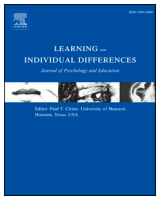
Learning and Individual Differences 118 (2025) 102620

Contents lists available at ScienceDirect

Learning and Individual Differences

journal homepage: www.elsevier.com/locate/lindif



Motivational profiles among high-ability students from a self-determination perspective: Stability, antecedents, and comparisons with average-ability students

Alicia Ramos [a,*], Maarten Vansteenkiste [b], Jeroen Lavrijsen [a], Bart Soenens [b], Karine Verschueren [a]

[a] School Psychology and Development in Context, KU Leuven, Leuven, Belgium
[b] Developmental Psychology, University of Ghent, Ghent, Belgium

ARTICLE INFO

Keywords:
Person-centered analysis
High-ability students
Motivational profiles
Self-determination

ABSTRACT

According to self-determination theory, motivation varies based on the fulfillment of psychological needs, ranging from autonomous to controlled forms. Cognitively high-ability students (IQ ≥120) may face unmet needs in general education, which is designed primarily for average learners. This study, involving two large samples (Sample 1: $N = 3429$ students; Sample 2: $N = 5740$ students) explores motivational profiles among high-ability students across four education stages, comparing them with average-ability students. Using latent profile and transition analysis, it identifies consistent profiles and transitions. High-ability students, more prevalent in profiles characterized by lower autonomous motivation, shifted towards even lower levels during secondary school. Insufficient curricular challenge, reported to a greater extent by the high-ability students, was linked to the lower quality profiles. Findings emphasize the necessity for tailored secondary school environments to better address the unique needs of high-ability students, highlighting the importance of adequate challenge for fostering quality motivation.

Educational relevance and implications: This study found less optimal motivation among high-ability students when compared to their peers. This was especially apparent in secondary school. Sufficient challenge in the curriculum was linked to higher quality motivation, and the high-ability students reported lower levels of adequate curricular challenge. These findings suggest that school environments must do more to meet the educational needs of high-ability students to foster their motivation for school, particularly by offering adequate challenge.

1. Introduction

Motivation is essential for learning. According to Self-Determination Theory (SDT; Ryan & Deci, 2020; Vansteenkiste et al., 2020), students can vary in their reasons for putting effort in their studies. The extent to which students display autonomous, controlled, or both types of motivations is largely dependent upon the extent to which their basic psychological needs for autonomy, competence, and relatedness are met within their educational and home environments (Niemiec & Ryan, 2009; Vansteenkiste et al., 2009). While variable-centered research sheds light on the correlates of autonomous and controlled types of student motivation (e.g., Gottfried et al., 2001), person-centered research sheds light on how different reasons co-occur, forming motivational profiles (Hayenga & Corpus, 2010; Vansteenkiste & Mouratidis, 2016; Wormington et al., 2012). Indeed, autonomous and controlled motivations for learning can coexist within a given student to varying degrees, with the most desirable 'good quality' motivation being characterized by high autonomous, or volitional, and low controlled, or pressured, motivation.

As the general educational system is often designed with the average learner in mind (Deunk et al., 2018), there is risk that the basic psychological needs of high-ability students (i.e., the top 10 % of cognitive ability; Gagné, 2004) are less optimally met in regular classes, with resulting implications for the quality of their learning motivation

* Corresponding author.
E-mail addresses: alicia.ramos@kuleuven.be (A. Ramos), maarten.vansteenkiste@UGent.be (M. Vansteenkiste), jeroen.lavrijsen@kuleuven.be (J. Lavrijsen), bart.soenens@UGent.be (B. Soenens), karine.verschueren@kuleuven.be (K. Verschueren).

https://doi.org/10.1016/j.lindif.2024.102620
Received 31 May 2024; Received in revised form 1 November 2024; Accepted 14 December 2024
Available online 28 December 2024

(Feuchter & Preckel, 2022; Shernoff, 2013; Snyder & Linnenbrink-Garcia, 2013). The present study therefore undertook a systematic examination of high-ability students' motivation in two large samples, comparing it to that of typical students to examine if there are meaningful differences among the groups of students and examining predictors to shed light on possible determinants of motivational development. The second sample followed students longitudinally across four stages of education to track stability and variation in high-ability learners' motivational profiles across time. Studying high ability learners' motivation longitudinally and comparatively to typical students can give important information to researchers and practitioners about whether the basic needs of high-ability students are being met within regular classes.

1.1. Motivational profiles

According to SDT (Ryan & Deci, 2020), students are intrinsically motivated when they engage in a learning activity for its own sake, while extrinsic motivation arises when the activity is seen as a means to an end. Extrinsic motivations can vary in degree of ownership or internalization, leading to different subtypes (Ryan & Deci, 2020; Vansteenkiste et al., 2020). Students with high identified motivation value learning and pursue it willingly, even if the activity is not inherently interesting. Both intrinsic and identified motivations are linked to a high level of willingness and are often combined under the term autonomous motivation (Vansteenkiste et al., 2005).

Autonomous motivation contrasts with controlled or pressured forms of motivation. In the case of introjected regulation, students are driven by internal pressures, including guilt, anxiety or shame or the desire to bolster their self-worth through obtaining good grades (Assor et al., 2009). Finally, external regulation denotes an even more pressured form of regulation, with students putting effort in their learning to obtain external rewards or to evade punishment and disappointment.

Recent meta-analyses (Howard et al., 2021; Vasconcellos et al., 2020) show that autonomous motivation relates positively to academic success and well-being, while controlled motivation is linked to negative outcomes like anxiety. These motivational types are not mutually exclusive, but can coexist in various combinations. A growing body of evidence highlights that humans display various behavioral and attitudinal profiles and respond differently to interventions (Bryan et al., 2021). Person-centered research identifies different variable patterns within individuals (Bergman & Magnusson, 1997), revealing how students draw from multiple motivational resources in their schoolwork (Linnenbrink-Garcia et al., 2018; Vansteenkiste & Mouratidis, 2016). These approaches, which model individual differences and heterogeneity, have gained support for their ability to uncover distinct subpopulations and their predictors (Howard & Hoffman, 2018; Saqr, 2023). They are particularly effective in examining developmental processes like motivation, allowing for the exploration of variable interactions and their combinative influence on educational outcomes (Siegle et al., 2017; Wormington & Linnenbrink-Garcia, 2017), leading to more personalized interventions (Howard & Hoffman, 2018; Molenaar, 2004).

Person-centered research from a SDT perspective has consistently indicated that three to four motivational profiles need to be retained to capture the motivational heterogeneity in students' functioning. Specifically, learners can either score high or low on autonomous and controlled types of motivation, representing a high and low quantity motivation profile. In some groups, scores for autonomous and controlled motivation are asymmetrically present, with a good quality profile characterized by high levels of autonomous and low levels of controlled motivation and a poor quality profile characterized by low autonomous and high controlled motivation. This set of profiles has been observed in middle school (Hayenga & Corpus, 2010), high school (Wormington et al., 2012) and college students (Vansteenkiste et al., 2009).

On top of these general trends, two findings are worth being mentioned. First, some differences in educational stages have been noted, both in terms of the number of retained motivational profiles as well as in terms of their prevalence. For instance, a study in elementary school found evidence for the same profiles except for the low-quantity profile (Corpus & Wormington, 2014). Presumably, elementary school children's intrinsic motivation has not eroded as much as is the case for high school students (Scherrer & Preckel, 2019), and as such a group of unmotivated children has not yet emerged at that age. For a similar reason, a higher share of early, relative to late, secondary school students were located in the good quality motivation group, whereas an opposite pattern was observed in the poor quality motivation group. This declining trend in motivation is countered in college years, with the percentage of college, relative to high school, students in the good quality motivation group being higher (Vansteenkiste et al., 2009).

Second, although the majority of available studies are cross-sectional, a few longitudinal studies have shed light on the stability versus change in students' profile membership. Specifically, the few longitudinal studies that have examined changes in profiles of autonomous and controlled motivation have shown that shifts in profiles are common over time. Mirroring the findings of declining intrinsic motivation in variable-centered research, movement in an early secondary school population was generally from the good quality and high quantity profiles to the poor quality and low quantity profiles as the students aged (Hayenga & Corpus, 2010), with the poor quality profile being the most stable profile. In a study among primary school students, however, the primarily autonomous profile was the most stable, with profile movement occurring primarily from the high quantity profile in to either the primarily autonomous or primarily controlled profiles (Corpus & Wormington, 2014). Because each of these studies focused on only one stage of education, it is difficult to determine if the differences in the profile shifts were due to sample characteristics, generalizable developmental trends, or changing school environments in the cases where students transitioned school systems (e.g., primary to secondary school).

Many existing studies on motivational profiles are cross-sectional, and thus do not give insight on how these profiles change over time. Furthermore, previous studies comparing profiles and their outcomes across different stages of education typically involves comparing separate samples from each stage (i.e. one sample in secondary school and another from higher education) rather than tracking the same students through these transitions. As a result, it is unclear whether the observed differences are consistent and replicable or if they are due to variations in the samples or educational contexts.

1.2. Motivation in high-ability students

Stage-environment fit theory posits that declines in school motivation occur because of a mismatch between the school environment and the students' changing developmental preferences (Eccles & Roeser, 2009). High-ability students are potentially at a greater risk of mismatch because schools find it more challenging to meet their advanced learning preferences compared to typical students (Deunk et al., 2018; Feuchter & Preckel, 2022). According to SDT, this mismatch can lead to unmet needs for competence and to autonomy frustration, resulting in maladaptive motivational development.

Despite the potential motivational risks for high-ability students, their motivation has rarely been studied longitudinally nor comparatively with average-ability students. One study to date explored motivational profiles from a SDT perspective among high-ability students and their classmates in a regular classroom setting in late primary school (Hornstra et al., 2023). This study found that high-ability students were more likely to shift away from the good quality motivation profile towards profiles marked with lower levels of autonomous motivation and higher levels of amotivation, or lack of motivation. However, the high-ability students in this study were selected based on clinical diagnosis of giftedness. Students who are experiencing more problems, motivational

and otherwise, may be more likely to be referred to psychologists and receive a clinical giftedness diagnosis (see Lavrijsen & Verschueren, 2023), and the findings may thus not be generalizable to all high-ability students. Research is needed among a non-selective population of high-ability students to determine if these findings apply broadly to high ability students. It is also important to establish whether these differences can be found throughout different levels of education, not only in primary school.

1.3. Outcomes of motivational profiles

Regarding outcomes of motivational profiles, across studies the good quality motivation profile often fares the best, except when compared to the high quantity motivation group (Hayenga & Corpus, 2010; Vansteenkiste et al., 2009; Wormington et al., 2012). Differences between the good quality and high quantity motivation group are less likely to emerge for positive outcomes (e.g., behavioral engagement) but are more visible for negative outcomes. Presumably, the additional presence of controlled next to autonomous motives explains the vulnerability of the high quantity motivation group for outcomes like test anxiety and procrastination (Vansteenkiste et al., 2009). Similarly, the poor quality group – despite being more strongly motivated than the low quantity motivation group – scores more poorly in regards to negative outcomes, whereas both groups are comparable for positive outcomes (Vansteenkiste et al., 2009).

