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Subject and time specificity of students' cognitive, behavioral, and emotional engagement at school

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ABSTRACT

This study aimed to better understand the extent of subject specificity in students' engagement across three engagement subdimensions (emotional, behavioral, and cognitive) and over time. We assessed students' engagement in two school subjects (math and German as the language of instruction) at the beginning and end of the first year of upper secondary school ($N = 1324$). The results of our longitudinal bifactorial modeling showed that the subdimensions had both subject-specific and subject-independent aspects. Emotional engagement was the most subject-specific, and behavioral engagement was the most subject-independent. Subject specificity was higher for math than German and increased over the school year. Furthermore, students' self-concept, self-efficacy beliefs, interest, and grades were more related to subject-specific than subject-independent aspects, especially in math. Our results suggest that it is essential to consider the increasing subject specificity and the variability in subject specificity across dimensions when developing strategies to strengthen students' engagement.

Educational Relevance: Subject-specific engagement is one of the critical factors influencing students' learning and achievement. However, little is known about how subject-specific and how general students' engagement is when they engage in a particular subject. Our study showed that subject specificity is quite high and increases over time. Our results thus encourage teachers to foster students' subject-specific engagement over and above their general tendency to engage at school – and to increase such efforts as students grow older. Given the varying subject specificity of different engagement dimensions, teachers should know that emotional engagement may tip the scales in subject-specific interventions. Separating subject-specific and subject-independent aspects of engagement might support schools in designing more targeted interventions to tackle students' disengagement. It can help to develop strategies that will lead students to become more engaged in individual subjects.

Engagement is considered a central element of understanding students' learning at school (Sinatra, Heddy, & Lombardi, 2015; Wang & Degol, 2014). Students who are more engaged learn better, perform better, and are less likely to drop out of school (e.g., Archambault et al., 2022; Ben-Eliyahu, Moore, Dorph, & Schunn, 2018; Engels, Spilt, Denies, & Verschueren, 2021; Fredricks, Blumenfeld, & Paris, 2004; Fredricks, Hofkens, Wang, Mortenson, & Scott, 2017; Hascher & Hagenauer, 2010; Li & Lerner, 2011; Sinatra et al., 2015; Wang, Fredricks, Ye, Hofkens, & Linn, 2016; Wang, Fredricks, Ye, Hofkens, & Linn, 2019; Weich, Lüthi, Templer, & Stalder, 2023).

Researchers commonly agree that engagement is multi-dimensional and context-dependent. Regarding its multidimensionality, researchers emphasize that engagement consists of subtypes (e.g., cognitive, emotional, and behavioral engagement) that reflect distinctive engagement dimensions (Fredricks et al., 2004; Fredricks, Reschly, & Christenson, 2019; Lee, 2021; Skinner & Pitzer, 2012). Regarding contextuality, it is proposed that students' learning experiences shape their engagement in specific environments, such as certain subjects or instructional settings (Appleton, Christenson, & Furlong, 2008; Christenson, Reschly, & Wylie, 2012; Engels et al., 2021; Flunger, Hollmann, Hornstra, & Murayama, 2022; Heemskerk & Malmberg, 2020; Kelly & Zhang, 2016; Skinner & Pitzer, 2012). However, in most studies of subject-related engagement, researchers only investigated students' engagement in one subject, making it difficult to examine whether and

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to what extent students' engagement results from their engagement in general or reflects engagement specific to one subject and their subject-specific experiences.

In the present study, we investigated students' cognitive, behavioral, and emotional engagement in two school subjects (i.e., German and math) after transitioning to upper secondary school. In particular, we examined whether and to what extent students' engagement exhibited subject-specific and subject-independent aspects. By assessing students' engagement at two measurement points, the study allowed us to test for potential changes in the specificity of students' engagement during the first year of upper secondary school. Finally, we investigated how students' subject-specific and subject-independent engagement were associated with learning outcomes regarding their academic self-concept, self-efficacy beliefs, interest, and achievement in German and math.

1.1. Behavioral, cognitive, and emotional dimensions of Students' engagement

Students' engagement is described as the quality of students' involvement in academic tasks or activities (Hofkens & Ruzek, 2019; Reschly & Christenson, 2012); it is assumed to consist of interrelated but distinct dimensions. In recent years, Fredricks et al.'s (2004) conceptualizations have become increasingly popular and stimulating in engagement research (e.g., Ben-Eliyahu et al., 2018; Hofkens & Ruzek, 2019; Reeve, Cheon, & Jang, 2020; Sinatra et al., 2015; Wang et al., 2016). These authors propose at least three engagement dimensions: behavioral, cognitive, and emotional engagement. Some authors suggest agentic engagement (Reeve et al., 2020; Sinatra et al., 2015) or social engagement (Wang et al., 2016) as an additional fourth dimension. However, behavioral, cognitive, and emotional engagement are the most prominent dimensions on which there is the broadest consensus.

Behavioral engagement refers to students' observable actions to stay on task and exert effort. It comprises attendance, attentiveness, compliance, concentration, focus, persistence, hard work, and initiative in academic tasks (Finn & Zimmer, 2012; Skinner, 2016). Cognitive engagement refers to students' mental investment and intellectual effort to optimize their thinking processes. It includes deep and sophisticated learning processes (e.g., elaboration), problem-solving, critical thinking, and self-regulatory learning strategies (Hofkens & Ruzek, 2019; Reeve et al., 2020; Skinner & Pitzer, 2012). Finally, emotional engagement refers to the affective connection between students and learning objects. It is based on the positive (e.g., enjoyment) or negative (e.g., boredom, anxiety) emotions that arise during learning experiences (Reschly & Christenson, 2012; Sinatra et al., 2015).

Various studies have shown that engagement is a strong predictor of important motivational outcomes such as self-efficacy beliefs, academic self-concepts, and interest (Appleton et al., 2008; Martin et al., 2022; Reeve et al., 2020; Skinner & Pitzer, 2012) as well as academic achievement (Engels et al., 2021; Fredricks et al., 2004; Galla et al., 2014; Li & Lerner, 2011; Wang et al., 2016; Weich et al., 2023; Weich & Stalder, 2019). Numerous empirical studies showed that students who are confident in their abilities and feel efficacious about learning a particular subject use effective learning strategies and work hard, even in the face of failure (Eccles & Wang, 2012; Galla et al., 2014; Lent, 2005; Lent & Brown, 2019; Rosenzweig, Wigfield, & Eccles, 2019). By succeeding, they become prouder of their abilities and continue to enjoy learning (Schunk & Mullen, 2012). Students also work harder, are more deeply involved cognitively, and enjoy learning more when they are interested in the subject (Hulleman & Harackiewicz, 2009; Lent, 2005; Patall, Vasquez, Steingut, Trimble, & Pituch, 2016; Reeve et al., 2020; Renninger & Hidi, 2015; Rosenzweig et al., 2019). The resulting higher achievement is, in turn, related to higher engagement, leading to a mutually reinforcing reciprocal learning process (Lent & Brown, 2019; Weich & Stalder, 2019).

