking or ability grouping in primary school. Therefore, we decided to include several student characteristics as background variables. We used students' achievement, gender, family background, and age as control variables.

To the best of our knowledge, this is the first study to consider intelligence and intrinsic value simultaneously in order to shed light on the relationship between

[1] In Grade 3, students are typically able to read questionnaires without any problems.

intelligence and academic boredom in primary school children. Furthermore, we modeled not only linear but also quadratic relationships. According to control-value theory, boredom develops in situations in which control is either too low or too high and value is assumed to be low or negative (Pekrun 2006). Thus, a U-shaped relationship between general cognitive ability and boredom can be expected, depending on the perceived value of the subject. Because this is the first study to investigate these relationships, we included quadratic terms not only for intelligence but also for value. We additionally included interaction terms in our analysis so that we could further explore possible nonlinear relationships between boredom and intelligence as well as value.

3 Method

3.1 Participants

The current sample came from a larger investigation of primary school students in the state of Baden-Württemberg, Germany, in the 2012/2013 school year. Primary schools were selected randomly from a sample of schools that had previously nominated students to participate in the Hector Children's Academy Program (HCAP), an extracurricular enrichment program for gifted primary school students in Baden-Württemberg. The schools were spread across Baden-Württemberg (http://www.hector-kinderakademie.de/,Lde/Startseite/Kinderakademien), a state with an area of 13,804 sq mi and approximately 2500 elementary schools. Children from (approximately) 2300 schools could have been nominated to attend the HCAP at one of 48 local sites (i.e., at one of the 48 elementary schools that served as "hosts" for a Hector Children's Academy). It was important to ensure that the sample comprised schools that had nominated children for the HCAP, as the primary research interest was to investigate the program's nomination procedure (Rothenbusch et al. 2016) and effectiveness (Golle et al. 2018).[2] Previously published studies used subsamples from the current data set, and further details concerning the study design and data collection can be found in the respective articles.

For this investigation, five primary schools in the catchment area of every local site were randomly selected from the schools that had previously nominated students for the HCAP. In total, 240 schools were asked to participate in this study, representing approximately 10% of all possible schools that had nominated children for the HCAP. One hundred eleven schools agreed to participate in the study. Two classes of third graders were included from each school. For schools with more than two third-grade classes, two classes were randomly selected. Thirty-five schools had only one third-grade class; hence, they contributed only one class. In two schools, three

[2] Because some children attended the enrichment program, which might have affected their perception of boredom in school, we ran all analyses with and without the subsample of students who attended the HCAP. The findings did not differ substantially. Therefore, we decided to present the finding for the complete sample in the main text and the results for the sample without the children who attended the HCAP in the Appendix.

third-grade classes were included for practical reasons. A total of 3741 students from 188 classes at 111 schools were asked to participate in this study. The minimum number of students in a class was nine, and the maximum number of students was 27. Written informed consent was provided by 2849 parents. Thus, there was a participation rate of 76.16%. The total sample for the current study comprised $N = 2849$ students (49.69% girls; $M_{age} = 8.63$ years, $SD = 5.64$ months) from 188 classes.[3]

3.2 Procedure

Participation was completely voluntary, and privacy issues were handled carefully. In particular, the assessments were administered by a professional test administrator so that only completely anonymized data were submitted to the researchers. The participants filled out standardized tests and questionnaires during regular school hours at the beginning of the 2012/2013 school year (Grade 3). Testing lasted 1.5 hr on each of two test days. The parents provided written informed consent for their children and were asked to fill out a questionnaire as well.

3.3 Measures

In the 2012/2013 school year, several measures were assessed (for an overview, see Golle et al. 2018). We chose the following measures, which were relevant to investigating our research question: demographic variables (age, gender, socioeconomic status), subject-specific boredom (mathematics, German), school achievement (school grades in mathematics, German), subject-specific intrinsic value (mathematics, German), as well as fluid and crystallized intelligence measures. Means, standard deviations, missing values rates, and internal consistency estimates for all variables are listed in Table 1. Correlations between all variables are presented in Table 2.