Although engagement and achievement are frequently studied outcomes of motivation, underachievement has been less frequently studied. Underachievement occurs when a student's performance falls short of their potential (Reis & McCoach, 2000). To our knowledge, underachievement has not been studied as a correlate of motivational profiles from a SDT perspective, despite the central role that motivational beliefs and psychological needs satisfaction play in the according to prominent models of underachievement among high-ability students (Siegle et al., 2017; Snyder & Linnenbrink-Garcia, 2013). Although there are many potential reasons that students underachieve, motivational reasons are a common factor influencing underachievement among many, if not most, underachieving high-ability students (White et al., 2018). One possibility is that groups characterized by high controlled motivation are more likely to underachieve as the pressure they experience may elicit test anxiety (Vansteenkiste et al., 2010), thereby precluding them to realize their full potential.

Just as different sets of motivation profiles have been found among samples of different ages, the connection between motivation profiles and educational outcomes such as engagement and achievement has also been found to vary among samples of different ages. For instance, Corpus and Wormington (2014) found no differences in school grades or standardized test scores among primary school students with primarily autonomous and primarily controlled motivations. In contrast, studies among high-school students generally indicate that students with primarily controlled motivation perform worse than their peers (Ratelle et al., 2007; Vansteenkiste et al., 2009; Wormington et al., 2012). This difference was attributed to the primary school context, where close teacher relationships may enhance students engagement even when students lack intrinsic motivation. However, making precise comparisons across studies with different age groups, motivational measures, and educational contexts proves challenging.

To address possible differences depending on educational context, researchers have called for more research to incorporate both young and older student populations from the same cultural context (Hayenga & Corpus, 2010). To address age-specific differences in profiles and profile outcomes, and to have more insight on profile stability, researchers have called for research among longitudinal samples spanning multiple stages of education (Tóth-Király et al., 2022). The current study will address the need for longitudinal research and the need for research spanning multiple stages of education by utilizing a longitudinal sample spanning primary school, early and late secondary school, and higher education to investigate profile composition, stability, and outcomes across educational stages.

1.4. Contextual predictors of motivational profiles of high-ability students

According to SDT, intrinsic motivation is fostered by teaching practices that support students' basic psychological needs (Ryan & Deci, 2020). These include autonomy support, structure, and involvement. Autonomy support involves offering meaningful choice, providing rationales for learning tasks, and minimizing controlling language (Aelterman et al., 2019; Reeve & Cheon, 2021). Structure entails clear objectives for learning tasks, competence-affirming tasks and adequate guidance (Aelterman et al., 2019; Patall et al., 2024). Involvement means showing genuine care, offering emotional support, and fostering a warm classroom environment. If these needs are not met, students can lose their motivation (Legault et al., 2006), becoming vulnerable to school burn-out and drop-out.

Studies suggest that teachers provide somewhat different degrees of need-supportive teaching to high-ability, versus average-ability, students. High-ability students receive more autonomy support, equal involvement, and less structure compared to their peers (Hornstra et al., 2020; Sypre et al., 2024). Despite these differences, need-supportive practices are equally important for stimulating intrinsic motivation and engagement in both groups (Hornstra et al., 2020; Lavrijsen et al., 2024). Previous research found that college-aged students in the good and poor quality motivation group perceived their teacher highest and lowest in need-supportive teaching, respectively (Vansteenkiste et al., 2009). The current study adds to this work by investigating the association between need-supportive teaching and motivational profiles among an early secondary school population, and to examine whether these associations are similar for high-ability and average-ability students.

High-ability students' need for competence is best fulfilled when they can use and extend their capacities with optimally challenging schoolwork (Ryan & Deci, 2020), which spurs motivation and engagement (Shernoff, 2013). Adequate curricular challenge can be seen as a necessary contributor to students' psychological need for competence, which is an essential element according to SDT for achieving optimal motivation. Previous work has shown that adequate curricular challenge predicts school motivation similarly among high-ability and typical students (Lavrijsen et al., 2021), yet is has also shown that high-ability students generally report lower levels of challenge than their classmates within general education classrooms (Feuchter & Preckel, 2022; Lavrijsen et al., 2021). The current study will expand previous findings by examining the relationship between adequate curricular challenge and patterns of different kinds of motivation, and it will do so comparatively among high-ability and average-ability students.

1.5. Present study

As person-centered research has sometimes been critiqued for being too sample-specific, thereby questioning the generalizability of the findings in a given sample (Pastor et al., 2007), the present research comprised two large samples to shed light on the stability of motivational profiles among high-ability students, as compared to their average-ability peers. Sample 1 consists of a cross-sectional cohort of first year of secondary school students whereas Sample 2 follows students across four different educational stages (late primary school, early secondary school, late secondary school, higher education).

Overall, we aim to estimate profiles of autonomous and controlled motivation, examine the stability and shifts in motivational profiles across time and link identified profiles to a host of affective (i.e., emotional engagement) and behavioral (i.e., underachievement, grades, grade retention) outcomes as well as antecedents (i.e., need-supportive teaching, adequate curricular challenge). In each step, we will compare findings among high-ability with those found among their average-

ability peers, to better understand the extent to which there are unique considerations in the role of motivational differences among high-ability group. Compared to prior work that was limited to clinically diagnosed high-ability students (Hornstra et al., 2023), in this study students' intelligence was formally assessed via a standardized intelligence test. As a result, a less selective sample of high-ability students was included in the present study, which allows us to shed a better light on the generalizability and replicability of the identified profiles among high-ability students. Specifically, we pursue four research objectives.

First, we seek to identify motivational profiles (i.e., score patterns for *intrinsic*, *identified*, *introjected*, and *external motivation*) among both samples (Research Objective 1a). Following previous work (Hayenga & Corpus, 2010; Vansteenkiste et al., 2009; Wormington et al., 2012), we generally expect to find four profiles, with two of them yielding parallel scores for autonomous and controlled motivation (i.e., the high quantity and low quantity motivation group) and two others yielding divergent scores (i.e., good quality and poor quality motivation groups). While cross-sectional Sample 1 is limited to early secondary school years, Sample 2, due to its longitudinal design involving four different educational stages (late primary school, early secondary school, late secondary school, higher education), allows us to examine whether a structurally equivalent set of profiles can be detected across ages. As controlled motivation may be less salient during primary school years (Corpus & Wormington, 2014), only three groups may emerge at that age, with the heterogeneity thus increasing as students become older. We will also compare the profiles between high-ability and average-ability students (Research Objective 1b). We would expect to initially find a higher share of high-ability students in profiles with high levels of autonomous motivation (Gottfried & Gottfried, 1996; Hornstra et al., 2023), although we would expect this share to be less pronounced with increasing levels of education.

Second, we will examine transitions between the motivational profiles across educational stages in longitudinal Sample 2 (Research objective 2a), and we will also compare the profile transitions between high- and average-ability students (Research objective 2b). We expect movement away from the good quality motivation group towards the poor quality motivation group as the students progress through compulsory education. This negative motivational trend may be more clearly visible among high-ability students (see Hornstra et al., 2023). As a learning environment in secondary education is less tailored to the fulfillment of basic needs of high-ability learners (Deunk et al., 2018), high-ability learners may be more likely to move away from good quality motivation towards low quantity or poor quality profiles. The negative trend may not continue into higher education when students are able to choose a major that more closely corresponds with their skills and interests than in secondary school (Vansteenkiste et al., in press). Particularly, high-ability students would presumably be more able to choose study options in line with their interests and ability level.

As a third research objective (RO3), we will investigate educational implications of the motivational profiles in both samples. Importantly, to avoid problems associated with shared method-variance, both self- and other-reported outcomes as well as objective indicators of success (i.e., GPA; retention) will be examined. Specifically, in Sample 1, students, teachers and parents will report on participants' engagement and underachievement. We posited the general hypothesis that students in the good quality motivation group should score highest on engagement and achievement and lowest on underachievement compared to the low quantity and poor quality motivational profile across stages of education (Ratelle et al., 2007; Vansteenkiste et al., 2009; Wormington et al., 2012). The difference with high quantity motivation group on adaptive outcomes may be less clear (Hayenga & Corpus, 2010) as autonomous motivation buffer some of the costs associated with controlled motivation, and controlled motivation can also result in some positive outcomes.

A fourth and final research objective involved examining whether students in Sample 1 in different motivational profiles would experience a different level of need support and adequate curricular challenge (Research Objective 4a), with these differences holding for both high-ability and average-ability students (Research Objective 4b). It is our expectation that teacher autonomy support and involvement will all positively predict membership in the good quality motivation profile, and that these relationships will be equally strong for high-ability and average-ability, although perceived mean levels of need supportive teaching may vary between the two groups of students (Hornstra et al., 2020; Sypre et al., 2024; Lavrijsen et al., 2024). Regarding adequate curricular challenge, we expect that cognitive high-ability students will report lower mean levels than their classmates (Feuchter & Preckel, 2022). We expect that students reporting lower levels of adequate curricular challenge will also be more likely to be in low quality motivational groups compared to the good quality group, as according to SDT their need for competence would not be satisfied. Based on earlier work (Lavrijsen et al., 2021), we would expect similar relationships between adequate curricular challenge and motivation among high-ability and typical students.

For an overview of all research objectives, refer to Table 1.

This study will build upon previous research in several important ways. First, we will use two samples to investigate generalizability of motivational profiles among high-ability and average-ability students. Second, we will utilize a longitudinal sample spanning four stages of compulsory and higher education to give unique long-term insight on how motivational profiles evolve among high-ability and average-ability students over the course of educational trajectories. Investigating profiles within different educational stages will give unique insight on whether certain stages of education are more or less motivationally optimal for students in general, and if this differs for high-ability students. Third, studying key predictors of the motivational profiles will help illuminate why students are characterized by specific patterns of motivations.

2. Materials and methods

2.1. Samples and measures

This study was carried out in Flanders, the Dutch-speaking part of Belgium. In Flanders, the age range of the vast majority students in each educational stage is 10–12 years old in the last year of primary school, 11–13 years in the first year of secondary school, 15–17 years in the fifth year of secondary school, and 20–22 years at the time of this study's measurement moment in higher education. In the Flemish educational system, students transition to secondary school after completing six years of primary school. In the first year of secondary school students are placed into either a general "A" track or a remedial/pre-vocational "B" track. From the third year of secondary school students can choose between academic, technical, vocational, and artistic studies based on their study results, teacher recommendations, and personal preferences. In higher education, dependent on their study track in secondary school, students can choose between academic and professional bachelor degree programs. Aside from a select few academic bachelor programs such as medicine that require an entrance exam, higher education institutions offer open enrollment to incoming students.

Sample 1 consists of data from all participants of the TALENT study, a sample of 3439 students (50.3 % males, 49.7 % females; 94 % born in Belgium; average age 12.4 years at first measurement occasion) from 166 classes within 27 schools during the year of secondary school in Flanders, Belgium. Schools were recruited for the study via open calls for participation within school networks. Within participating schools, all students who had successfully completed primary school and who were beginning the first year of secondary school were invited to participate. Students filled out questionnaires during class hours at the beginning and end of the school year in the 7th grade, which is the first year of secondary education in Belgium, and they also completed a standardized test assessing fluid and crystallized intelligence at the beginning of the

Table 1
Overview of research objectives and methods.