1.2. Subject specificity of Students' engagement

Previous studies have shown that individual students fundamentally differ in their school engagement. It has been suggested that this could be due to their disposition to be generally more or less engaged in school subjects (Finn & Zimmer, 2012; Fredricks et al., 2004). However, most existing studies make it difficult to determine whether an individual's engagement results from their general (i.e., subject-independent) engagement in school or their specific engagement in a specific subject. Although many studies ask students about their engagement in a specific subject (e.g., Archambault et al., 2022; Fredricks et al., 2017; Kelly & Zhang, 2016; Weich & Stalder, 2019), they focus on one subject or, when investigating more than one, examine them separately. Other researchers considered variation in students' engagement within one subject over time or across learning activities (Ben-Eliyahu et al., 2018; Flunger et al., 2022; Heemskerk & Malmberg, 2020; Patall et al., 2016). For instance, Heemskerk and Malmberg (2020) showed that the within-student within-lesson engagement varied considerably, suggesting that engagement is susceptible to students' experiences in specific learning situations. Flunger et al. (2022) found intraindividual variations in students' academic efforts across multiple lessons for one subject.

In the present study, we tested the subject specificity of students' engagement by considering two school subjects. Generally, it is plausible that students' engagement in a particular subject is composed of subject-specific and subject-independent aspects. We know from motivational studies that domain-specific constructs such as academic self-concepts and values contain a substantial amount of subject-specific aspects, which might vary considerably between school subjects, and have some subject-independent (general) aspects, which are less bound to specific situations, tasks, or school subjects (Bong, 2001; Gogol, Brunner, Martin, Preckel, & Goetz, 2017; Marsh, 1990). Because motivational constructs and engagement are interrelated (Appleton et al., 2008; Cabrera, Bae, & DeBusk-Lane, 2023; Eccles & Wigfield, 2002; Lent & Brown, 2019; Putwain, Nicholson, Pekrun, Becker, & Symes, 2019; Skinner & Pitzer, 2012; Wang et al., 2019), it is likely that both aspects also come into play for students' engagement in a particular subject.

A study by Pöysä et al. (2018) empirically supports the idea of subject-independent and subject-specific aspects of engagement. Using an experience-sampling method, they observed subject-related variations in students' engagement. To do so, they applied a concept of engagement consisting of emotional engagement, behavioral/cognitive engagement, and disaffection. Their analyses indicated that students generally differed in their engagement regardless of whether they reported their engagement in math, English, academic, or nonacademic subjects. This finding thus supports the idea that engagement is independent of specific subjects and comprises subject-independent aspects. Moreover, their results revealed engagement differences among individual students between nonacademic and academic subjects and between math and English, which supports the assumption of subject-specific aspects of engagement.

Even though Pöysä et al.'s (2018) study provided valuable insights into the general nature of engagement and its subject specificity, it is limited in two important aspects. First, the researchers combine the cognitive and behavioral engagement dimensions into one dimension, making determining subject specificity for each dimension impossible. In line with their findings, one might assume a quite similar level of subject specificity in students' emotional and behavioral/cognitive engagement. Second, Pöysä et al. (2018) did not investigate whether and to what extent students' engagement was related to their grades, interest, self-efficacy, or competence beliefs in the respective subjects. The importance of subject-independent and subject-specific engagement for students' learning remains open.

1.3. Time dependence of subject specificity in Students' engagement

Students' engagement can change over time, complicating the answer to the subject specificity of students' engagement. In fact, there is a long tradition of examining motivational constructs over time (see Scherrer & Preckel, 2019). In most such studies, researchers investigated mean-level changes, revealing that students become more disengaged throughout secondary education (e.g., Van de Gaer et al., 2009; Wang & Eccles, 2012).

Other perspectives on temporal variations in students' engagement have been explored less intensively. Most importantly for this study, it is unclear whether the extent of subject specificity in students' engagement might change over time. In fact, the subject specificity of engagement can be expected to become more pronounced due to an age-related differentiation process. Specifically, several studies have shown that students differentiate more in terms of their interests, emotions, academic self-concept, self-efficacy expectations, and task-value beliefs as they get older (Bong, 2001; Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Krapp, 2002). Denissen, Zarrett, and Eccles (2007) demonstrated that students were mainly interested in domains where they felt competent, which led to a clustering of subject-specific interests, academic concepts, and achievement over time. The differentiation process also aligns with career-related goals and choices at school. For example, students can decide to put particular effort into math because they believe they will be more successful in math than in other subjects and can use it better than other subjects in their future careers (Lent & Brown, 2019; Möller & Marsh, 2013). As students gain more academic experience, they become more attuned to each subject area's requirements and opportunities; this, in turn, should contribute to finer differentiation between subjects (Bong, 2001). In the first year of upper secondary school, such differentiation processes should be particularly intense since many things change for young people. These changes are rooted in both their biological development and their socialization in the new school environment. Students are in the midst of puberty when they enter upper secondary school. Their mood, motivation, and behavior change significantly due to puberty hormones (Balzer, Duke, Hawke, & Steinbeck, 2015; Duke, Balzer, & Steinbeck, 2014; Schultheiss & Wirth, 2018). These inner forces may contribute to differentiation processes regarding students' needs, preferences, attitudes and interests. Additionally, the transition to upper secondary school is a very new experience that goes hand in hand with more personal responsibility for learning, increased opportunities for individual subject specialization, and the pressure to meet higher academic demands. The differentiation of students' interest and their academic engagement can be expected to be a close consequence of these fundamental changes in students' learning environment during the initial year of upper secondary school.

1.4. The present study

Addressing the research gaps outlined above, we investigated variations in students' engagement in two school subjects (German and math). We assessed students' engagement at the beginning and end of the first year after transitioning to upper secondary school. Four research questions guided our research; first, we investigated whether students' engagement exhibited a three-dimensional structure consisting of behavioral, cognitive, and emotional engagement. In the past, researchers have examined the three-dimensional structure for math (Wang et al., 2016), while the study of engagement structure and operationalization in language subjects needs further clarification (Hiver, Al-Hoorie, Vitta, & Wu, 2021). Second, we explored to what extent students' engagement exhibited subject-specific and subject-independent aspects. Corresponding to the hierarchical nature of motivational constructs, we expected engagement to have subject-specific and subject-independent aspects. Third, we examined whether and how the subject specificity in students' engagement changed over one year by comparing the beginning and end of the first school year at students' new school. We assumed that subject specificity would increase during the school year. Finally, we investigated the association between students' subject-specific and subject-independent engagement and German- and math-related self-concepts, self-efficacy beliefs, interests, and grades at the beginning and end of the school year. We expected to find associations between subject-specific engagement and all these motivational outcomes, with the associations more pronounced than for students' subject-independent engagement.

2. Method

2.1. Participants

We used data from the panel survey, "Pathways Through Upper Secondary General School: Subject-Specific (Dis)Engagement and How It Contributes to Student Success," which examined students' engagement in math, German (as the language of instruction), and French as a second language (Author et al., 2022) in baccalaureate schools ("gymnasiale Maturitätsschulen") in the canton of Berne in Switzerland. The survey aimed to gain further insight into the structure of subject-specific engagement, the development of engagement over time, the reasons for (dis)engagement, and possible effects on educational success. In Berne canton, only 20 % of students enroll in baccalaureate schools, with the rest opting for a vocational program. Upper secondary education (baccalaureate schools) begins in ninth grade and lasts four years. Math, German, and French are compulsory subjects for all students.

Students from 73 classes in 13 public and private upper secondary schools completed self-report online questionnaires at the beginning (T1, 2017) and end of Grade 9 (T2, 2018), followed by three additional surveys at the end of Grades 10, 11, and 12 (year of graduation). We analyzed data from the panel's waves 1 and 2 ($N = 1324$; 42 % male, 58 % female). The participants were 14.6 years old at the first measurement point (T1), and most (92 %) were born in Switzerland.