3.3.1 Demographics

The schools provided information concerning students' gender (0 = *boy* 1 = *girl*) and age. Furthermore, the socioeconomic status of a child's family was measured with the

[3] To evaluate the representativeness of our sample, we compared our sample with official statistics from the state education ministry regarding mean class size, proportion of girls, share of students who are foreign citizens, and share of students with immigration backgrounds. No statistics from the ministry to assess the socioeconomic background of our sample were available. Therefore, we used PISA 2012 data (https://www.pisa.tum.de/fileadmin/w00bgi/www/Berichtsbaende_und_Zusammenfassungungen/PISA_2012_Skalenhandbuch_final-openaccess.pdf). In the 2012/2013 school year, the average number of students in a class was 19.53. In Grade 3, 48.79% of students were girls, 8.78% were citizens of foreign countries, and 20.01% had immigration backgrounds (personal correspondence). In PISA 2012, a total of 2792 parents reported an average HISEI of 53.44 ($SD = 19.90$, Min = 11.74, Max = 88.96). In our sample, the average number of students in a class (with written informed consent) was 15.15. A total of 49.69% of the students were girls, 6.14% were foreign citizens, and 33.87% had immigration backgrounds. Parent reports of socioeconomic background (HISEI) revealed a mean score of 53.48 ($SD = 14.63$, Min = 23, Max = 90). Overall, our sample did not exactly mirror the population of third graders in Baden-Württemberg, but there were no extreme deviations from the population.

Table 1 Descriptive Statistics

Variable	*M*	*SD*	Cronbach's α	Missing rate Total	Missing rate Design
Age (y; m)	8.63	5.64	–	.03	.00
Female	0.50	–	–	.03	.00
HISEI	52.62	14.76	–	.32	.00
Fluid Intelligence	99.86	10.03	.79/.78	.08	.05
Crystallized Intelligence	99.93	10.02	.75/.74	.07	.05
Composite Score Intelligence	100.00	8.64	–	.09	.05
Grade Mathematics	3.89	0.87	–	.07	.00
Grade German	3.80	0.86	–	.07	.00
Value Mathematics	3.89	1.23	.92	.56	.54
Value German	3.80	1.19	.89	.56	.54
Boredom Mathematics	1.74	0.91	.93	.57	.56
Boredom German	1.93	0.94	.91	.57	.56

$N = 2833$. Means and standard deviations were estimated in Mplus 8 (Muthén and Muthén 1998–2017). To handle missing values, we used full information maximum likelihood estimation (FIML)

Table 2 Bivariate Correlations Between All Considered Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Age	–	–	–	–	–	–	–	–	–
(2) Female	–.067*	–	–	–	–	–	–	–	–
(3) HISEI	–.199**	.013	–	–	–	–	–	–	–
(4) Composite Score Intelligence	–.084**	–.045*	.272**	–	–	–	–	–	–
(5) Grade Mathematics	–.194**	–.097**	.275**	.504**	–	–	–	–	–
(6) Grade German	–.262**	.152**	.287**	.493**	.627**	–	–	–	–
(7) Value Mathematics	–.038	–.141**	.009	.089*	.223**	.073*	–	–	–
(8) Value German	–.038	.227**	.003	.051	–.001	.176**	.221**	–	–
(9) Boredom Mathematics	.035	–.036	–.106*	–.135**	–.201**	–.170**	–.598**	–.153*	–
(10) Boredom German	.072*	–.230**	–.061*	–.119**	–.049	–.192**	–.124*	–.573**	.447**

$N = 2833$. Correlations were estimated in Mplus 8 (Muthén and Muthén 1998–2017). To handle missing values, we used full information maximum likelihood estimation (FIML)
$^{**}p < .001$, $^{*}p < .050$

Highest International Socio-Economic Index of Occupational Status (HISEI) with respect to the parents' current occupations as reported by the parents. The HISEI represents the score of the parent with the highest International Socio-Economic Index of Occupational Status (ISEI, Ganzeboom et al. 1992), calculated on the basis of the International Standard Classification of Occupations 1988 (Ganzeboom and Treiman 1996).