Number	Research objective	Analysis method	Sample(s)	Variables	Grades
1a	To identify motivational profiles in multiple samples	Latent profile analysis	TALENT & SiBO	Intrinsic, identified, introjected, and external motivation	TALENT: 7 (Spring)
1b	To compare profiles among high-ability and average-ability students	BCH method			SiBO: 6, 7, 11, Higher Ed.
2a	To examine transitions between the motivational profiles across educational stages	Latent transition analysis	SiBO	Intrinsic, identified, introjected, and external motivation	6, 7, 11, Higher Ed.
2b	To compare the profile transitions between high- and average-ability students	Multinomial logistic regression			
3	To investigate educational implications of the motivational profiles	BCH method	TALENT & SiBO	TALENT: emotional & behavioral engagement, achievement, underachievement	TALENT: 8 (Spring)
				SiBO: school engagement, math achievement, underachievement, grade retention, study track	SiBO: 6, 7, 11, 7–12, Higher Ed.
4a	To examine predictors of motivational profile membership	BCH method	TALENT	Teacher autonomy support teacher involvement adequate curricular challenge	7 (Fall)
4b	To investigate if there are differences in predictive relationships between high-ability and average-ability students	Multinomial logistic mixed models			

school year. The students' parents and teachers also completed questionnaires at the end of the school year.

Sample 2 comprises data of all the participants of the SiBO-study, a largescale longitudinal project which followed children throughout primary and into secondary school in Flanders, the Dutch-speaking part of Belgium. One hundred and seventy-two schools were originally selected as a quasi-representative sample of primary schools in Flanders based on their size, region, and school network. All students beginning kindergarten in these schools were asked to participate in the study, resulting in a sample of 5740 students (49.5 % male, 76.7 % speaking only Dutch at home). The students completed standardized intelligence tests when they were in Grade 3. They completed questionnaires in primary school, again in the first and fifth year of secondary school, and finally three years following secondary school, when many of the students were enrolled in higher education. For the purposes of the current study, the following waves of questionnaire data will be used: Grade 6, Grade 7, Grade 11, and Higher Education.

In both studies, informed consent was obtained from students as well as their parents and teachers, the studies were found to be in accordance with human subjects guidelines and principles, and they were subsequently approved by the ethical committee of the university affiliated with the first author. For an overview of the measures used from each study in the current paper, refer to Tables 2 and 3.

2.1.1. Measures: Sample 1

Cognitive ability was assessed in Sample 1 by a standardized intelligence test developed and validated in the Flemish context (CoVaT-CHC; Magez, 2015) that measures students' fluid and crystalized intelligence. IQ-scores were calculated by comparing test results to those of a representative norming sample. On basis of these scores, students achieving in the top 10 % (i.e., an IQ-score of 120 or higher; $N = 403$) were considered high-ability. This cut-off criteria comes from the

Table 2
Instruments used from the TALENT study (Sample 1).

Variable	Measurement times	Corresponding research objective(s)	# of items	Sample item or *description*	α
Motivational variables					
Intrinsic motivation	G7 - spring	1,3,4	4	I am motivated to study because I find learning interesting	0.87
Identified motivation	G7 - spring	1,3,4	4	I am motivated to study because I want to learn new things.	0.77
Introjected motivation	G7 - spring	1,3,4	4	I am motivated to study because I would feel guilty if I didn't.	0.73
External motivation	G7 - spring	1,3,4	4	I am motivated to study because others (parents, friends, teachers) expect this from me.	0.75
Outcome variables					
Behavioral engagement					
Student perspective	G8 - spring	3	5	I participate actively in class.	0.80
Parent perspective	G8 - spring	3	5	My child does his/her best for school.	0.83
Teacher perspective	G8 - spring	3	2	This student does his/her best for school.	
Emotional engagement					
Student perspective	G8 - spring	3	5	When we are working on something in class, I am interested.	0.81
Parent perspective	G8 - spring	3	5	My child enjoys school activities or events.	0.80
Teacher perspective	G8 - spring	3	2	This student is interested when s/he is working on something for school.	
Underachievement					
Student perspective	G8 - spring	3	3	I am performing below my capability in school.	0.86
Parent perspective	G8 - spring	3	3	My child is performing below his/her capability in school.	0.92
Teacher perspective	G8 - spring	3	1	This student is performing below his/her capability in school.	–
Achievement	G8 - spring	3	1	*Average grade, in percent, across all school subjects, standardized within schools.*	–
Predictor variables					
Adequate curricular challenge	G7 - fall	4	4	The lessons at this school are sufficiently challenging.	0.59
Needs supportive teaching: autonomy support	G7 - fall	4	4	My teachers let me choose how I deal with my schoolwork.	0.67
Needs supportive teaching: involvement	G7 - fall	4	4	My teachers pay attention to me.	0.77

Differentiated Model of Giftedness and Talent (Gagné, 2004), which states that individuals with the top 10 % of ability within a given domain can be considered gifted within that domain. Students scoring within one standardized deviation of the mean IQ score were considered average-ability (n = 2237), and students scoring below this threshold were not included in the study so that the comparison group did not skew towards low ability.

Motivation was assessed in the spring of 7th grade using validated subscales based on a self-determination perspective (Academic Self-Regulation Questionnaire; Ryan & Connell, 1989). The subscales were 4 items each and included measures of students' *intrinsic*, *identified*, *introjected*, and *external* motivations. Internal consistency of the measures was acceptable to high, with alphas ranging from 0.73 to 0.87.

Emotional and behavioral engagement was assessed by students using validated subscales (Skinner et al., 2008) in the spring of Grade 7. Behavioral engagement (four items) measured the students' participation and effort in learning activities, while emotional engagement (five items) determined the students' positive feelings about school tasks. The scales showed high internal reliability, with Cronbach's alphas of 0.80 and 0.81, respectively. Parents rated their children's behavioral engagement using a 5-item subscale of the Research Assessment Package for Schools (Institute for Research and Reform in Education, 1998), and they rated their emotional engagement using a 5-item subscale from the School Liking and Avoidance Questionnaire. Both scales were designed for and validated among parents. For each student, both parents were invited to fill out the questionnaires. When both parents responded, the two scores were average to obtain a single measure for each student. Averaged across the two sets of parents, the internal reliabilities of the scales were high, with Cronbach's alphas of 0.83 for behavioral engagement and 0.80 for emotional engagement. Teachers responded for each student with two items per construct. The reliabilities of the scales were high, with Cronbach's alphas of 0.84 for behavioral engagement and 0.86 for emotional engagement.

Achievement was assessed by collecting the students' average of all grades across school subjects at the end of the school year, recorded as a percentage. As grading practices can vary across schools, these average grades were standardized within the schools for use in the current study.

Underachievement was assessed by students (3 items), parents (3 items), and teachers (1 item) in the spring of Grade 7 using a validated scale designed to measure the perception of a student's performance relative to their ability (Snyder & Adelson, 2017). Internal reliability of the scale was very high, as the Cronbach's alpha was 0.86 in the student measure and averaged 0.92 across the two sets of parent measures.

Adequate cognitive challenge was assessed in the fall of Grade 7 by the students using a 4-item scale that has been validated in the Flemish context (Lavrijsen et al., 2021). A sample item is 'The lessons at this school are sufficiently challenging.' The internal reliability of this scale was 0.59.

Need-supportive teaching (autonomy support & involvement) was assessed in the fall of Grade 7 by the students about their teachers. Autonomy support was assessed with a short version of the Teacher as Social Context Questionnaire (TASCQ; Belmont et al., 1988), while involvement was assessed with the 'People in my life' scale (Cook et al., 1995). *Autonomy support* was measured with 4 items (e.g., *My teachers let me choose how I deal with my schoolwork*) and *Involvement* was measured with 4 items (e.g., *My teachers pay attention to me*). The internal reliability coefficients of these scales were 0.67 for autonomy support and 0.77 for involvement.

2.1.2. Measures: Sample 2

Cognitive ability was assessed in Sample 2 by means of standardized intelligence tests measuring crystallized (CIT 3-4; Hendrikx et al., 2008) and fluid (Standard Progressive Matrices; Raven et al., 2000) intelligence, administered when the students were in Grade 3. Scores were aggregated to estimate a single IQ per student. Students scoring in the 90th percentile according to benchmarks from the quasi-representative sample were considered high-ability (n = 630, $M\ IQ$ = 120.9), according to the criteria of Gagné (2004) described in Sample 1, and students scoring within one standard deviation of the average IQ score were considered average-ability (n = 2237; IQ range = 85 to 115). Again, students scoring below one standard deviation of the average IQ score were excluded from the analysis so that the average-ability group did not skew towards low ability.

Motivation was assessed in Grades 7, 6, 11, and again in higher education using validated subscales derived from a self-determination perspective (Academic Self-Regulation Questionnaire; Ryan & Connell, 1989). Specifically, students' autonomous (*intrinsic*: 2 items, *identified:* 2 items) and controlled (*introjected*: 4 items, *external:* 2 items) motivations were assessed. The scales generally showed minimal acceptability in terms of reliability across measurement moments, with Cronbach's alphas ranging from 0.69 to 0.77 for intrinsic motivation, 0.62 to 0.67 for identified motivation, 0.71 to 0.76 for introjected motivation, and 0.63 to 0.79 for external motivation.

A previously validated scale (8 items) was used to assess students' *school engagement* in Grades 6, 7, and 11. This scale seeks to gauge students' positive emotions for daily life at school (Maes et al., 2005; Smits

Table 3
Instruments used from the SiBO study (Sample 2).

Variable	Measurement times	Corresponding research objective(s)	# of items	Sample item or *description*	α
Motivational variables					(Range where applicable)
Intrinsic motivation	G6, G7, G11, HE	1,2,3,4	2	I am motivated to study because I find learning interesting	0.69–0.77
Identified motivation	G6, G7, G11, HE	1,2,3,4	2	I am motivated to study because I want to learn new things.	0.62–0.67
Introjected motivation	G6, G7, G11, HE	1,2,3,4	4	I am motivated to study because I would feel guilty if I didn't.	0.71–0.76
External motivation	G6, G7, G11, HE	1,2,3,4	3	I am motivated to study because others (parents, friends, teachers) expect this from me.	0.63–0.79
Outcome variables					
School engagement	G6, G7, G11	3	8	Mostly I find pleasure in the work that I do for school.	0.84–0.87
Engagement: vigor	HE	3	4	I feel strong and energetic when I am studying.	0.67
Engagement: dedication	HE	3	5	I am enthusiastic about my studies.	0.87
Engagement: absorption	HE	3	4	Time flies when I am studying.	0.67
Teacher-perceived underachievement	G7	3	1	This student performs under his/her abilities.	–
Math achievement	G6, G7, G11	3	50–80	*Standardized tests covering the domains of mental arithmetic, number sense, word problems, measurement, and calculations.*	0.81–0.91
Grade retention	G7-G12	3	1	*Administrative data demonstrating whether the student had repeated a year in secondary school (1) or not (0)*	–
School track	G9, G12	3	1	*Administrative data demonstrating whether the student followed a non-academic (1) or academic (0) study track*	–

& Vorst, 1990). The scale has demonstrated reliability and validity in previous published studies (e.g., Vanwynsberghe & Van Damme, 2014; Vanwynsberghe et al., 2017). Furthermore, it showed a high reliability within the present sample, Cronbach's alphas of 0.87 for Grade 6, 0.84 for Grade 7, and 0.87 for Grade 11. In higher education, school engagement was assessed using three subscales, namely *vigor* (4 items), *dedication* (5 items), and *absorption* (4 items) (Schaufeli et al., 2002). In the present study, the reliability of these subscales was marginally acceptable to high, with Cronbach's alphas of 0.67 for Vigor and Absorption and 0.87 for Dedication.