2.2. Procedure

The ethics commission of the Bern University of Teacher Education approved the study before data collection. It confirmed that the procedures aligned with ethical standards for research with human subjects.

In spring 2017, we approached the principals of 13 upper secondary education schools and invited them to participate in the panel study with their ninth-grade students. These principals then decided whether and how many classes would participate. In the fall of the 2017–2018 school year, we invited all ninth-grade students in 73 classes to participate in a longitudinal study on engagement in various school subjects. With assistance from the school principals, we distributed letters describing the study to the students and parents. The research staff then administered computer-based surveys to the students. We only included students who had given informed consent, and only one student refused to participate in the study. The surveys were administered during regular lessons and lasted 60 min. During the survey administration, research staff members were available to answer students' questions and assist with potential technical problems.

2.3. Measures

2.3.1. Students' engagement

We assessed emotional, cognitive, and behavioral engagement in math and German based on a shortened and slightly adapted version of the Math and Science Engagement Scale (Wang et al., 2016). We used 11 items and added one from Miserandino (1996) for behavioral engagement. The cognitive engagement scales encompassed five items that assessed self-regulated and deep learning strategies in math and German (e.g., "In [math/German], I try to understand my mistakes when I get something wrong"). The behavioral engagement scales encompassed

four items that assessed student involvement and investment in math and German (e.g., "In [math/German] class, I do other things when I am supposed to be paying attention"). The emotional engagement scales encompassed three items that assessed students' feelings about math and German (e.g., "I look forward to [math/German] class"). Respondents answered all items on a 5-point rating scale, indicating how closely the item describes them (1 = *not at all like me*, 5 = *very much like me*). The internal consistency for behavioral engagement was $\omega_{T1/T2} = 0.82/0.81$ for math and $\omega_{T1/T2} = 0.78/0.78$ for German. For emotional engagement, it was $\omega_{T1/T2} = 0.88/0.87$ for math and $\omega_{T1/T2} = 0.80/0.78$ for German. For cognitive engagement, it was $\omega_{T1/T2} = 0.72/0.79$ for math and $\omega_{T1/T2} = 0.62/0.68$ for German. The Cronbach's alpha values were very similar to the reported McDonald's Omega values (see Table 1 for the descriptive statistics on the item level).

2.3.2. Students' academic self-concept, self-efficacy, interest, and grades

We assessed students' academic self-concept, self-efficacy, interest, and grades in math and German at both measurement points. We measured academic self-concept with three items (Rost, Sparfeldt, & Schilling, 2007) referring to students' evaluations of their competence and skills in the respective subject areas (e.g., "I am one of the good students in [math/German]"). Students responded to all items on a 5-point Likert scale (1 = *disagree completely*, 5 = *agree completely*). The scale's internal consistency was $\alpha_{T1/T2} = 0.90/0.91$ for math and $\alpha_{T1/T2} = 0.77/0.78$ for German. We assessed self-efficacy in math and German with three items from Schwarzer and Jerusalem (1995) adapted by Moser, Ramseier, Keller, and Huber (1997) that describe students' beliefs about to what extent they can successfully handle difficult situations based on their competence (e.g., "In [math/German], I can solve even difficult problems"). Again, students responded to these items on a 5-point Likert scale (1 = *disagree completely*, 5 = *agree completely*). The internal consistency was $\alpha_{T1/T2} = 0.89/0.90$ for math and $\alpha_{T1/T2} = 0.75/0.77$ for German. We measured interest with a single item that asked students to indicate how interested they were in the subject ("[Math/German] interests me…") on a scale of 1 (*not at all*) to 5 (*very much*). Finally, we obtained students' grades in the respective subjects (ninth-grade mid-year and end-of-year grades) from the school administration (see Table 2 for descriptive statistics on the item level).

2.4. Data analytic strategy

2.4.1. Factor structure

To answer our first research question, we examined whether students' engagement reflected distinct engagement factors in each of the two subjects and the two measurement points. We used a confirmatory factor analysis with twelve factors in total and evaluated its fit to the data.

2.4.2. Bifactor models

We examined a bifactor model to address our second and third research questions, separating subject-specific from subject-independent factors (Cucina & Byle, 2017; Reise, 2012) for each engagement dimension and the two measurement points. Specifically, for each engagement dimension at a given time point, we modeled one subject-independent factor that directly influenced all observed measurement indicators of the dimension across the two subjects. Furthermore, we modeled math-specific and German-specific dimensional factors that directly influenced the observed measurement indicators of the given subject (see Fig. 1). For reasons of model identification, correlations between specific engagement factors within one engagement dimension were constrained to be zero. Correlations between specific engagement factors and the subject-independent engagement factors were constrained to be zero. We allowed residual covariances between the same items to covary within each time point. In addition, we allowed subject-independent dimensional factors to covary at each time point as well as over time. We also allowed subject-specific factors to covary across engagement dimensions and time.

Finally, we included students' academic self-concept, self-efficacy, interest, and grades at both measurement points to address our final research question. We examined their associations with students' subject-independent and subject-specific engagement at each measurement point.

2.4.3. Measurement invariance models

To ensure that the subject-independent and subject-specific factors of the three engagement dimensions are comparable across time, we also tested for their temporal invariance. We did so by including multiple sets of parameter constraints over time and determining whether including the model constraints resulted in a poorer model fit. Specifically, we compared a series of models with consecutive model constraints, including a model with factor loadings equal over time (metric invariance), a model with item intercepts equal over time (scalar invariance), and a model with equal residual variances over time (strict invariance).

Finally, we applied a chi-square difference test to determine whether differences in the amount of subject specificity changed over time. To do this, we compared a constrained and a freely estimated model with respect to the latent variances of both subject-independent and subject-specific engagement factors. If the fit decreased with constraint, a significant change could be assumed.

2.4.4. Model fit

We evaluated the models' appropriateness using the χ^2-test, the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). We considered CFI values above 0.90, RMSEA values below 0.05, and SRMR values below 0.08, indicative of a satisfactory to good model fit (Hu & Bentler, 1995). To compare the fit of nested models using methods other than a χ^2-difference test, we followed the recommendations of Chen (2007) and Cheung and Rensvold (2002), who posit that a decrease of <0.01 in the fit of the more parsimonious model on incremental fit indices such as the CFI should be treated as support for that model. In addition, an increase of <0.015 in the RMSEA and an increase in SRMR of <0.03 for loading invariance and 0.01 for invariance of intercepts and residual variances indicate support for the less constrained model.

We conducted all analyses with the Mplus 8.6 software (Muthén & Muthén, 2017). Robust maximum likelihood estimation (MLR) for continuous data was used to obtain reliable standard errors and tests of fit in the case of non-normally distributed data. We selected that method over alternative modeling procedures (e.g., IRT models) because student responses were coded on a frequency scale with at least five response categories and category thresholds for each of the items used were distributed symmetrically around the mean (Rhemtulla, Brosseau-Liard, & Savalei, 2012). Given the data's nested structure, with students clustered within classes, we used cluster-robust standard errors (McNeish, Stapleton, & Silverman, 2017) to avoid underestimating the standard errors (see, e.g., Muthen & Satorra, 1995). We performed statistical significance testing at the 0.05 level (two-tailed).