3.3.2 *Subject-specific achievement*

Starting at the end of Grade 2, students received grades in mathematics and German in their end-of-year report card. In German elementary schools, a 6-point grading scale is used to assess students' performance. School grades range from 1 = *very good* to 6 = *insufficient* (1 = *very good*, 2 = *good*, 3 = *satisfactory*, 4 = *sufficient*, 5 = *deficient*, 6 = *insufficient*). The grades of the students in the current sample ranged from 1 to 5, with a mean of 2.10 ($SD = 0.87$) in mathematics and a mean of 2.20 ($SD = 0.86$) in German. We recoded the variables so that low values indicated low achievement and high values indicated high achievement for easier interpretation of the results. Table 1 shows the means and standard deviations of the recoded variables.

3.3.3 *General cognitive ability*

Students' intelligence was measured with an adapted version of the *Berlin Test of Fluid and Crystallized Intelligence for Grades 8–10* (BEFKI; Wilhelm et al. 2014). The test had been adapted to serve as an appropriate measure of intelligence for third and fourth graders (Schroeders et al. 2016). Two versions of the test were administered, each consisting of 34 items for fluid intelligence (gf) and 42 items for crystallized intelligence (gc). The means for gf were 15.86, $SD = 5.46$ (Version A) and 15.55, $SD = 5.19$ (Version B). The means for gc were 19.10, $SD = 5.87$ (Version A) and 18.57, SD = 5.70 (Version B). Fluid and crystallized intelligence scores were moderately positively correlated with each other ($r = 0.49$, $p < 0.001$). The Cronbach's alpha values for fluid intelligence were $\alpha = 0.79$ (Version A) and $\alpha = 0.78$ (Version B). The Cronbach's alpha values for crystallized intelligence were $\alpha = 0.75$ (Version A) and $\alpha = 0.74$ (Version B). We analyzed our data using both measures of intelligence as well as a composite score of these measures. To calculate the composite score, we averaged the z-standardized scores for fluid and crystallized intelligence. The correlations between each intelligence scale and the composite score were both $r = .86$. Below, we only report the findings from the models that included the composite intelligence score because the pattern of findings did not change between the different models. For the results of all models, see the Appendix.

3.3.4 *Subject-specific intrinsic value*

Students' subject-specific intrinsic value was measured via three items each concerning (a) mathematics and (b) German. Parallel item wordings were used to assess intrinsic value in mathematics and German. The items were "I like math," "I am looking forward to math class," and "I am interested in math." The response scale ranged from 1 (*false*) to 5 (*true*). We used structural equation modeling to model intrinsic value as well as boredom in mathematics and German as correlated latent factors with their respective indicator variables. The analysis was done in Mplus 8 (Muthén and Muthén 1998–2017). To account for the nonnormal distributions of the variables, we used robust standard errors (MLR). The multilevel structure of the data (students nested within classes) was taken into account by using cluster-robust standard errors at the class level (McNeish et al. 2017). To handle missing values, we used full information maximum likelihood estimation (FIML). All other variables were included as auxiliary variables. We assumed strong measurement invariance across subjects for both intrinsic value and boredom. The model had an excellent fit to the data ($\chi^2 = 259.69$, $df = 141$, $p < .001$; CFI = .989; TLI = .986; RMSEA = .017; SRMR = .023, AIC = 95,089.18, SBIC = 95,335.87).[4] Intrinsic value in mathematics and German were moderately correlated ($r = .22$). The composite reliabilities were acceptable: .92 for intrinsic value in mathematics and .89 for intrinsic value in German.