Math achievement was assessed through standardized tests, which were developed for each grade level with the objective of testing the competences that students should have at the end of each grade according to Flemish educational standards. Each test consisted of 50 to 80 items and covered the general domains of mental arithmetic, number sense, word problems, measurement, and calculations. Previously published research using these measure has shown evidence for validity and reliability (Pinxten et al., 2015; Vandecandelaere et al., 2016; Vanwynsberghe et al., 2017). In the present sample, internal consistency estimates were high, ranging between 0.81 and 0.91 depending on the school year.

The math assessment in Grade 11 primarily used items from previous versions of the Program for International Student Assessment (PISA; OECD, 2013). Twelve different versions of the tests were created to account for the wide range of math ability among the students in different study tracks. Common items linked the tests to each other, and these items were calibrated using 3PL models based on item response theory to calculate ability scores for all students that could be compared across tests (see Vanwynsberghe & Van Damme, 2014, for more information).

Teacher-Perceived Underachievement was rated by the students' homeroom teacher. Teacher-perceived underachievement has been found to relate significantly and moderately to measured underachievement in previous research (Lavrijsen et al., 2020). As teachers had to potentially respond for many students, a single item ("This student performs under his/her abilities") was used to reduce survey fatigue.

Administrative information regarding *grade retention* and choice of *study track* (academic or non-academic) was gathered from the Flemish Government each year of secondary school from Grade 7 to Grade 12, the final grade in secondary school.

2.1.3. Missingness: Sample 1

In Sample 1, missing data ranged from 2.5 % to 50.8 % per item. Student-reported variables, including the motivational variables used to determine the profiles in the present study, had the lowest rates of missingness, ranging from 13.8 % to 23.5 % ($M = 6.5$ %). Little's MCAR test, which compares participants with and without complete data, was significant ($\chi^2 = 2303.13$ (1757), $p < .001$), so the data cannot be considered missing completely at random. The variable with the highest rates of missingness was Achievement in Grade 8, with 50.8 % missing. Due to school grading policies, 19 schools did not provide their students with a grade point average. The teacher-reported variables *Engagement*, *Disengagement*, and *Underachievement* also had rather high rates of missingness (ranging from 41 % to 44 %). Because these scores were generally missing for entire classes because a number of teachers did not submit evaluations for all of their students, we can assume that the missingness did not have to do with characteristics related to individual students. To account for missing data, Full Information Maximum Likelihood Estimation (FIML) was used in our models. This approach obtains parameter estimates by maximizing a likelihood function of the incomplete data of each individual in the dataset (Dong & Peng, 2013).

2.1.4. Missingness: Sample 2

The SiBO study was a longitudinal study spanning the entirety of a cohort's compulsory education. As such, a certain amount of attrition took place. Most of the attrition occurred because of students transferring to schools not included in the study's sample (Vandenberghe et al., 2011). By Grade 6, the first year of the primary analysis in the current study, there were 4780 students being followed in the SiBO sample, which represented 83 % of the original sample. Of these students, 96.84 % ($n = 4629$) submitted questionnaire. The non-response was mostly situated at the school-level, with 95.79 % of schools submitting questionnaires that year (Vandenberghe et al., 2011). In Grade 7, the first year of secondary school, 3763 students submitted questionnaires. There was some additional attrition, then, occurring between Grades 6 and 7, but much of this again can be presumed to be at the school level due to the sampling procedure taken in secondary school, in which only schools with 10 or more students from the SiBO sample were contacted. Despite this sampling procedure, 91.4 % of the students who submitted a questionnaire in Grade 6 also submitted a questionnaire in Grade 7. In Grade 11, there was a response rate of 72.58 % of the students who were a part of the sample in Grade 7 (Vanwynsberghe & Van Damme, 2014). In the sub-sample used in this study, 81 % of the students who had been followed in Grade 7 also filled out questionnaires in Grade 11, resulting in 3059 responses. The students were asked to provide contact information to be contacted for future research; four years later, this information was used to reach out to them, but it was no longer all valid, as some participants had moved or changed phone numbers or email addresses. We were able to reach 1730 of the students, of which 1482 students completed or mostly completed surveys. Of these students, 1146 students indicated that they were enrolled in some form of higher education and completed the questionnaire measures used in the present study.

Largely due to the considerable attrition over time, some of which was planned into the study design through selection criteria (i.e. secondary schools, students enrolled in higher education), percentage of missing data ranged from 0.03 to 78 %. Little's MCAR test showed that the data was not Missing Completely at Random ($\chi^2(978) = 1072.37$, $p < .05$). Missing at Random was a reasonable assumption given the fact that the Little's MCAR test was barely significant, as well as the fact that much of the missingness during compulsory education occurred at the school level, with schools either submitting data or not in a given year. Missingness in higher education was less random, as students had agency in choosing whether or not to attend higher education that was likely in part influenced by their motivation for school. Follow-up analysis comparing variable levels in Grade 11 among students who did and did not attend higher education revealed a significant difference in identified motivation between the two groups of students, with students attending higher education reporting higher levels of identified motivation ($M = 3.97$ compared to $M = 3.83$, $F = 15.012$, $P < .001$). The groups did not significantly differ in levels of intrinsic, introjected, or external motivation. To minimize the bias associated with attrition and missing data, the Full Information Maximum Likelihood approach was used in our models.

2.2. Transparency and openness

We report how we determined our sample size, all manipulations, and all measures in the study. Materials and analysis code for the study are available by emailing the corresponding author. Data were analyzed using the statistical software Mplus 8 (Muthén & Muthén, 2017). This study's design and hypotheses were preregistered after data had been collected but before analyses were undertaken; see https://osf.io/r56b7/.

2.3. Analyses

We followed a parallel analysis procedure to address research objectives 1 and 3 in Samples 1 and 2, with extra steps added to address the second research objective in Sample 2 and the fourth research objective in Sample 1. Before performing the primary analysis, we analyzed the

missingness of the data and tested the motivational variables for measurement invariance over ability groups in Sample 1, and over time and ability groups in Sample 2. Next, we examined intercorrelations of the study variables.

Addressing RO1a, we used latent profile analysis and the standardized variables *intrinsic*, *identified*, *introjected*, and *external motivation* to estimate motivational profiles for each of the measurement moments (1 measurement in Sample 1, 4 measurements in Sample 2). Latent profile analysis seeks to uncover hidden groups in a multivariate dataset using mixture modelling techniques (Vermunt & Magidson, 2002). A series of models ranging from one to six classes were estimated for each measurement moment, and we accounted for the clustering of students within classes (Sample 1) or schools (Sample 2) by adding class or school as a random effect in the model. Clustering was done differently between the datasets because class information was not available for all measurement moments within the Sample 2, so clustering within schools was used instead. To determine the optimal number of profiles for each set of data, we examined a variety of indicators: (1) the BIC, AIC, and SA-BIC, with lower values preferred over higher values; (2) entropy and posterior class membership probabilities, with numbers approaching one indicating a greater degree of classification accuracy (Nagin, 1999); (3) the adjusted Vuong-Lo-Mendell-Rubin test (VLMR; Lo et al., 2001) and bootstrap Lo-Mendell and Rubin test (BLRT; Nylund et al., 2007), with significant values indicating that a given model had better fit than the model with one less class; (4) parsimony, preferring solutions with fewer profiles, especially if additional profiles were similar to existing profiles; and (5) interpretability of solution. After determining the optimal number of profiles, we added ability group (high-ability vs. average-ability) to the models, to address RO1b of determining whether high-ability students showed different profile memberships than their average-ability peers. In the LPA models, associations between profile membership with ability group were explored using the BCH method (Bolck et al., 2004). The BCH method estimates weights reflecting assignment probabilities to the different classes, and it incorporates those weights in auxiliary models comparing variables across classes (Asparouhov & Muthén, 2021).

Next, to have insight in profile stability and students' profile transition patterns across time points (RO2a), we used latent transition analysis (LTA, Muthen & Asparouhov, 2022) to estimate the probability of students transitioning between the different profiles between each of the different time points in Sample 2. LTA is an extension of LPA which models profile membership for each time point as well as probability estimates for transitions between the profiles, using auto-regressive modelling techniques (Muthen & Asparouhov, 2022). We used the optimal number of classes determined by the LPA models in our LTA modelling, and fixed this number across time points; in the case where a different number of classes was considered optimal at different measurement times, we used the optimal number of classes of the chronologically earlier measurement moment. Once the LTA solution had been determined, we added ability group (high-ability vs. average-ability) to the models, to address RO2b of determining whether high-ability students showed different transition patterns than their average-ability peers. Ability group was modeled as a dummy variable and the transitions were regressed on ability group using multinomial logistic regressions, yielding odds ratios showing whether high-ability students were more or less likely than their peers to exhibit specific transition patterns.

To explore outcomes of the motivational profiles (RO3), we used the BCH method in both samples to explore profile-based differences in outcome values. We used Wald's test to test for significant differences in outcome values across classes, and we calculated Cohen's effect sizes *d* to determine the magnitude of class-based outcome differences. Finally, in Sample 1 only, we assessed associations between the motivational profiles and antecedents (RO4a) by exploring associations of LPA profiles with need supportive teaching practices and adequate curricular challenge as predictors. We again used the BCH method to explore these associations and accompanying effect sizes of class-based variable differences. Finally, we used multinomial logistic mixed models to compare the predictor-profile associations between high-ability and average-ability students (RO4b). Specifically, ability group was modeled as a known class in a series multi-group models in which need supportive teaching practices and adequate challenge were constrained and unconstrained and then compared for model fit using a scaling-corrected chi-square difference test based on the models' log-likelihood values.

3. Results

3.1. Preliminary analyses

3.1.1. Sample 1

The intercorrelations of motivation variables at adjacent measurement time points were significant at the $p < .001$ level. Furthermore, the motivational variables were generally correlated with each other to a small to moderate degree and small to moderate, except for External and Identified Motivations, which were not significantly correlated. Regarding the outcome variables, Behavioral and Emotional Engagement were generally positively correlated with Intrinsic, Identified, and Introjected Motivations, and negatively correlated with External Motivation, across perspectives. Underachievement showed small negative correlations with Intrinsic, Identified, and Introjected Motivations, and small positive correlations with External Motivation, across perspectives. Regarding predictors, Adequate Curricular Challenge and Needs Supportive Teaching practices were positively correlated with Intrinsic, Identified, and Introjected Motivations to a small degree, and negatively correlated with External Motivation to a trivial or insignificant degree. For tables of correlations of all study variables, refer to Appendix A.