Table 1
Item-descriptive statistics and psychometric properties for engagement subscales in math and German (T1/T2).

Scale	Math			German		
	M	*SD*	Internal Consistency	*M*	*SD*	Internal Consistency
Cognitive engagement						
In [subject], I try to connect what I am learning to things I have learned before.	3.98/ 3.65	0.86/ 0.95		3.76/ 3.53	0.85/ 0.89	
In [subject], I try to understand my mistakes when I get something wrong.	4.32/ 4.09	0.74/ 0.88		4.19/ 3.93	0.72/ 0.83	
In [subject], I would instead be told the answer than have to do the work. (rev)	3.74/ 3.51	1.07/ 1.06		3.64/ 3.56	0.98/ 0.99	
In [subject], I only study the easy parts when work is hard. (rev)	3.69/ 3.33	0.96/ 1.06		3.73/ 3.56	0.89/ 0.92	
In [subject], I reflect difficult tasks only superficially. (rev)	3.74/ 3.48	0.88/ 0.97		3.61/ 3.52	0.81/ 0.86	
Scale	3.89/ 3.60	0.62/ 0.72		3.79/ 3.62	0.54/ 0.59	
Cronbach's alpha			0.71/0.78			0.62/0.67
McDonald's Omega (latent)			0.72/0.79			0.62/0.68
Behavioral engagement						
In [subject] class, I stay focused.	4.08/ 3.67	0.80/ 0.95		3.93/ 3.74	0.73/ 0.85	
In [subject], I complete my home-work on time.	4.17/ 3.50	0.91/ 1.25		4.26/ 3.80	0.84/ 1.07	
In [subject] class, I do other things when I am supposed to pay attention. (rev)	4.07/ 3.50	0.81/ 1.06		3.95/ 3.53	0.82/ 1.02	
In [subject] class, I listen care-fully.	4.09/ 3.74	0.75/ 0.93		3.97/ 3.77	0.73/ 0.87	
Scale	4.10/ 3.60	0.67/ 0.83		4.03/ 3.71	0.57/ 0.72	
Cronbach's alpha			0.81/0.81			0.77/0.78
McDonald's Omega (latent)			0.82/0.81			0.78/0.78
Emotional engagement						
I look forward to [subject] class.	3.41/ 3.11	1.10/ 1.20		3.20/ 3.08	0.96/ 1.04	
I enjoy learning new things about [subject].	3.69/ 3.45	1.05/ 1.11		3.51/ 3.36	0.89/ 0.93	
I feel good when I am in [subject] class.	3.78/ 3.66	1.01/ 1.07		3.81/ 3.84	0.88/ 0.90	
Scale	3.63/ 3.41	1.0/1.07		3.50/ 3.43	0.79/ 0.80	
Cronbach's alpha			0.87/0.86			0.79/0.76
McDonald's Omega (latent)			0.88/0.87			0.80/0.78/

Note. To assess subject-specific constructs, we replaced "[subject]" with "math" or "German." Students responded to the items on a 5-point rating scale: *disagree completely, disagree, partially disagree—partially agree, agree, agree completely*.

3. Results

3.1. Behavioral, cognitive, and emotional engagement in math and German

Our first question addressed the factor structure of students' subject-specific engagement. We hypothesized that engagement in math and German reflects three separable factors. A model assuming three factors for each subject and at each measurement point resulted in an acceptable model fit ($\chi^2 = 2875.198$, $df = 973$, $p < .001$, RMSEA = 0.04, SRMR = 0.05, CFI = 0.92, TLI = 0.91)[2 and 3]. For both subjects and both measurement points, all standardized factor loadings reached statistical significance and were above 0.40 (see Table 3). Table 4 shows descriptive statistics on the factor level and the factor correlations at both measurement points. All dimensions within one subject correlated positively with each other on a high or moderate level, confirming the separability of students' engagement into three related but distinctive learning aspects. Furthermore, we found cross-subject associations for students' behavioral engagement (T1: $r = 0.64$; T2: $r = 0.47$) and students' cognitive engagement (T1: $r = 0.51$; T2: $r = 0.50$) at each measurement point. In contrast, we found no statistically significant association between students' emotional engagement across the two subjects. Cross-time associations within one subject ranged between 0.58 and 0.78 (see Table 4), indicating substantial temporal stability of students' engagement over one year.

3.2. Subject specificity of Students' engagement

Turning to our second research question, we investigated the subject specificity in students' engagement. To do so, we specified a bifactor model including additional subject-independent and subject-specific factors for each of the three engagement dimensions at both measurement points (see Fig. 1). The resulting model showed a good model fit ($\chi^2 = 2.495{,}233$ $df = 940$, $p < .001$; RMSEA = 0.04, SRMR = 0.05, CFI = 0.94, TLI = 0.92), with statistically significant factor loadings for subject-independent and subject-specific factors. The results revealed non-substantial variances in the cognitive factors reflecting subject-specific engagement in German at each measurement point. Based on

[2] We also compared the three-dimensional model with an alternative one-factor model, whose model fit was much worse ($\chi^2 = 7562.078$, $df = 1033$, $p < .001$; RMSEA = 0.07, SRMR = 0.09, CFI = 0.73, TLI = 0.71). Furthermore, we modeled various ESEM (Exploratory Structural Equation Modeling) with 1, 2, 3, and 4 factors per subject, separately for both measurement points. The 3-factor and 4-factor solutions showed the best fit. Both confirmed the cognitive, emotional, and behavioral dimensions, with the factor loadings in the 3-factor solution proving to be more plausible and easier to interpret than the 4-factor solution.

Table 2
Item-descriptive statistics and psychometric properties for scales measuring academic self-concepts, self-efficacy, interests, and grades in math and German (T1/T2).

Scale	Math			German		
	M	*SD*	Internal Consistency	*M*	*SD*	Internal Consistency
Self-concept [a, b and c]						
I know the answer to a question in [subject] faster than the others.	2.81/ 2.76	1.09/ 1.18		2.87/ 2.89	0.80/ 0.87	
I get good grades in [subject].	3.39/ 3.05	0.98/ 1.22		3.60/ 3.33	0.72/ 0.88	
I am one of the good students in [subject].	3.20/ 3.03	1.06/ 1.23		3.37/ 3.22	0.77/ 0.94	
Scale	3.13/ 2.95	0.95/ 1.11		3.28/ 3.15	0.63/ 0.74	
Cronbach's alpha			0.89/0.91			0.77/0.77
McDonald's Omega (latent)			0.90/0.91			0.78/0.80
Self-efficacy [a]						
In [subject], I can usually handle anything that comes my way.	3.74/ 3.58	0.96/ 1.12		4.11/ 4.17	0.67/ 0.72	
In [subject], I can solve even difficult problems.	3.52/ 3.31	0.99/ 1.06		3.61/ 3.63	0.74/ 0.75	
I can solve most problems in [subject].	3.78/ 3.55	0.93/ 1.01		4.02/ 3.95	0.69/ 0.72	
Scale	3.68/ 3.48	0.87/ 0.97		3.92/ 3.91	0.57/ 0.61	
Cronbach's alpha			0.89/0.90			0.74/0.77
McDonald's Omega (latent)			0.89/0.90			0.74/0.77
Interest [b]						
[Subject] interests me…	3.84/ 3.58	1.01/ 1.17	–	3.70/ 3.50	0.84/ 0.95	–
Grades [c]						
Mid-year / end-of-year report	4.49/ 4.53	0.79/ 0.71	–	4.65/ 4.69	0.49/ 0.46	–

Note. To assess subject-specific constructs, we replaced "[subject]" with "math" or "German."