3.3.5 Subject-specific boredom

Students were administered four items for each subject, which they answered on a 4-point Likert scale (1 = *do not agree at all* to 4 = *fully agree*). The items were derived from Goetz et al. (2007a). An example item is "I get bored in mathematics classes." Parallel item wordings were used to assess boredom in German. As reported above, we modeled boredom and intrinsic value as correlated latent factors. The model had excellent fit to the data. Boredom in mathematics and German were moderately positively correlated ($r = .45$). The composite reliabilities were excellent: .93 for boredom in mathematics and .91 for boredom in German.

3.4 Analysis

All analyses were conducted in Mplus 8 (Muthén and Muthén 1998–2017). To account for the nonnormal distributions of the variables, we used robust standard errors (MLR). The multilevel structure of the data (students nested within classes) was taken into account by using cluster-robust standard errors at the class level (McNeish et al. 2017). To handle missing values, we used full information maximum likelihood estimation (FIML). In all models, because variables that were not part of a respective regression model were included as auxiliary variables, the sample size was $N = 2833$.

We estimated boredom in mathematics and boredom in German in the same model. All nonbinary variables were z-standardized prior to the analyses. We entered the predictors into the regression model in a stepwise procedure. First, we ran our analyses with intelligence only and then included all control variables (gender, age, HISEI, academic achievement). Second, we included subject-specific intrinsic value. Third, we included the interaction between value and intelligence. Fourth, we added

[4] To evaluate model fit, we applied commonly used fit indices for latent variable models, namely, the Satorra-Bentler-scaled chi-square test (Satorra and Bentler 2010), comparative fit index (CFI), Tucker Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR; Hu and Bentler 1998). According to Hu and Bentler (1999), a good fit is indicated by CFI/TLI ≥ .95 and RMSEA/SRMR ≤ .05.

the quadratic terms for value and intelligence as well as the interactions between value and intelligence. All significant findings were based on an alpha level of 0.05.

4 Results

4.1 Boredom in mathematics

The regression results for boredom in mathematics are presented in Table 3. Only the linear association between intelligence and academic boredom reached statistical significance, $\beta = -0.12$, $p < .001$, when no control variables were considered. The higher students' intelligence, the lower their reported level of academic boredom. However, this association disappeared when we controlled for academic achievement, gender, family background, and age.

Across all models, intrinsic value was the only variable that was consistently associated with academic boredom (M4 to M6). The linear terms, all $\beta s > |-0.54|$, $ps \leq .001$, as well as the quadratic term, $\beta = 0.25$, $p < .001$, were statistically significant when all the other variables in the model were controlled for. This result indicates that below-average as well as high levels of intrinsic value were associated with higher levels of boredom compared with average levels of intrinsic value across different levels of intelligence when gender, age, HISEI, and academic achievement were controlled for. Furthermore, in contrast to our expectations, intelligence—as an antecedent of subjective control—was not significant in any of the models that included value (all $\beta s \leq |-0.06|$, $ps \geq .184$). Moreover, the interactions between value and intelligence were not significant (all $\beta s \leq |0.03|$, $ps \geq .301$). In line with previous research, school achievement was negatively associated with boredom in the model without intrinsic value, $\beta = -0.17$, $p < .001$ (M3). There were also differences between girls and boys, $\beta s = -0.23$, $p < .001$, indicating that girls were less bored in mathematics (but only in the models with linear value and intelligence terms). Family background was also associated with academic boredom, $\beta s = -0.07$, $p \leq .028$. Students from families with high socioeconomic status reported being less bored than students from families with low socioeconomic status (but only in the models with linear value and intelligence terms).

4.2 Boredom in German

The regression results for boredom in German are presented in Table 4. The pattern was similar to the findings for boredom in mathematics. Only the linear association between intelligence and academic boredom reached statistical significance, $\beta = -0.11$, $p < .001$, when no control variables were considered. The higher the students' intelligence, the lower their reported level of academic boredom. However, this association disappeared when we controlled for academic achievement, gender, family background, and age.