Appendix B1 shows the mean values of all study variables comparatively in the High-Ability and Average-Ability groups. Regarding motivational variables, there were no significant differences between high-ability and average-ability students for autonomous or controlled forms of motivation. In regards to the outcome measures, parents and teachers reported higher behavioral engagement, teachers reported higher emotional engagement, and students and parents reported lower underachievement among high-ability students relative to their peers. The high-ability students also achieved more highly in school, as evidenced by a significantly higher average grade point average. Lastly, in regards to contextual predictors, high-ability and average-ability students differed significantly in their perceptions of adequate curricular challenge and need supportive teaching practices, with high-ability students reporting lower levels of adequate curricular challenge and higher levels of both autonomy support and involvement from teachers.

3.1.1.1. Measurement invariance. For the motivational variables in Sample 1, we tested measurement invariance across ability groups in a stepwise manner by imposing increasingly strict equality constraints to our model. First we tested configural invariance (i.e., invariance in the pattern of factor loadings), then metric invariance (i.e., invariance in the equality of factor loadings), and lastly scalar invariance (i.e., invariance of factor intercepts) (Geiser, 2013). To compare two nested models with consecutive levels of invariance, we examined the differences in model fit using the comparative fit indices (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR), according to established thresholds specific to each level of measurement (Chen, 2007). For all variables, factor patterns and loadings were found to be equal over ability groups in all constructs (i.e., configural and metric invariance). Full scalar invariance was established (CFI = 0.952, RMSEA = 0.036, SRMR = 0.057), which allowed for comparative analysis between ability groups.G

3.1.2. Sample 2

For tables of correlations of the study's variables, refer to Appendix

A. Autonomous forms of motivation (i.e. intrinsic and identified motivation) were positively correlated with each other across measurements moments, as were forms of controlled motivation (i.e. introjected and external motivation). Correlations between autonomous and controlled forms of motivation were very small and often insignificant. Autonomous forms of motivation showed small to moderate positive correlations with engagement measures, insignificant or barely significant correlations with math achievement, and trivial negative correlations with teacher-perceived underachievement and non-academic track selection in secondary school. Within compulsory education, controlled forms of motivation showed trivial or insignificant negative correlations with engagement, and mostly insignificant positive correlations with underachievement and track selection. In higher education small negative correlations between external motivation and engagement (flow) measures became apparent.

Appendices B2 and B3 shows the mean values of all study variables comparatively in the high-ability and average-ability groups. Regarding motivational variables, the high-ability students evidenced lower levels of identified motivation throughout compulsory education compared to their average-ability peers. They also showed lower levels of introjected motivation in Grades 6 and 7, but this difference was no longer present by Grade 11. Significant differences in intrinsic motivation were found on two instances, with high-ability students showing lower levels in Grade 7 and higher levels in higher education compared to their classmates. Regarding outcome measures, no differences were found in school engagement between the two ability groups in any stage of education. The high-ability students demonstrated persistently higher math achievement throughout compulsory education, and they were rated by teachers to be less likely to underachieve in Grade 7. The high-ability students were less likely to pursue non-academic studies and to be retained in secondary school, and they were also more likely to pursue higher education compared to the average-ability students.

3.1.2.1. Measurement invariance. Using the procedure detailed for Sample 1, we tested measurement invariance across ability groups for the motivation variables in Sample 2. For all variables, factor patterns and loadings were found to be equal over time and ability groups in all constructs (i.e., configural and metric invariance). Full scalar invariance was established for the measures across time (CFI = 0.927, RMSEA = 0.027, SRMR = 0.054), and partial scalar invariance was established for the measures across ability groups (CFI = 0.917, RMSEA = 0.029, SRMR = 0.075). Establishing (partial) scalar invariance permitted us to do analysis over time and comparatively between groups (Byrne, 2012). For full results of measurement invariance testing, refer to Appendix C.

3.2. Latent profiles of motivation

3.2.1. Sample 1

Investigating RO1a, we examined motivational profiles in the first year of secondary education using latent profile analysis. The 4-class solution was chosen because it had sufficient entropy (E = 0.705) and posterior classification probabilities (≥0.713), significant VLMR, lower BIC, AIC, and SABIC than the 3 profile solution, and distinct motivational patterns across classes. Although the AIC, BIC, and SABIC values elbowed at the 3 class solution, this was rejected because the motivational values were not as discriminant across classes, particularly for external motivation. For tables showing fit statistics for all class solutions, please refer to Appendix D in the Supplementary Materials.

The profiles in the optimal 4-class solution included a Good Quality motivation profile, characterized by high levels of intrinsic and identified motivation and low levels of introjected and external motivation, a High Quantity profile characterized by high levels of intrinsic, identified, introjected, and external motivation, a Moderate profile characterized by levels of all motivational variable at or around the sample mean, and a Low Quantity profile, characterized by values of intrinsic, identified, introjected, and external motivation that were all lower than the sample mean values. For variable values and patterns per profile, see Table 4, which depicts the raw and standardized values, and Fig. 1, which depicts the standardized values. For percentages of students per profile, see Table 5.

To explore whether certain profiles had higher shares of high-ability students (RO1b), ability groups and intelligence were associated with the LPA profiles using the BCH method. In this sample high-ability students were slightly more likely to be in the Low Quantity profile in Grade 7 compared to the Moderate and High Quantity profiles, and the Low Quantity profile also had a slightly higher average intelligence than the High Quantity profile. For all comparisons of intelligence scores and ability group prevalence between profiles, see Table 6.

3.2.2. Sample 2

Addressing RO1a, we examined motivational patterns in four stages of education (primary school, early secondary school, late secondary school, and higher education) using latent profile analysis. For primary school, early secondary school, and late secondary school, the four-profile solution was considered optimal; for higher education, the three-profile solution was chosen. Several factors influenced these decisions. In primary school, AIC, BIC, and SABIC values declined with increasing number of classes and elbowed at four classes. Although entropy peaked at three classes, it was still quite high at four classes (E = 0.841). The four class solution also had quite high posterior classification probabilities, at or exceeding 0.881, and the VLMR value indicated that it was better than three classes. Qualitatively, the four class solution was more compelling because the levels of introjected and external motivation were more distinct across classes than in the three class solution, and it yielded a unique class type. The five class solution was rejected because the additional class was similar to an existing class from the four class solution. For early secondary school, although the AIC, BIC, and SABIC values elbowed at five classes and entropy also peaked at the five class solution, again the fifth class was very similar to an existing class from the four-class solution. The four-class solution was favored for its high entropy value (E = 0.733), high posterior probability classification values (≥0.713), significant VLMR and BLRT values, and distinctness of variable combinations compared to the three-class and five-class solutions. For late secondary school, AIC, BIC, and SABIC values elbowed at the four-class solution. The entropy value for the four class solution was high (E = 0.702), as were the posterior classification probabilities (≥0.666), the VLMR value was significant, and the variable combinations were unique in each profile. The five class solution was rejected due to its insignificant VLMR value and the fact that the fifth profile was very similar to an existing profile. Finally, for higher education, the three class solution was chosen because the AIC, BIC, and SABIC values elbowed at this solution, the entropy value (E = 0.683) and posterior classification probabilities (≥0.784) were high, the variable combinations were distinct, and the VLMR and BLRT values were both significant. The four class solution, while yielding a higher entropy value and distinct variable combinations, was rejected because the VLMR value was not significant. Once the optimal class solutions were chosen for each dataset, the analyses were re-run using different seed values to ensure that the solution was replicable. For tables showing fit statistics for all class solutions across measurement moments, please refer to Appendix D in the Supplementary Materials.

The profile configurations were mostly similar across time, with the exception of the profiles found in higher education (see Table 4). In primary school, early secondary school, and late secondary school, Good Quality, High Quantity, Moderate, and Low Quantity profiles were found, similarly to the profiles and general variable combinations found in Sample 1. In higher education, there were Good Quality and High Quantity profiles similar to the other stages of education, but the third profile was unique to this educational stage; we labeled it External Motivation, as it was defined by high levels of external motivation, average levels of introjected motivation, and very low levels of intrinsic

Table 4
Estimated parameters of motivational variables for the optimal latent profile solutions.

	M (SD)	Good quality		High quantity		Moderate		Low quantity		Wald χ^2 (df)
		M	Z-score	M	Z-score	M	Z-score	M	Z-score	
Sample 1										
Grade 7										
Intrinsic motivation	2.49 (0.89)	3.37_a	0.99_a	3.17_b	0.77_b	2.18_c	-0.34_c	1.45_d	-1.17_d	3292.86 (3)***
Identified motivation	3.55 (0.84)	4.28_a	0.86_a	4.28_a	0.86_a	3.37_b	-0.22_b	2.21_c	-1.59_c	5186.40 (3) ***
Introjected motivation	2.89 (0.93)	2.38_a	-0.54_a	3.74_b	0.92_b	2.85_c	-0.04_c	2.03_a	-0.92_a	1957.98 (3) ***
External motivation	2.96 (0.86)	2.22_a	-0.86_a	3.38_b	0.50_b	2.99_c	0.05_c	2.83_d	-0.15_d	811.41 (3)***
Sample 2										
Grade 6										
Intrinsic motivation	3.38 (1.04)	3.57_a	0.20_a	3.88_b	0.50_b	2.92_c	-0.41_c	2.43_d	-0.87_d	604.41 (3)***
Identified motivation	4.38 (0.73)	4.87_a	0.65_a	4.88_a	0.67_a	3.83_b	-0.64_b	2.83_c	-1.89_c	12,911.79 (3)***
Introjected motivation	2.67 (1.03)	2.01_a	-0.63_a	3.58_b	0.90_b	2.52_c	-0.13_c	2.29_d	-0.36_d	1790.14 (3)***
External motivation	3.35 (0.98)	2.80_a	-0.56_a	4.10_b	0.75_b	3.29_c	-0.07_c	3.09_d	-0.27_d	1128.84 (3)***
Grade 7										
Intrinsic motivation	3.30 (1.02)	3.60_a	0.32_a	4.00_b	0.70_b	2.96_c	-0.29_c	2.28_d	-0.94_d	817.94 (3)***
Identified motivation	3.99 (0.86)	4.66_a	0.78_a	4.76_a	0.88_a	3.59_b	-0.36_b	2.43_c	-1.58_c	5204.109 (3)***
Introjected motivation	2.82 (0.91)	2.12_a	-0.74_a	3.58_b	0.85_b	2.75_c	-0.05_c	2.32_d	-0.52_d	1094.77 (3)***
External motivation	3.57 (0.94)	2.89_a	-0.70_a	4.18_b	0.65_b	3.53_c	-0.04_c	3.30_d	-0.27_d	935.78 (3)***
Grade 11										
Intrinsic motivation	2.93 (0.89)	3.49_a	0.66_a	3.63_b	0.81_b	2.77_c	-0.14_c	1.89_d	-1.10_d	1173.69 (3)***
Identified motivation	3.88 (0.76)	4.57_a	0.89_a	4.63_a	0.97_a	3.71_b	-0.16_b	2.72c	−1.37c	1844.78 (3)***
Introjected motivation	2.74 (0.89)	1.86_a	-0.95_a	3.42_b	0.78_b	2.76_c	0.05_c	2.19_d	-0.59_d	762.04 (3)***
External motivation	3.57 (0.89)	2.53_a	-1.13_a	4.06_b	0.54_b	3.59_c	0.03_c	3.46_c	-0.12_c	511.94 (3)***
		Good quality		**High quantity**		**Externally motivated**				
		M	**Z-score**	**M**	**Z-score**	**M**	**Z-score**			
Higher education										
Intrinsic motivation	3.29 (0.87)	3.60_a	0.36_a	3.59_a	0.35_a	2.42_b	-1.01_b			42,730 (2)***
Identified motivation	4.11 (0.62)	4.28_a	0.28_a	4.35_b	0.39_b	3.50_c	-0.98_c			323.52 (2)***
Introjected motivation	3.20 (0.85)	2.33_a	-1.02_a	3.76_b	0.66_b	3.14_c	-0.07_c			687.69 (2)***
External motivation	3.11 (0.91)	2.17_a	-1.03_a	3.48_b	0.41_b	3.46_b	0.38_b			441.50 (2)***

Note: A profile mean is significantly different from another mean if it has a different superscript than another profile. A mean without superscript is not significantly different from any other means.
*** $p < .001$.