[a] Students responded to these items on a 5-point rating scale: *disagree completely, disagree, partially disagree—partially agree, agree, agree completely.*

[b] Students responded to these items on a rating scale with five categories: *not at all, not much, moderately, quite a bit, very much.*

[c] Grades range from 1 to 6 (higher grades indicate better achievement).

this result, we then constrained the factor loadings and intercepts of the used indicators to be equal over time. Again, the model revealed a similar fit ($\chi^2 = 2648.351$, df = 991, $p < .001$; RMSEA = 0.04, SRMR = 0.05, CFI = 0.93, TLI = 0.92). There were no remarkable changes in model fit indices (ΔCFI = 0.004, ΔTLI = 0.001, ΔRMSEA = 0.001, ΔSRMR = 0.003). However, the results showed a significant change in fit when residual variances were additionally constrained to be equal over time (ΔCFI = 0.02, ΔTLI = 0.02, ΔRMSEA = 0.03, ΔSRMR = 0.01). For this reason, we conducted all the analyses using a model with constrained factor loading and item intercepts. To answer our third research question about the changes in subject specificity within the three engagement dimensions over time, we also compared the results with a model that assumed strict measurement invariance over time.

Fig. 2 presents the results of the constrained model, showing the variances of the subject-specific and subject-independent factors. All remaining subject-specific and subject-independent engagement factors showed substantial variations, with the variances in the subject-specific engagement factors larger than those in the subject-independent factors. The largest subject-specific variations were found for students' emotional engagement (math T1/T2: 0.95/1.18; German T1/T2: 0.56/0.59). Subject-specific variations were lower for behavioral engagement (math T1/T2: 0.23/0.46; German T1/T2: 0.12/0.26) and were lowest for students' cognitive engagement (math T1/T2: 0.11/0.18; German T1/T2: 0.02/0.03). In addition, the results showed that students' engagement in the behavioral dimension (T1/T2: 0.20/0.26) and somewhat in the cognitive dimension (T1/T2: 0.13/0.15) were subject-independent. The factor capturing subject-independent emotional engagement was very small (T1/T2: 0.09/0.10). Variances in math-specific factors were larger than those for German, indicating that engagement in math was more subject-specific than in German. In addition, math-specific engagement factors were more highly correlated with each other than the German-specific factors were (Table 5).

3.3. Time dependence of subject specificity in Students' engagement

Our third research question addressed the cross-time consistency of subject-specific and subject-independent aspects of students' engagement over one school year (Fig. 2). As expected, the subject-specific variance increased considerably in both subjects, especially for students' behavioral engagement (math: from 0.23 to 0.46, German: from 0.12 to 0.26) and somewhat for cognitive engagement (math: from 0.11 to 0.18, German: from 0.02 to 0.03). Changes in the subject specificity of emotional engagement did not become significant (math: from 0.95 to 1.06, German: from 0.56 to 0.59); the subject specificity here remained high.[3]

3.4. Associations between Students' engagement and their self-concept, self-efficacy, interest, and grades

For our last research question, we investigated associations between students' subject-specific and subject-independent engagement and their self-concept, self-efficacy beliefs, interest, and grades in German and math. All results for the first measurement point (T1) are shown in Table 6. For math, higher associations were consistently found for subject-specific engagement factors (T1: self-concept math r_{range} = 0.42–0.75, $ps < 0.001$; self-efficacy math r_{range} = 0.45–0.81, $ps < 0.001$; interest math r_{range} = 0.46–0.81, $ps < 0.001$; grades math r_{range} = 0.10–0.35, $ps < 0.05$) than subject-independent engagement factors (T1: self-concept math r_{range} = 0.03−−0.09, $ps > 0.05$; self-efficacy math r = 0.19, $p < .001$ for cognitive dimension; interest math $r = 0.06$, $p < .05$ for cognitive dimension; grades math r_{range} = −0.06–0.09, $ps > 0.05$).

[3] To make sure that the assumption of only scalar invariance did not impact the results referring to cross-time differences of the latent factors, we also conducted a model assuming strict invariance. Overall, the results only revealed negligible differences: For the model assuming strict invariance subject-specific variances increased for behavioral engagement in math from 0.22 to 0.45, in German from 0.11 to 0.26. For cognitive engagement subject-specific variances increased in math from 0.11 to 0.17, in German from 0.02 to 0.03. For emotional engagement, they increased in math from 0.93 to 1.07, in German from 0.55 to 0.62.

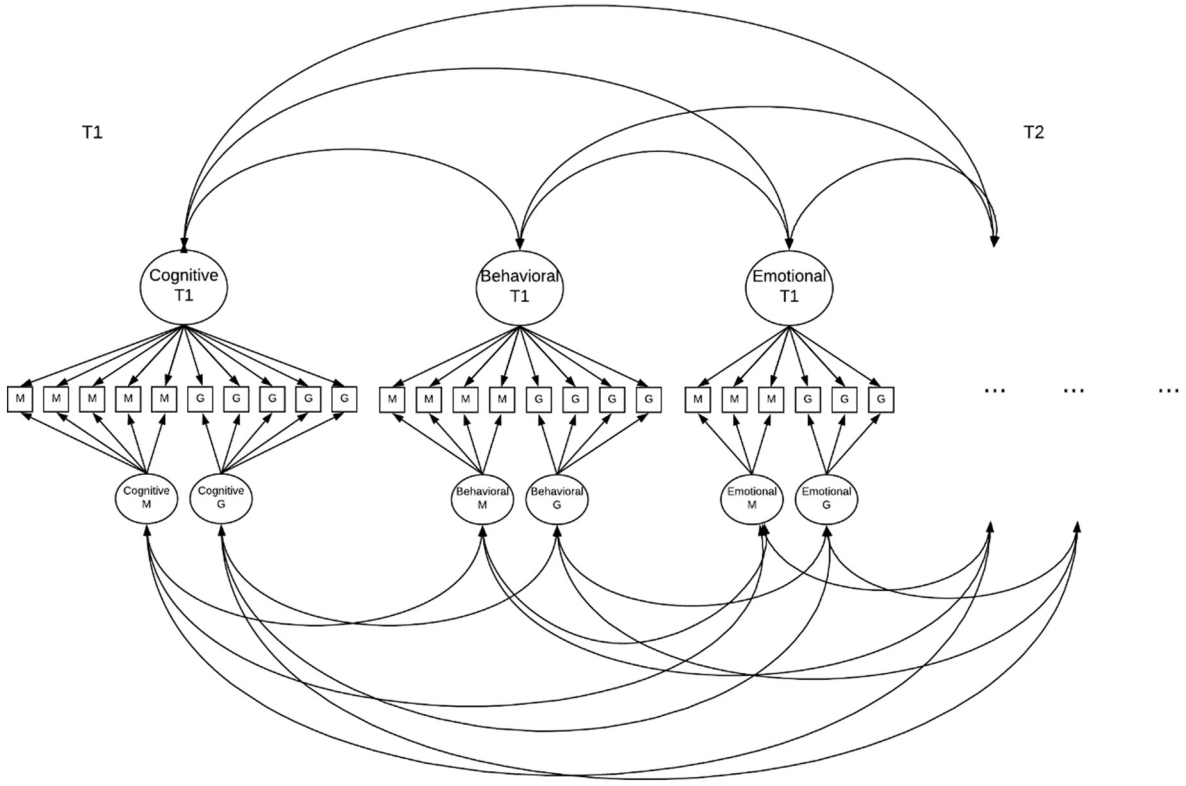


Fig. 1. *Bifactor model with subject-specific and subject-independent factors for cognitive, behavioral, and emotional engagement dimensions in math and German (schematic figure)*
Note. T1 = first measurement point; T2 = second measurement point; M = math, G = German.
Illustration of the model for T1; the overall model includes T1 and T2, whereby the model for T2 is structured analogously to T1 and is linked to T1 by correlations.