Across the models, intrinsic value was consistently associated with academic boredom (G4 to G6). The linear terms, all $\beta s > |-0.51|$, $ps \leq .001$, as well as the quadratic term, $\beta = 0.19$, $p < .001$, reached statistical significance when all the other

Table 3 Regression Analyses of Boredom in Mathematics

	Model M1				**Model M2**				**Model M3**			
	β	*SE*	*z*	*p-value*	*β*	*SE*	*z*	*p-value*	*β*	*SE*	*z*	*p-value*
Intelligence	–0.12	0.02	–5.35	<.001	–0.12	0.02	–5.14	<.001	–0.03	0.03	–0.93	.355
Intelligence^2	–	–	–	–	0.01	0.02	0.57	.569	0.01	0.02	0.34	.736
VM	–	–	–	–	–	–	–	–	–	–	–	–
Intelligence*VM	–	–	–	–	–	–	–	–	–	–	–	–
Intelligence^2*VM	–	–	–	–	–	–	–	–	–	–	–	–
VM^2	–	–	–	–	–	–	–	–	–	–	–	–
Intelligence*VM^2	–	–	–	–	–	–	–	–	–	–	–	–
Age	–	–	–	–	–	–	–	–	–0.02	0.03	–0.60	.551
Female	–	–	–	–	–	–	–	–	–0.10	0.06	–1.71	.087
HISEI	–	–	–	–	–	–	–	–	–0.04	0.03	–1.39	.164
Grade Mathematics	–	–	–	–	–	–	–	–	–0.17	0.04	–4.26	<.001
R^2	.018	0.01	2.64	.008	.019	0.01	2.44	.015	.049	0.01	3.61	<.001

Table 3 (Continued)

	Model M4				Model M5				Model M6			
	β	*SE*	*z*	*p-value*	*β*	*SE*	*z*	*p-value*	*β*	*SE*	*z*	*p-value*
Intelligence	–0.04	0.04	–1.08	.279	–0.04	0.04	–1.09	.277	–0.06	0.04	–1.33	.184
Intelligence^2	–	–	–	–	–	–	–	–	0.01	0.03	0.23	.819
VM	–0.54	0.06	–9.26	<.001	–0.54	0.06	–9.41	<.001	–0.56	0.05	–10.82	<.001
Intelligence*VM	–	–	–	–	0.03	0.04	0.71	.476	0.00	0.04	0.04	.970
Intelligence^2*VM	–	–	–	–	–	–	–	–	0.03	0.03	1.03	.301
VM^2	–	–	–	–	–	–	–	–	0.25	0.03	8.36	<.001
Intelligence*VM^2	–	–	–	–	–	–	–	–	0.02	0.02	0.92	.359
Age	–0.02	0.03	–0.85	.394	–0.02	0.03	–0.84	.400	–0.02	0.02	–1.08	.279
Female	–0.23	0.06	–3.66	<.001	–0.23	0.06	–3.64	<.001	–0.10	0.06	–1.70	.089
HISEI	–0.07	0.03	–2.20	.028	–0.07	0.03	–2.25	.024	–0.04	0.03	–1.35	.176
Grade Mathematics	–0.04	0.04	–1.04	.296	–0.04	0.04	–1.03	.304	–0.02	0.04	–0.65	.514
R^2	.388	0.07	5.72	<.001	.384	0.07	5.71	<.001	.529	0.08	6.33	<.001

N = 2833. Standardized coefficients are presented and can be interpreted as effect sizes
VM Value of Mathematics