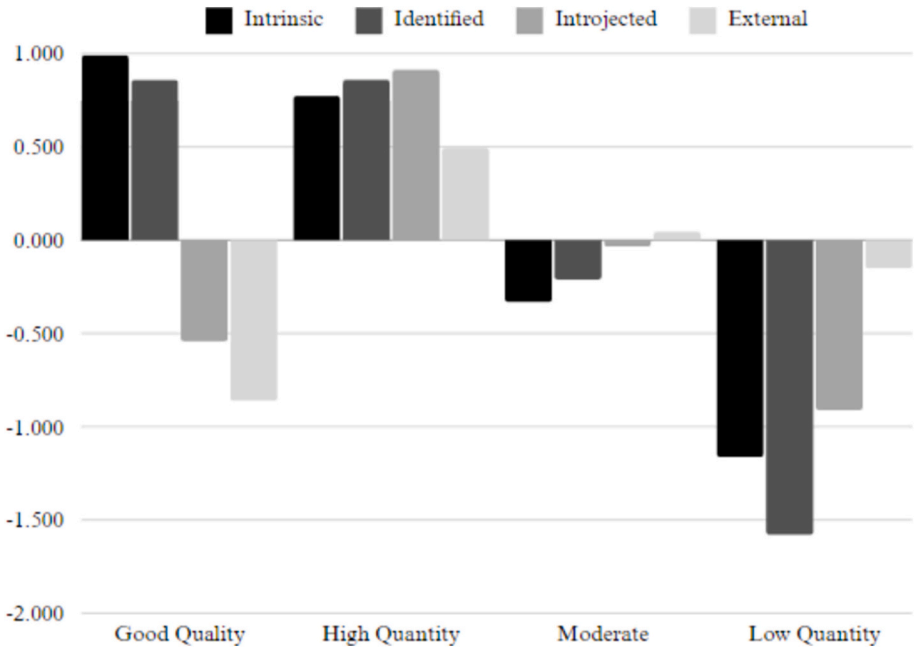


Fig. 1. Sample 1: standardized means of motivational variables.

and identified motivation. For variable patterns per profile and grade, see Fig. 2.

To examine whether there were differences across ability groups in profile memberships (RO1b), ability groups and intelligence were associated with the LPA profiles using the BCH method. These analyses yielded significant differences in profile membership between high-ability and average ability students, and across range of IQ scores for all educational stages except for higher education (see Table 6). In Grade 6, there were significantly higher concentrations of High-Ability students in the Good Quality and Moderate profiles than there were in the High Quantity Profile, and students in the High Quantity profile had a significantly lower average IQ score than students in the other profiles.

Table 5
Share of students per profile and stage of education, both samples (percentages).

Class	Good quality	High quantity	Moderate	Low quantity
Sample 1				
Grade 7	17.5	24.8	43.8	14.0
Sample 2				
Grade 6	28.8	31.8	28.3	11.0
Grade 7	25.1	29.0	38.4	7.6
Grade 11	22.1	29.5	42.3	6.0
Higher education	26.9	26.3	41.3	5.4

In Grade 7, although students in the Good Quality profile still had a higher average IQ score than students in the High Quantity profile, students in the Moderate profile had the highest share of high-ability students compared to all other profiles. In Grade 11, this pattern continued, with the highest IQ and the highest share of High-Ability students being found in the Moderate group. In higher education, there were no differences in intelligence or ability groups across profiles, and the average IQ level was high across profiles.

3.3. Latent profile transitions

3.3.1. Sample 2

Addressing RO2a, latent transition analysis was used among Sample 2 with the optimal profile solution from the LPAs. The four-profile solution was used across times, as this was the optimal solution in three of the four datasets. Percentage of students in each profile varied across stages of education (see Table 5), with the amount of students in the Good Quality profile decreasing slightly throughout compulsory education and then increasing in higher education, the amount of students in High Quantity decreasing across all stages of education, the amount of students in Moderate increasing across compulsory education increasing across compulsory education and remaining consistent into higher education, and the amount of students in Low Quantity decreasing consistently across educational stages. Profile stability was found to vary depending on which transition was taking place. In the transition from primary to secondary school, the High Quantity profile was most stable, while from early to late secondary school the Moderate profile was most stable. In the transition from secondary school to higher education, the Good Quality profile was most stable. For the Good Quality, High Quantity, and Moderate profile students tended to stay in the same profile from one measurement moment to the next, while students in the Low Quantity profile tended to change to another profile, with consistent transitions to especially the Moderate but also to the Good Quality profile across educational stages. For a full picture of all transitions between all measurement moments, refer to Table 7.

Next, to explore whether transition patterns differed among ability groups (RO2b), we examined ability group (1 = High-Ability, 0 = Average-Ability) as a predictor of transition probabilities, expressed as odds ratios. At 95 % confidence, in the transition from Grade 6 to Grade 7 high-ability students were found to be almost three times as likely to transition into the Moderate profile rather than stay in the High Quantity profile when compared to their peers. They were also much less likely to transition into the High Quantity or Low Quantity profiles from the Moderate profile. From Grade 7 to Grade 11, the high-ability students were five times as likely to transition from the Good Quality profile to the Moderate profile compared to their peers. From Grade 11 to higher education, there were no difference in profile transitions based on ability group. To view the role of ability group in predicting all transition probabilities, refer to Table 8.

Table 6
Share of high-ability group and mean intelligence, effect size d among motivational profiles.

Dimension and variable	(1) Good quality α	(2) High quantity α	(3) Moderate α	(4) Low quantity α	Wald χ^2 (df)	1 vs. 2 Effect size d	1 vs. 3 Effect size d	1 vs. 4 Effect size d	2 vs. 3 Effect size d	2 vs. 4 Effect size d	3 vs. 4 Effect size d
Sample 1											
Grade 7											
High-ability % (IQ ≥ 120)	15_{ab}	14_{a}	15_{a}	21_{b}	5.91 (3)	0.12	0.01	0.18	0.03	0.19*	0.17*
Intelligence	106.72_{ab}	106.27_{a}	106.76_{a}	108.81_{b}	7.34 (3)	0.04	0.00	0.18	0.04	0.22**	0.18*
Sample 2											
Grade 6											
High-ability % (IQ ≥ 120)	25_{a}	19_{b}	28_{a}	24_{ab}	11.91 (3)**	0.14*	0.08	0.02	0.23***	0.12	0.11
Intelligence	110.9_{a}	107.7_{b}	112.6_{a}	111.1_{a}	19.28 (3)***	0.19**	0.09	0.01	0.28***	0.20*	0.08
Grade 7											
High-ability % (IQ ≥ 120)	20_{ac}	13_{a}	30_{b}	22_{c}	47.45 (3)***	0.16	0.25**	0.05	0.42***	0.21*	0.20*
Intelligence	109.2_{a}	105.4_{b}	112.8_{c}	110.1_{ac}	50.02 (3)***	0.22*	0.22**	0.06	0.43***	0.27**	0.16
Grade 11											
High-ability % (IQ ≥ 120)	16_{a}	20_{ac}	33_{b}	26_{bc}	23.04 (3)***	0.08	0.39***	0.24*	0.30***	0.16	0.15
Intelligence	106.5_{a}	108.4_{a}	114.6_{b}	110.8_{a}	28.09 (3)***	0.11	0.46***	0.24	0.35***	0.13	0.21*
	(1) Good quality α	**(2) High quantity α**	**(3) Externally motivated α**		**Wald χ^2 (df)**	**1 vs. 2 Effect size d**	**1 vs. 3 Effect size d**	**2 vs. 3 Effect size d**			
Higher education											
High-ability % (IQ ≥ 120)	45	46	35		2.80 (2)	0.03	0.20	0.22			
Intelligence	118.9	120.1	116.2		2.37 (2)	0.06	0.14	0.21			

Note: A profile mean is significantly different from another mean if it has a different superscript than another profile. A mean without superscript is not significantly different from any other mean.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

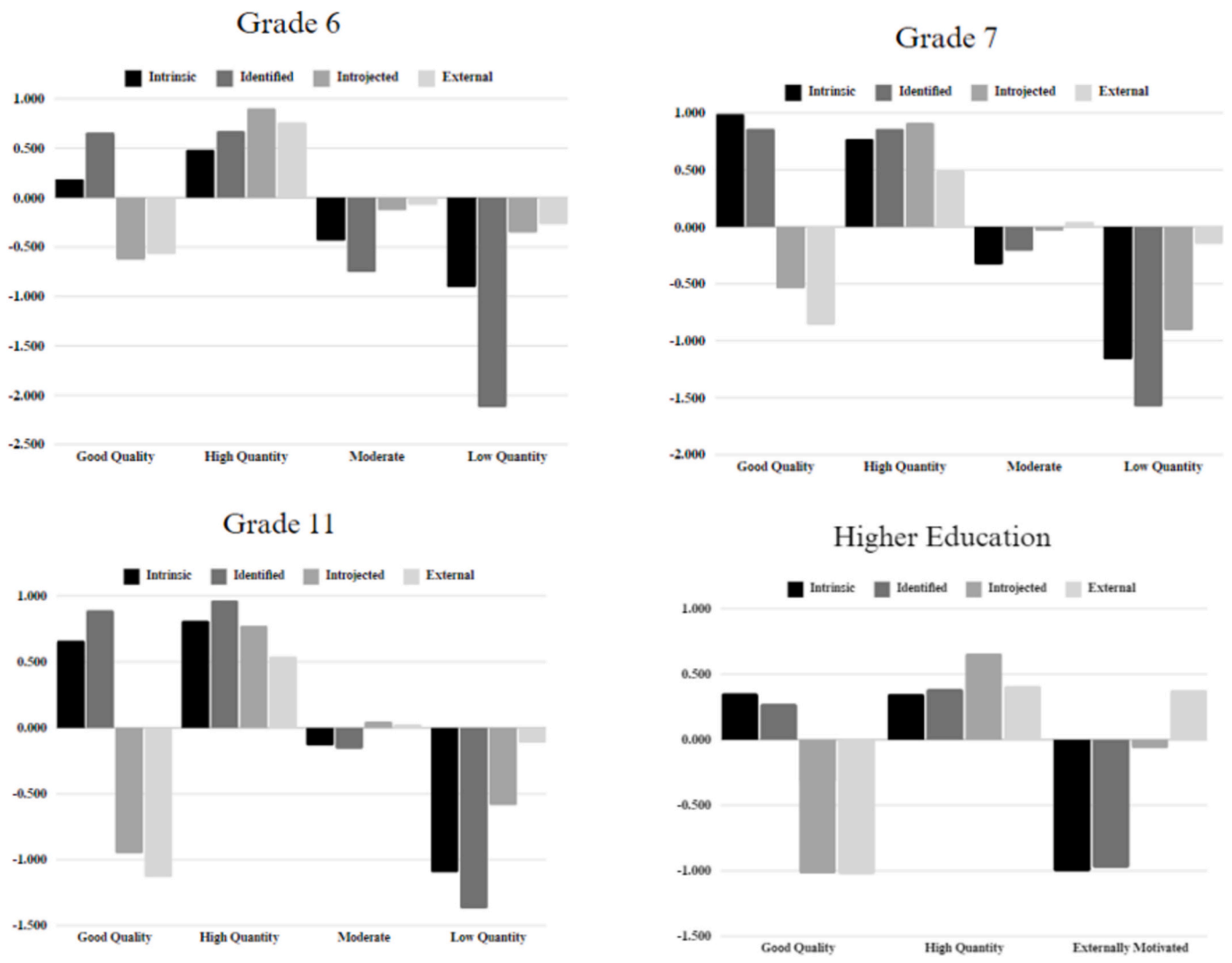


Fig. 2. Sample 2: standardized means of motivational variables per profile.