Similar results were found for German. However, the motivational outcomes were also substantially related to subject-independent engagement factors (T1: self-concept German $r_{range} = 0.27–0.31$, $ps < 0.05$ for cognitive and emotional dimensions; self-efficacy German $r_{range} = 0.21–0.38$, $p < .05$ for behavioral and cognitive dimensions; interest German $r_{range} = 0.28–0.55$, $ps < 0.001$ for all three dimensions; grades German $r_{range} = 0.15–0.16$, $ps < 0.05$ for behavioral and cognitive dimensions). A similar pattern of results was found for the second measurement point (see Table 7 for T2 results). Concerning dimension-specific effects, emotional and cognitive engagement were more strongly associated with the outcome variables than behavioral engagement, especially in math.

4. Discussion

This study aimed to extend previous research on students' engagement by investigating the following questions: How subject-specific is students' engagement in particular school subjects (math and German)? Does the degree of subject specificity in students' engagement change from the beginning to the end of the first year of upper secondary school? To what extent are students' subject-specific and subject-independent engagement associated with subject-related motivational constructs (academic self-concept, self-efficacy beliefs, and interest) and grades?

The results confirmed the three-dimensional structure of engagement encompassing emotional, behavioral, and cognitive engagement in math and German. In addition, we found that students' engagement had subject-specific but also subject-independent parts, with the degree of subject specificity varying between the engagement dimensions. Emotional engagement showed the most pronounced subject specificity, whereas behavioral engagement encompassed subject-specific and substantial subject-independent parts. The subject specificity of behavioral and cognitive engagement dimensions increased over the first year of upper secondary school (Grade 9). Finally, students' academic self-concept, self-efficacy, interest, and grades were more strongly associated with subject-specific than subject-independent engagement aspects, with the associations generally more pronounced for math than for German.

4.1. Subject-specific and subject-independent engagement aspects

In line with previous findings, the present study showed that students' engagement comprises emotional, cognitive, and behavioral dimensions. Our results confirmed that the engagement dimensions are quite subject-specific. This had been implicitly assumed in previous research on students' subject-related engagement (e.g., Archambault et al., 2022; Ben-Eliyahu et al., 2018; Engels et al., 2021; Fredricks et al., 2017; Sinatra et al., 2015; Wang et al., 2016), but had not been empirically tested. By providing empirical support for the subject specificity of students' engagement, our study thus helps to fill this research gap.

Furthermore, our results suggest that engagement in a particular subject could also be partially attributed to students' individual engagement, which affects their learning in and across different subjects. Although there is a large body of research on school-related engagement (e.g., Fredricks et al., 2004; Li & Lerner, 2011; Wang et al., 2019), these general trends have not yet been considered when exploring students' engagement in particular subjects. Thus, our study shows that when investigating engagement in subjects like math, science, or language, we can also learn about students' tendency to be engaged in general. This is in line with the findings of Pöysä et al. (2018).

Unlike Pöysä et al. (2018), who reported similar degrees of subject specificity in emotional and behavioral/cognitive engagement, we

Table 3
Standardized factor loadings of the three-dimensional model for math and German engagement at T1 and T2.

Engagement item	T1		T2	
	Math	German	Math	German
Factor 1: Cognitive engagement				
In [subject], I try to connect what I am learning to things I have learned before.	0.56***	0.54***	0.54***	0.44***
In [subject], I try to understand my mistakes when I get something wrong.	0.53***	0.52***	0.57***	0.51***
In [subject], I would instead be told the answer than have to do the work. (rev)	0.55***	0.50***	0.70***	0.60***
In [subject], I only study the easy parts when work is hard. (rev)	0.63***	0.48***	0.73***	0.56***
In [subject], I reflect difficult tasks only superficially. (rev)	0.64***	0.49***	0.74***	0.61***
Factor 2: Behavioral engagement				
In [subject] class, I stay focused.	0.83***	0.78***	0.88***	0.84***
In [subject], I complete my homework on time.	0.47***	0.41***	0.51***	0.44***
In [subject] class, I do other things when I am supposed to pay attention. (rev)	0.76***	0.71***	0.70***	0.69***
In [subject] class, I listen carefully.	0.82***	0.81***	0.85***	0.84***
Factor 3: Emotional engagement				
I look forward to (subject] class.	0.91***	0.82***	0.89***	0.77***
I enjoy learning new things about [subject].	0.78***	0.70***	0.84***	0.74***
I feel good when I am in [subject] class.	0.82***	0.72***	0.76***	0.67***

Note. To assess subject-specific constructs, we replaced "[subject]" with "math" or "German." T1 = first measurement point; T2 = second measurement point. ***$p < .001$.

found that subject specificity varied depending on the engagement dimension considered. The highest amount of subject specificity was found for students' emotional engagement, indicating that students' reported enjoyment and pleasure in a specific subject stem less from students' tendency to be engaged in general. These results align with previous research showing that students' learning emotions such as enjoyment, anxiety, pride, and boredom typically reflect subject specificity, as indicated, for instance, by relatively low associations between emotions regarding different subjects (e.g., Goetz et al., 2007). In contrast, the lower subject specificity of students' behavioral engagement might reflect its higher relatedness with students' tendency to persist, work hard, concentrate, and focus in lessons, which might be generally more independent of the specific subject. It is likely driven by more general dispositions (e.g., consciousness; Rieger et al., 2022; Trautwein, Nagengast, Roberts, & Lüdtke, 2019) or by more general educational goals at school (see Bong, 2001; Eccles & Wigfield, 2002; Lent, 2005), such as achieving a good GPA.

Our results also showed that the extent of subject specificity differed between math and German, with subject-specific engagement more pronounced for math than for German. While the nature of these differences did not fall within the scope of the study, we think that our results correspond very well to previous findings pointing to the specificity of students' math learning (e.g., Goetz et al., 2014; Jansen, Lüdtke, & Schroeders, 2016; Weich & Stalder, 2019). Students and math teachers seem to perceive math as a quite specialized, more difficult subject in which knowledge acquisition is more strongly dependent on previously learned content (Goetz et al., 2014; Weich & Stalder, 2019). In contrast, German seems to be more associated with everyday life and current topics and was shown to be more inherently linked to students' general learning habits (Goetz et al., 2014).