Table 4 Regression Analyses of Boredom in German

	Model G1				**Model G2**				**Model G3**			
	β	*SE*	*z*	*p-value*	*β*	*SE*	*z*	*p-value*	*β*	*SE*	*z*	*p-value*
Intelligence	–0.11	0.03	–3.74	<.001	–0.12	0.03	–3.72	<.001	–0.07	0.04	–1.64	.101
Intelligence^2	–	–	–	–	0.03	0.02	1.20	.231	0.02	0.02	0.64	.521
VG	–	–	–	–	–	–	–	–	–	–	–	–
Intelligence*VG	–	–	–	–	–	–	–	–	–	–	–	–
Intelligence^2*VG	–	–	–	–	–	–	–	–	–	–	–	–
VG^2	–	–	–	–	–	–	–	–	–	–	–	–
Intelligence*VG^2	–	–	–	–	–	–	–	–	–	–	–	–
Age	–	–	–	–	–	–	–	–	0.02	0.03	0.66	.507
Female	–	–	–	–	–	–	–	–	–0.40	0.06	–6.30	<.001
HISEI	–	–	–	–	–	–	–	–	0.00	0.03	–0.03	.976
Grade German	–	–	–	–	–	–	–	–	–0.11	0.04	–2.74	.006
R^2	.014	0.01	1.88	.061	.016	0.01	1.75	.080	.082	0.02	4.84	<.001

Table 4 (Continued)

	Model G4				**Model G5**				**Model G6**			
	β	*SE*	*z*	*p-value*	*β*	*SE*	*z*	*p-value*	*β*	*SE*	*z*	*p-value*
Intelligence	–0.07	0.04	–1.82	.069	–0.07	0.04	–1.80	.071	–0.06	0.05	–1.35	.177
Intelligence^2	–	–	–	–	–	–	–	–	0.02	0.02	0.95	.342
VG	–0.51	0.06	–8.14	<.001	–0.51	0.06	–8.12	<.001	–0.52	0.05	–9.66	<.001
Intelligence*VG	–	–	–	–	–0.02	0.03	–0.62	.535	–0.04	0.04	–0.86	.393
Intelligence^2*VG	–	–	–	–	–	–	–	–	0.01	0.03	0.45	.653
VG^2	–	–	–	–	–	–	–	–	0.19	0.03	6.05	<.001
Intelligence*VG^2	–	–	–	–	–	–	–	–	0.00	0.02	0.17	.868
Age	0.02	0.03	0.84	.398	0.02	0.03	0.87	.385	0.03	0.03	1.01	.314
Female	–0.19	0.06	–3.06	.002	–0.19	0.06	–3.01	.003	–0.11	0.06	–1.94	.052
HISEI	–0.02	0.03	–0.73	.467	–0.02	0.03	–0.68	.496	0.00	0.03	0.11	.909
Grade German	–0.03	0.04	–0.68	.498	–0.03	0.04	–0.71	.478	–0.03	0.04	–0.70	.486
R^2	.351	0.07	4.99	<.001	.355	0.07	5.06	<.001	.413	0.08	5.07	<.001

N = 2833. Standardized coefficients are presented and can be interpreted as effect sizes
VG Value of German

variables in the model were controlled for. Again, this result indicates that below-average as well as high levels of intrinsic value were associated with higher levels of boredom compared with average levels of intrinsic value across different levels of intelligence and when gender, age, HISEI, and academic achievement were controlled for. The association between intelligence and boredom was not significant in any of the models that included intrinsic value (all $\beta s \leq |-0.07|$, $ps \geq .069$). The interactions between value and intelligence were also not significant (all $\beta s \leq |-0.04|$, $ps \geq .393$). School achievement was negatively associated with boredom in the model without intrinsic value, $\beta = -0.11$, $p = .006$. There were also significant differences between girls and boys, $\beta s \geq |-0.19|$, $p < .003$, such that girls were less bored in German across all models except the one that included the quadratic terms. Family background was not significantly associated with academic boredom, $\beta s \leq |-0.02|$, $ps \geq 0.467$.

5 Discussion

The goal of the current study was to investigate how subject-specific academic boredom is associated with general cognitive ability and intrinsic value while controlling for academic achievement, gender, age, and socioeconomic status in a sample of German primary school students. According to control-value theory as well as empirical findings, we assumed that student characteristics, such as intelligence, intrinsic value, achievement, and gender, would be associated with academic boredom (e.g., Pekrun et al. 2007, 2010). We were particularly interested in testing linear and nonlinear relationships between academic boredom, intelligence, and intrinsic value, as previous empirical evidence had revealed rather ambiguous findings on this issue (e.g., Feldhusen and Kroll 1985; Gjesme 1977; Goetz et al. 2007a).