Table 7
Transition probabilities per profile, Sample 2.

Class	Good quality	High quantity	Moderate	Low quantity
Grade 6 (row) to Grade 7 (col.)				
Good quality	**0.66**	0.00	0.29	0.05
High quantity	0.00	**0.75**	0.23	0.12
Moderate	0.17	0.14	**0.58**	0.10
Low quantity	0.11	0.10	0.56	**0.23**
Grade 7 (row) to Grade 11 (col.)				
Good quality	**0.48**	0.23	0.25	0.04
High quantity	0.11	**0.51**	0.34	0.04
Moderate	0.14	0.22	**0.57**	0.06
Low quantity	0.19	0.05	0.56	**0.21**
Grade 11 (row) to High. Ed. (col.)				
Good quality	**0.75**	0.12	0.10	0.04
High quantity	0.08	**0.52**	0.40	0.01
Moderate	0.15	0.20	**0.57**	0.09
Low quantity	0.29	0.01	0.60	**0.10**

Note: Numbers in bold indicate students who remained in the same profile between measurements. Underlined numbers represent the most likely transition besides remaining in the same profile.

3.4. Outcomes of latent motivational profiles

3.4.1. Sample 1

Next, we explored outcomes of the motivational profiles (RO3), using the BCH method. School engagement varied dramatically across profiles. Differences were also found between students in the Good Quality and High Quantity profiles in Grade 7, with Good Quality students showing higher levels of emotional engagement. Teacher and Parent perspectives also showed these differences, and measures of Behavioral Engagement were also discriminant across most profiles and perspectives. Underachievement showed profile-based differences across perspectives, with students in the Good Quality profile generally showing the lowest level of underachievement and students with Low Quantity motivation showing the highest. Similarly, students with Good Quality motivation showed the highest achievement as indicated by GPA, although there was no significant difference between these students and those in the High Quantity group, and students with Low Quantity motivation showed the lowest average achievement, although they were indistinguishable from the Moderate students. The intercepts of all distal outcome variables, as well as the Wald tests and effect sizes of value differences between profiles, can be found in Table 9.

3.4.2. Sample 2

We also used the BCH method to explore outcomes of the

Table 8
High-ability group as predictor of profile transitions, Sample 2 (odds ratios).

Class	Good quality	High quantity	Moderate	Low quantity
Grade 6 (row) to Grade 7 (column)				
Good quality	1.00	0.00	1.30	2.07
High quantity	0.00	1.00	2.86*	0.00
Moderate	0.48	0.23*	1.00	0.28*
Low quantity	0.54	0.00	0.78	1.00
Grade 7 (row) to Grade 11 (column.)				
Good quality	1.00	0.81	5.08*	2.17
High quantity	0.00	1.00	0.92	2.58
Moderate	0.48	1.23	1.00	0.60
Low quantity	0.54	0.00	3.23	1.00
Grade 11 (row) to High. Ed. (col.)				
Good quality	1.00	1.17	0.04	0.56
High quantity	0.41	1.00	12.14	1.06
Moderate	0.00	1.14	1.00	3.90
Low quantity	1.01	1.04	0.14	1.00

Note: Odds ratio values indicate how much more likely a high-ability student is to be in that profile compared another profile.
* $p > .05$.

motivational profiles in Sample 2. For the results of this analysis, please refer to Table 10. In this Sample, most profiles diverged to a great extent in their levels of school engagement, particularly within compulsory education. Students in Good Quality and High Quantity profiles did not differ from each other, but they each showed higher levels of emotional engagement compared to students in Moderate and Low Quantity profiles, with differences characterized by large effect sizes. The Low Quantity profile experienced the steepest average decline in school engagement, with differences pronounced by increasingly larger effect sizes compared to other profiles in progressive stages of education. Regarding math achievement, this varied depending on level of education. In Grade 6, there were no significant differences in math achievement across profiles. In Grade 7, the Good Quality and Moderate profiles showed the highest level of math achievement. In Grade 11, the highest level of math achievement was found only in the Moderate profile. In Grade 7, underachievement assessed by teachers had a significant lower average value among students in the Good Quality profile compared to all other profiles, and students in the High Quantity profile had significantly lower underachievement values than students in the Moderate profile. Students in the Low Quantity profile were more likely than students with Good Quality and Moderate motivation to choose a non-academic track in Grade 9, and students in the Good Quality profile were least likely to be retained during high school. In Grade 11, students in the Moderate profile were less likely to end up in a non-academic track by the end of high school than students with Good Quality or Low Quantity motivation, and they were more likely than these profiles to pursue higher education.

3.5. Contextual predictors of motivational profiles

Next, we examined contextual predictors of the motivational profiles in Sample 1, addressing Research Objective 4. Adequate curricular challenge as well as the need supportive teaching practices autonomy

Table 9
Sample 1: intercepts of distal outcome variables by class, effect size d between classes.

Dimension and variable	(1) Good quality α	(2) High Quantity α	(3) Moderate α	(4) Low quantity α	Wald χ^2 (df)	1 vs. 2 Effect size d	1 vs. 3 Effect size d	1 vs. 4 Effect size d	2 vs. 3 Effect size d	2 vs. 4 Effect size d	3 vs. 4 Effect size d
Behavioral engagement											
Student perspective (n = 2470)	4.27	4.16	3.67	3.16	544.16 (3)***	0.20*	1.04***	1.93***	0.84***	1.73***	0.90***
Parent perspective (n = 1887)	4.26	3.96	3.80	3.48	137.04 (3)***	0.45***	0.68***	1.16***	0.24**	0.72***	0.48***
Teacher perspective (n = 1784)	4.26	4.08	3.85	3.46	85.27 (3)***	0.19	0.44***	0.86***	0.25**	0.67***	0.41***
Emotional engagement											
Student perspective (n = 2470)	4.15	3.92	3.21	2.69	837.09 (3)***	0.37***	1.49***	2.32***	1.13***	1.95***	0.83***
Parent perspective (n = 1887)	4.20	3.98	3.87	3.62	103.14 (3)***	0.38***	0.58***	1.02***	0.20**	0.64***	0.44***
Teacher perspective (n = 1783)	4.08	3.84	3.65	3.27	71.81 (3)***	0.25***	0.44***	0.82***	0.19*	0.58***	0.39***
Underachievement											
Student perspective (n = 2456)	2.12	2.53	2.74	3.10	99.48 (3)***	−0.37***	−0.56***	−0.88***	−0.18**	−0.51***	−0.32***
Parent perspective (n = 1890)	1.98	2.41	2.52	2.88	69.40 (3)***	−0.40***	−0.50***	−0.84***	−0.10	−0.44***	−0.34***
Teacher perspective (n = 1785)	1.84	1.97	2.09	2.51	40.66 (3)***	−0.12	−0.22*	−0.62***	−0.10	−0.50***	−0.39***
GPA (%) (n = 2209)	76.74	74.99	73.05	71.85	39.30 (3)***	0.19	0.39***	0.52***	0.21**	0.33***	0.13
Number of significant differences						**7/10**	**10/10**	**10/10**	**8/10**	**10/10**	**9/10**

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

Table 10
Sample 2: intercepts of distal outcome variables by class, effect size d between classes.

Compulsory education: dimension and variable	(1) Good quality α	(2) High quantity α	(3) Moderate α	(4) Low quantity α	Wald χ^2 (df)	1 vs. 2 Effect size *d*	1 vs. 3 Effect size *d*	1 vs. 4 Effect size *d*	2 vs. 3 Effect size *d*	2 vs. 4 Effect size *d*	3 vs. 4 Effect size *d*
Sample 2											
Grade 6 profiles											
School engagement, Gr 6	3.96_a	3.92_b	3.39_c	3.04_d	341.67 (3)***	0.06	0.78***	1.25***	0.72***	1.19***	0.47***
Math achievement, Gr 6	107.55_a	107.53_a	107.83_a	106.04_b	5.86 (3)	0.00	0.04	0.19*	0.04	0.19*	0.22*
Grade 7 profiles											
School engagement, Gr 7	4.05_a	4.00_a	3.50_b	2.97_c	420.96 (3)***	0.80	0.89***	1.73***	0.81***	1.65***	0.84***
Math achievement, Gr 7	111.98_a	109.79_b	112.02_a	109.66_c	11.95 (3)**	0.20*	0.00	0.21*	0.20**	0.01	0.22*
Underachievement, Gr 7	2.44_{ac}	2.72_b	2.94_c	2.95_b	28.77 (3)***	0.21*	0.39***	0.39***	0.18**	0.18	0.00
Non-academic track, Gr 9	0.45_a	0.52_{ab}	0.46_a	0.57_b	7.70 (3)*	0.13	0.01	0.24*	0.12	0.11	0.23*
Grade retention, Gr 7–12	0.12_a	0.23_b	0.18_b	0.23_b	11.78 (3)**	0.29**	0.16*	0.29**	0.13	0.00	0.13
Grade 11 profiles											
School engagement, Gr 11	3.75_a	3.79_a	3.32_b	2.62_c	320.92 (3)***	0.06	0.72***	1.90***	0.78***	1.96***	1.18***
Math achievement, Gr 11	-0.05_a	0.06_a	0.30_b	0.01_a	23.26 (3)***	0.13	0.42***	0.07	0.29***	0.06	0.35***
Non-academic track, Gr 12	0.75_a	0.65_{ac}	0.60_{bc}	0.73_a	10.76 (3)**	0.21	0.30**	0.03	0.09	0.18	0.27**
Pursuit of higher education	0.76_{ac}	0.89_{ab}	0.90_b	0.69_c	10.79 (3)**	0.38	0.40*	0.22	0.03	0.60**	0.62**
Number of significant differences						**3/11**	**8/11**	**8/11**	**6/11**	**5/11**	**9/11**
Higher education: dimension and variable	**(1) Good quality α**	**(2) High quantity α**	**(3) Externally motivated α**		**Wald χ^2 (df)**	**1 vs. 2 Effect size *d***	**1 vs. 3 Effect size *d***	**2 vs. 3 Effect size *d***			
School engagement: vigor	2.98_a	3.04_a	2.34_b		65.46 (2)***	0.09	1.02***	1.11***			
School engagement: dedication	4.04_a	3.98_a	2.96_b		155.42 (2)***	0.12	2.02***	1.90***			
School engagement: absorption	3.03_a	3.07_a	2.30_b		72.94 (2)***	0.07	1.09***	1.17***			
Count of significant differences						**0/3**	**3/3**	**3/3**			

Note: A profile mean is significantly different from another mean if it has a different superscript than another profile. A mean without superscript is not significantly different from any other mean.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

support and involvement were all found to vary significantly across most profiles (RO4a). The highest level of adequate curricular challenge was reported by students in the Good Quality profile, followed by the High Quantity profile, then the Moderate profile, and lastly the Low Quantity profile. Students with Good Quality and High Quantity motivation did not report average differences in need supportive teaching, but there were differences between these two groups and all the remaining groups, with students in the Moderate profile reporting lower levels of both Autonomy Support and Involvement, and students in the Low Quantity profile reporting even lower levels of both practices. For an overview of the intercepts of all predictor variables per profile, as well as the Wald tests and effect sizes of value differences between profiles, refer to Table 11.