4.2. Time dependence of subject specificity in Students' engagement

As expected, students' engagement in both subjects became more subject-specific over one school year after transitioning to upper secondary school. Several reasons could explain this finding: First, there is a strong indication that students' motivation becomes more differentiated when students enter adolescence. At this time, students' self-efficacy and task-value beliefs start to differ more strongly between achievement domains (Bong, 2001), which might be due to maturation processes that make students more engaged in one subject than another (Rimfeld, Ayorech, Dale, Kovas, & Plomin, 2016). A second reason might be that the resources individuals need for engagement in general are limited (Eccles, 2009; Freund & Baltes, 2002; Lent, 2005; Rosenzweig et al., 2019). Notably, in the context of normative transitions, such as the transition to upper secondary school, the need for differentiation is evident as the sheer number of subjects requiring higher student investment increases (Freund & Baltes, 2002). Students must master a much larger quantity of coursework and learning material and further develop their learning strategies. To cope with these increasing demands, students likely adapt their learning to teachers' different subject-specific expectations and instructional practices as the school year progresses. Thus, different learning environments probably encourage students to allocate different amounts of resources to specific subjects. These effects of learning environments and individual differentiation processes might play a vital role in math's "more daunting" subject (Weich et al., 2023), where the subject specificity of engagement increases more than in German.

Table 4
Correlations and descriptive statistics for factors of the three-dimensional model of math and German engagement at T1 and T2.

Engagement factor	1	2	3	4	5	6	7	8	9	10	11	12
1. Cognitive Math T1	–			.								
2. Behavioral Math T1	0.62***	–										
3. Emotional Math T1	0.72***	0.49***	–									
4. Cognitive German T1	0.51***	0.40***	0.10*	–								
5. Behavioral German T1	0.34***	0.64***	0.19***	0.64***	–							
6. Emotional German T1	0.09*	0.20***	0.02	0.59***	0.55***	–						
7. Cognitive Math T2	0.74***	0.37***	0.53***	0.39***	0.20***	0.03	–					
8. Behavioral Math T2	0.35***	0.58***	0.31***	0.29***	0.44***	0.19***	0.46***	–				
9. Emotional Math T2	0.52***	0.40***	0.67***	0.13**	0.17***	0.02	0.70***	0.60***	–			
10. Cognitive German T2	0.48***	0.31***	0.12**	0.78***	0.46***	0.48***	0.50***	0.34***	0.14***	–		
11. Behavioral German T2	0.18***	0.38***	0.10***	0.38***	0.61***	0.36***	0.18***	0.47***	0.16***	0.53***	–	
12. Emotional German T2	0.06	15**	−0.03	0.42***	0.34***	0.60***	−0.03	0.18***	−0.06	0.58***	0.55***	–
M	3.89	4.10	3.63	3.79	4.03	3.50	3.60	3.60	3.41	3.62	3.71	3.43
SD	0.48	0.67	1.0	0.046	0.57	0.79	0.52	0.83	1.07	0.39	0.72	0.80

Note. T1 = first measurement point; T2 = second measurement point.
*$p < .05$. **$p < .01$. ***$p < .001$.

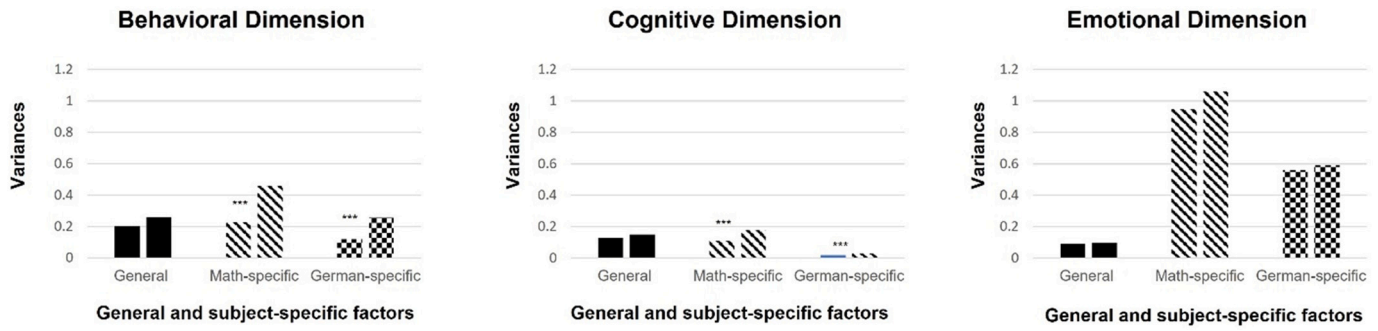


Fig. 2. *Variances of subject-specific and subject-independent engagement factors*
Note. T1 = first measurement point; T2 = second measurement point.
$^{**}p < .01$.$^{***}p < .001$, concerning changes from T1 to T2.

Table 5
Correlations for math-specific, German-specific, and subject-independent engagement factors at T1 and T2.

Engagement factor	1	2	3	4	5
Math-specific				.	
1. Cognitive T1					
2. Behavioral T1	0.56***				
3. Emotional T1	0.77***	0.53***			
4. Cognitive T2	0.71***	0.30***	0.55***		
5. Behavioral T2	0.26***	0.41***	0.24***	0.36***	
6. Emotional T2	0.52***	0.39***	0.64***	0.69***	0.57***
German-specific					
1. Cognitive T1					
2. Behavioral T1	0.39***				
3. Emotional T1	0.50***	0.58***			
4. Cognitive T2	0.77***	0.21**	0.35***		
5. Behavioral T2	0.09	0.45***	0.15	0.15*	
6. Emotional T2	0.28***	0.34**	0.49***	0.35***	0.38***
General					
1. Cognitive T1					
2. Behavioral T1	0.70***				
3. Emotional T1	0.71***	0.65***			
4. Cognitive T2	0.86***	0.58***	0.64***		
5. Behavioral T2	0.54***	0.79***	0.75***	0.80***	
6. Emotional T2	0.58***	0.53***	1.00***	0.84***	0.83***

Note. T1 = first measurement point; T2 = second measurement point.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

4.3. Associations between subject-specific and subject-independent engagement and academic self-concept, self-efficacy, interest, and grades

Finally, our results showed that students' interests, self-concepts, self-efficacy beliefs, and grades were associated with subject-specific and subject-independent engagement aspects at the beginning and end of the first year of upper secondary school. Overall, the findings confirmed prior studies showing that engaged students are interested in the learning object, are confident about their abilities, and expect to succeed and perform well (Engels et al., 2021; Lent & Brown, 2019; Schunk & Mullen, 2012; Wang et al., 2016; Weich et al., 2023; Wigfield & Eccles, 2000). Our finding that subject-specific aspects of engagement were more strongly related to the investigated motivational and achievement outcomes than general aspects further support the relevance of distinguishing between students' subject-specific and subject-independent engagement.

Our finding that the outcomes had stronger associations with subject-specific cognitive and emotional engagement than with subject-specific behavioral engagement is in line with Wang and Holcombe (2010). In their study, school-related affective states (emotional engagement) and the use of self-regulation strategies (cognitive engagement) were more strongly related to students' achievement than school participation (behavioral engagement).

Interestingly, there were moderate associations between subject-independent engagement aspects and interest, self-concept, self-efficacy beliefs, and grades in German. That is, we found a stronger

Table 6
Correlations between students' academic self-concept, self-efficacy, interest, grades, and engagement factors in math and German (T1).