The study's findings showed that the association between intelligence and academic boredom was significant only when intelligence was the only predictor of academic boredom. Thus, the higher the students' intelligence, the lower their academic boredom. Moreover, we found no evidence of a quadratic relationship between boredom and intelligence. These findings are not in line with expectations from previous research that low *and* high levels of intelligence are associated with higher levels of boredom compared with average levels of intelligence (e.g., Feldhusen and Kroll 1991; Fogelman 1976; Galbraith et al. 1985). There are several possible reasons for the contradictory findings. On the one hand, previous studies investigated associations between intelligence and boredom or achievement and boredom in isolation from each other as well as from other variables (for an overview, see Lohrmann 2008a, b). On the other hand, general cognitive ability might not explain any additional variation in academic boredom over and above subject-specific intrinsic value as well as subject-specific academic achievement (see also Pekrun et al. 2017). Thus, findings from studies considering only measures of general cognitive ability and academic boredom should be interpreted with caution. Highly intelligent students are not necessarily more bored in school than their peers (in contrast to the boredom hypothesis, see also Preckel et al. 2010); value appraisals should also be taken into account in order to understand the relationship between academic boredom and intelligence.

Overall, we found evidence of a significant negative association between intrinsic value and academic boredom in the respective school subject. This finding is in line with theoretical assumptions as well as previous research indicating that value appraisals are negatively associated with academic boredom (e.g., Goetz et al. 2010; Kögler and Göllner 2018; Pekrun and Perry 2014). Students with higher levels of interest reported lower levels of boredom than their less interested peers. These associations were found for boredom in mathematics as well as in German class and provide further empirical support that students' interest is critically important for students' boredom in primary school (see Putwain et al. 2018; Raccanello et al. 2022).

In addition, the study also revealed quadratic effects of students' interest on boredom in both subjects. That is, students with very high or low levels of interest reported higher levels of boredom than students with a moderate level of interest. So far, a quadratic relationship with academic boredom has been reported only for control appraisals (e.g., Struk et al. 2021; but also see Pekrun et al. 2010) and perceived task difficulty (Westgate and Wilson 2018). Even though quadratic effects of intrinsic value on boredom had not been previously reported, it is important to bear in mind that the detection of complex, nonlinear relationships is not very common in research on achievement emotions in general (for a brief discussion, see, e.g., Putwain et al. 2021). The studies by Goetz et al. (2010) and Bieg et al. (2013) are notable exceptions. Furthermore, the surprising finding that students with higher levels of interest have a higher likelihood of becoming bored might be explained by theories of interest. Specifically, primary school students who are very interested in a subject's content might have a particular need to fulfill their need to learn in a more autonomous way (for an overview of intrinsic motivation and autonomy-supportive teaching, see Reeve and Cheon 2021) and might feel limited by the typical classroom instructional setting, which might in turn be related to more negative achievement emotions. In line with this idea, a very recent study by Flunger et al. (2022) showed that students with high baseline intrinsic motivation profited more from lessons in which teachers used autonomy-supportive strategies than students with low baseline intrinsic motivation did.

These findings show that domain-specific interest is an important predictor of academic boredom, whereas students' intelligence is not systematically related to students' boredom. This pattern of results stresses the domain specificity of academic boredom (see e.g., Goetz et al. 2006).

The findings for academic achievement and gender were partly in line with the literature. The overall association between achievement and academic boredom was negative (see also Tze et al. 2016). The higher students' school grades, the lower their academic boredom in the respective subject. This pattern of results is the same as it has been reported for secondary school students (e.g., Ahmed 2013) and undergraduate students (e.g., Artino and Jones 2012). However, the association between achievement and academic boredom became insignificant in the models considering intrinsic value. Academic achievement did not explain any variation in academic boredom over and above subject-specific value. Furthermore, girls were less bored than boys in German classes, the correlation between gender and academic boredom was moderate and significantly different from zero ($r = -0.23$), and the regression coefficients were significant in all models except the one that included all linear as well as quadratic terms (although the *p*-value was .052). For mathematics classes, the pattern of results was different (for gender differences that depend on the subject, see also Raccanello et al. 2019). The correlation between gender and boredom in mathematics did not differ significantly from zero, but girls reported being less bored than boys in the models in which intrinsic value was controlled for and in which the quadratic terms were not included. To sum up, girls were less bored than boys in mathematics and German classes (Daschmann et al. 2011; Frenzel et al. 2007; Goetz et al. 2008; Pekrun et al. 2007), even though they reported similar levels of intrinsic value and comparable family backgrounds, age, and cognitive abilities.

5.1 Limitations

It is important to bear several limitations in mind when interpreting the findings. First, we used only a cross-sectional study design to test for the assumed associations between the considered variables. Even though the design allowed us to investigate the interplay between intrinsic value, general cognitive ability, and boredom by using a latent variable analysis, we were not able to draw any conclusions about the directions of the associations between these variables.

Second, despite using a domain-specific measure of value to predict boredom, we did not additionally measure control over a certain academic activity. We used general cognitive ability—an antecedent of control appraisals. It has been linked to very low and high perceived control (Brunner et al. 2008) and has been used to operationalize students' capabilities in relation to the demands of the environment (i.e., level of challenge), resulting in being over- or underchallenged in terms of achievement emotions. However, we did not explicitly ask students whether they felt bored due to overchallenge or underchallenge (see Feuchter and Preckel 2022; Krannich et al. 2019; Preckel et al. 2010).

Third, the internal consistencies of the intelligence measures were low (Borkenau et al. 2011; Fisseni 1997), especially compared with other measures of general cognitive ability, such as the CFT 20-R or IST 2000-R. Therefore, we decided to use the composite score of both fluid and crystallized measures of intelligence in our final analyses.

Fourth, academic boredom is defined as an academic emotion related to a specific academic task (see Pekrun 2006). In this study, we considered only situation-unspecific measures of boredom and intrinsic value. However, to gain deeper insight into the development of boredom in a specific academic setting, situation-specific information must be considered (see, e.g., Kögler and Göllner 2018). We also did not assess instructional quality (see Lohrmann et al. 2011; Smedsrud et al. 2022) or any other information regarding a specific learning situation. Thus, we did not identify the environment for determining whether students' goals, perceived control, or abilities are exhibiting a misfit with a particular academic task.

Therefore, future studies should make use of longitudinal designs (a) to separate students' general cognitive ability, control and value appraisals, academic achievement, feelings of over- and underchallenge, and academic boredom over time and (b) to test for interactions between control and value appraisals and their quadratic relationships in specific academic situations. For example, a study combining general with domain- and situation-specific measures of abilities and value and direct measures of control appraisals will help to further explore the antecedents of students' boredom. Furthermore, studies with primary-school-aged children are needed. The lack of empirical evidence for this age group makes it difficult to compare our findings with those from other studies.

5.2 Conclusion

Although general cognitive ability has been discussed as one critical factor that shapes students' boredom (e.g., Plucker and McIntire 1996), students' intelligence was not systematically related to students' boredom in this study after academic achievement and intrinsic value were controlled for. However, subject-specific intrinsic value is a meaningful predictor of boredom in German and mathematics classes among primary school students. In addition to first-order effects of interest, quadratic effects of interest on boredom were found in both subjects. Interestingly, students with high levels of interest reported lower levels of boredom than moderately interested students. Thus, the ways in which students with high interest levels prefer to learn might be less compatible with ordinary instructional settings in classrooms (see, e.g., Flunger et al. 2022). As feedback loops may solidify students' beliefs and make them more prone to certain emotional experiences over time (see e.g., Pekrun et al. 2002), it is worthwhile to consider academic boredom and its antecedents beginning at this young age.

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