Engagement factor	General behavioral	General cognitive	General emotional	Math-specific behavioral	Math-specific cognitive	Math-specific emotional	German-specific behavioral	German-specific cognitive	German-specific emotional
Self-concept Math	−0.09	0.03	−0.07	0.42***	0.75***	0.73***	0.10	−0.12″‘	0.01
Self-efficacy Math	0.06	0.19***	−0.01	0.45***	0.80***	0.81***	0.05	.-06	0.01
Interest Math	−0.07	0.06*	0.08	0.46***	0.66***	0.81***	0.15	0.00	−0.01
Grades Math	0.09	0.06	0.08	0.10	0.35***	0.30***	−0.11	−0.10*	−0.10*
Self-concept German	0.16	0.27***	0.31*	−0.05	−0.07	−0.08*	0.27*	0.49***	0.45***
Self-efficacy German	0.21*	0.38***	0.11	0.03	0.01	0.04	0.28**	0.50***	0.55**
Interest German	0.28***	0.32***	0.55***	−0.05	−0.14***	−0.14***	0.34**	0.36***	0.49***
Grades German	0.16*	0.15**	0.22	−0.10	−0.05	−0.14**	−0.01	0.20***	0.04

Note. T1 = first measurement point.
No values are shown for the German-specific cognitive engagement factor because its variance was constrained to 0.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7
Correlations between students' academic self-concept, self-efficacy, interest, grades, and engagement factors in math and German (T2).

	Engagement factor								
	General behavioral	General cognitive	General emotional	Math-specific behavioral	Math-specific cognitive	Math-specific emotional	German-specific behavioral	German-specific cognitive	German-specific emotional
Self-concept Math	−0.03	0.06	−0.01	0.35***	0.68***	0.71***	0.03	−0.18***	−0.05
Self-efficacy Math	0.15*	0.27***	0.16**	0.38***	0.73***	0.75***	0.05	.-17***	−0.05
Interest Math	0.02	0.11*	0.12	0.49***	0.64***	0.81***	0.13	−0.02	0.03
Grades Math	0.07	0.15*	0.03	0.23***	0.48***	0.53***	−0.06	−0.15***	−0.09
Self-concept German	−0.11	0.26***	0.20**	0.13	−0.09*	−0.09**	0.41*	0.37***	0.48***
Self-efficacy German	0.11	0.44***	0.15	0.08	−0.07	0.02	0.34***	0.43***	0.58**
Interest German	0.33***	0.39***	0.74***	−0.02	−0.08**	−0.12***	0.29**	0.24***	0.44***
Grades German	0.06	0.26***	0.17	0.06	−0.01	−0.04	0.10	0.20***	0.19

Note. T2 = second measurement point. No values are shown for the German-specific cognitive engagement factor because its variance was constrained to 0.
*$p < .05$. **$p < .01$. ***$p < .001$.

relationship between subject-specific engagement and outcomes in math than in German. In contrast, subject-independent engagement exhibited higher associations with the outcomes in German than in math. All this also aligns with the assumption of a more pronounced specificity of students' math learning compared to German.

4.4. Limitations and future directions

This study was one of the few examining students' engagement in different subjects simultaneously (see Pöysä et al., 2018; Shernoff, Csikszentmihalyi, Shneider, & Shernoff, 2003). Our research approach made it possible to separate subject-specific and subject-independent aspects of the engagement dimensions, revealing variations depending on the dimension, subject, and point in the school year. The present study has some limitations that can guide future research. First, although we used a well-established conceptualization of students' engagement, future research might consider alternative ways of assessing students' engagement. Most importantly, some currently available measures provide a more fine-grained assessment of engagement (e.g., BEQ; Miserandino, 1996). This may be an approach to pursue further, also because the items of the engagement measure used encompass different learning situations (e.g., during class, assignments, homework). These learning situations were not equally distributed across the three dimensions. Therefore, it cannot be ruled out that the revealed differences in subject specificity between the dimensions are also influenced by these imbalances.

Furthermore, the data presented in this study are based on self-report measures. Even though self-report measures are most widely used to assess students' engagement, assessing engagement from an external perspective might also be beneficial. Combining different indicators might help to further investigate the distinction between students' subject-specific and subject-independent engagement. We posit, however, that valid assessment necessarily requires self-report measures (Green, Martin, & Marsh, 2007). Some scholars even argue that self-report methods are uniquely correct in this context because students are uniquely positioned to know and report on their thoughts and feelings (Appleton et al., 2008; Hofkens & Ruzek, 2019). However, future researchers could use a multi-informant approach that includes teacher assessments to obtain holistic insights into the subject specificity of engagement across various subjects.

Second, whereas we found that the extent of subject specificity in students' engagement increased over time, further research is needed to investigate the reasons for this. To this end, it would be necessary to study individual learning experiences but also consider alternative explanations. For instance, our design did not allow us to examine whether the increase in subject specificity is caused by (changing) learning environments, such as instructional quality, student-teacher relationships, or class composition.

Third, our study used data from two measurement points over one academic year. Although we argue that the first year of upper secondary school is pertinent for studying the structure and development of engagement in a new learning environment, future research might investigate more extended periods and measurement points. Such an approach might help examine the extent to which students' engagement is susceptible to changes in subject-related learning environments. For instance, researchers could test for teacher specificity in students' engagement by including additional measurement points in upcoming school years and accounting for teacher changes.

Fourth, for future research, it would be recommendable to employ the proposed study design and modeling approach to explore additional dimensions of engagement that were not within the scope of the current study, such as agentic engagement.

4.5. Practical implications

The study offers valuable knowledge to teachers and schools on several issues. First, our findings help to better understand subject-specific engagement and its three components (emotional, behavioral, and cognitive). A more profound understanding might support teachers in recognizing emerging disengagement earlier, for example, when students actively participate in class (behaviorally engaged) but do so without delving deeply into the material (cognitively disengaged).

Second, our study provides information about the extent of subject-specific engagement and how it varies by subject. At the same time, it shows at what point subject-specific engagement aligns with a student's tendency to engage in general, i.e., independently of a particular subject. Our study thus allows teachers to understand their students' learning beyond their subject-specific expertise. It advises them to address subject-specific and general aspects of engagement when developing strategies to improve students' engagement.

Third, our analyses showed that subject-specific engagement was more pronounced in the emotional than cognitive and behavioral dimensions. This result emphasizes that teachers must find ways to boost students' emotional engagement. Creating moments of joy during lessons is crucial to strengthen engagement and counteract disengagement at the subject level. It may tip the scale in “hard-to-learn-subjects” like

math or science.

Finally, by showing that subject-specific engagement increased over time, we emphasized that engagement is malleable. For teachers, this is both an opportunity and a challenge. As students mature, educators are urged to adjust their teaching methods and prioritize subject-specific interventions. Failing to do so may result in the disengagement of students who have already progressed to upper secondary school with minimal engagement.

5. Conclusion

Educators and researchers need a richer conceptualization and comprehension of the engagement construct than is currently available (Reeve et al., 2020; Wang et al., 2016). Our study expanded previous knowledge about the multidimensional nature of engagement by investigating subject-specific and subject-independent aspects of emotional, cognitive, and behavioral engagement. We showed that subject specificity varied considerably, depending on the engagement dimension, the subject under consideration, and the time of observation. This knowledge helps us better understand the nature of students' engagement in the school and subject context. This could inform the design of better-tailored intervention plans for strengthening engagement.

CRediT authorship contribution statement

Miriam Weich: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Richard Göllner:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Barbara E. Stalder:** Writing – original draft, Supervision, Project administration, Data curation.

Declaration of competing interest.

None+.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.lindif.2024.102511.

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