Finally, we examined differences in the predictive relationships between the contextual predictors and the motivational profiles between ability groups (RO4b). The multi-group analyses in the multinomial logistic mixed models revealed that, for each of the predictor variables, the model in which the parameters were allowed to vary between ability groups did not have significantly better model fit than the model in which the parameters were constrained across groups (see Table 12 for the model results of the best-fitting models). As such, we concluded that there were no significant group-based differences in the relationships between the predictor variables and the motivational profiles.

4. Discussion

The present research gives comprehensive comparative insight on the motivation of high-ability students and their classmates in general classrooms across multiple samples and within multiple stages of education. By utilizing multiple samples and identifying high-ability students in a non-selective manner, the findings in this paper clarify and expand upon earlier findings about motivational profiles among students generally and among high-ability students in particular. Complementary findings within the two samples allowed us to make more confident assertions about motivational development among high-ability student and their peers. Analyzing data spanning compulsory and higher education allowed us to pinpoint stages of education that are less motivationally optimal for high-ability students, implying that particular attention should be paid to their educational needs during these times. In the text below, we will systematically discuss our findings according to our research objectives and identify implications and further questions that are raised by this study.

Table 11
Sample 1: intercepts of distal predictor variables by class, effect size d between classes.

Dimension and variable	(1) Good quality α	(2) High Quantity α	(3) Moderate α	(4) Low Quantity α	Wald χ^2 (df)	1 vs. 2 Effect size *d*	1 vs. 3 Effect size *d*	1 vs. 4 Effect size *d*	2 vs. 3 Effect size *d*	2 vs. 4 Effect size *d*	3 vs. 4 Effect size *d*
Grade 7											
Adequate curricular challenge (n = 2323)	4.10_a	3.99_b	3.78_c	3.59_d	100.85 (3)***	0.17***	0.51***	0.81***	0.34***	0.64***	0.30***
Teaching: autonomy support (n = 2346)	3.83_a	3.81_a	3.50_b	3.34_c	97.87 (3)***	0.03	0.45***	0.66***	0.42***	0.63***	0.21*
Teaching: involvement (n = 2349)	3.88_a	3.92_a	3.53_b	3.36_c	138.85 (3)***	0.06	0.50***	0.73***	0.56***	0.79***	0.23**

Note: A profile mean is significantly different from another mean if it has a different superscript than another profile. A mean without superscript is not significantly different from any other mean.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 12
Logistic regression models predicting motivational profile of high-ability (HA) and average-ability (AA) students, controlled for clustering within classes.

Coefficient	Adequate curricular challenge	Teacher autonomy support	Teacher involvement
Model fit			
Loglikelihood	−3838.733	−3879.725	−3863.470
Scaling correction factor for MLR	1.2806	1.3783	1.3483
AIC	7703.466	7779.449	7746.941
BIC	7778.224	7837.054	7804.558
Odds ratios (95 % CI)			
Reference class: good quality motivation			
Poor quality motivation	0.308*** (0.228, 0.415)	0.456*** (0.365, 0.570)	0.396*** (0.311, 0.503)
Moderate motivation	0.476*** (0.377, 0.601)	0.601*** (0.503, 0.719)	0.552*** (0.454, 0.670)
High quantity motivation	0.822 (0.633, 1.066)	0.966 (0.791, 1.18)	1.064 (0.856, 1.321)

Note: ***$p < .001$. The models depicted are the final multi-group models, all in which the parameters were constrained to be equal across the ability groups, indicating that there were no group-based differences in the predictive relationships.

4.1. Motivational profiles across four stages of education

Our first research objective was to identify motivational profiles across educational stages. We identified consistent profiles within compulsory education: Good Quality, High Quantity, Moderate, and Low Quantity profiles. While three of these profiles align with prior research (Hayenga & Corpus, 2010; Vansteenkiste et al., 2009; Wormington et al., 2012), we found a Moderate profile characterized by moderate levels of all types of motivation, contrasting previous findings. An additional Externally Motivated profile emerged in Higher Education. Our study aimed to ascertain generalizability by incorporating multiple samples, revealing largely consistent findings across samples and alignment with prior research.

Consistent with previous studies, autonomous motivation levels decreased throughout compulsory education but increased in higher education, likely due to students engaging with subjects more aligned with their skills and interest (Vansteenkiste et al., in press). However, this trend might also reflect sample characteristics, as students with low quantity motivation were less likely to pursue higher education. Additionally, the higher education sample only included students still in school after 3 years, excluding dropouts and likely raising overall motivation levels.

Regarding differences in profile membership between high-ability students and average-ability students (RO1b), when differences did exist higher membership by the high-ability students was noted in profiles characterized by lower levels of autonomous motivation. These differences were observed primarily in secondary school, and they were observed among both samples. These findings suggest that secondary school may not be meeting the developmental needs of high-ability students. This interpretation is reinforced by the finding that there were no significant differences in ability group or intelligence across profiles in higher education, although differences could also be masked by the general higher ability level within higher education.

4.2. Transitions between profiles across different educational stages

Our second research objective explored motivational transitions across four stages of education (RO2a). In Sample 2, while most students remained in their original profile, those who did transition predominantly moved towards the Moderate profile. This was true of students in the Good Quality and High Quantity profiles, which might be expected given the decreasing levels of autonomous motivation throughout compulsory education (Gottfried et al., 2001), but it was also true for the Low Quantity profile, which indicated an increase in autonomous motivation for a subset of students. Moreover, a fair number of students from the Low Quantity profile transitioned to the Good Quality profile in the transition from primary to secondary school (transition probability = .11), within secondary school (transition probability = .19), and especially in the transition to higher education (transition probability = .29). This finding lends some evidence that the nature of higher education may be more bolstering to students' autonomous motivation than secondary education as proposed by Vansteenkiste et al. (in press). Further, and more generally, these findings suggest that educational transitions can offer opportunities for motivational improvement among students with sub-optimal motivation in previous stages, indicating that different student subtypes may be optimally motivated in different educational stages.

Regarding differences between high-ability and average-ability

students (RO2b), previous work indicated that clinically diagnosed high-ability students were more likely than their peers to shift towards less favorable motivational patterns in late primary school (Hornstra et al., 2023). Our study aimed to test this trend across a longer time frame among multiple nonselective samples of a non-clinical population of students with high cognitive ability. Results showed that high-ability students were more likely than their peers to transition to lower quality motivation as the progressed from late primary to late secondary school. First, in the transition from primary to secondary school, high-ability students were almost three times as likely than their peers to move from the High Quantity to the Moderate profile, implying decreases in both autonomous and controlled motivation. Second, in the transition from early to late secondary school, high-ability students were five times as likely than their peers to transition from Good Quality to Moderate motivation, implying primarily decreases in autonomous forms of motivation. These findings highlight secondary school as a problematic context for the motivational development of high-ability students, at least in the Flemish context, and they echo trends found within formally identified populations of high-ability students in late primary school in the Dutch context (Hornstra et al., 2023).

4.3. What are the outcomes of the profiles, and does adaptability of profiles vary between educational stages?

Regarding our third research objective on examining outcomes of motivational profiles, consistent findings emerged across samples and educational stages. Similar to previous research (Hayenga & Corpus, 2010; Vansteenkiste et al., 2009; Wormington et al., 2012), the Good Quality motivational profile generally yielded the most favorable educational outcomes. In Sample 2, this profile was associated with the highest levels of engagement in all educational stages, along with the High Quantity profile. Students with Good Quality motivation exhibited lower rates of underachievement in Grade 7, and of grade repetition in secondary school, compared to other profiles. They also demonstrated higher math achievement than students with Low Quantity (Grades 6 and 7) and High Quantity (Grade 7) motivation, and they were more likely to pursue academic studies than students with Low Quantity motivation. Sample 1 further reinforced these findings, showing higher behavioral and emotional engagement and lower rates of underachievement according to multiple perspectives among students with Good Quality motivation compared to other profiles. In both samples, students in the Moderate profile were characterized by relatively good performance in regards to achievement outcomes, but tended to do more poorly in regards to other variable (e.g., underachievement, engagement, adequate curriculum challenge). Given that more high ability students are present in this group, this may explain why the students performed well academically while not showing optimal engagement.

Beyond the overall agreement with previous work, however, the current research also brings up some caveats. Similar to the findings of Corpus and Wormington (2014), in Sample 2 there were no large differences in math achievement across profiles in primary school—the overall Wald test was insignificant for this variable, and only slight profile-specific differences were found between the Low Quantity and other profiles. While the authors assumed in their study that the lack of differences in achievement across profiles could be because close relationships with teachers could encourage engagement, the current study did find marked differences in engagement between motivational profiles, with students exhibiting lower quality motivation also showing lower levels of engagement. In light of this finding, it is more likely that differences in achievement are not seen yet in primary school because motivational decline and disengagement often precede declines in achievement (Landis & Reschly, 2013), not because close relationships with teachers compensate for lack of autonomous motivation.

Another assertion put forward in previous work is that high quantity motivation is likely to be more beneficial to achievement outcomes in older student populations compared to younger ones (Hayenga & Corpus, 2010). However, this assertion was not confirmed in our study, as the High Quantity profile showed consistently positive outcomes across samples and educational stages, without increasing in advantageousness compared to other profiles. Granted, the lowest age in this study was the last grade of primary school, so it is possible that it is already beneficial to have high quantity motivation at this age, and that the differences would be more pronounced in relation to even younger students.

4.4. Do needs supportive teaching practices and adequate curricular challenge predict profile membership?

Finally, our hypotheses regarding the associations between motivational profiles and needs supportive teaching practices and adequate curricular challenge (RO4a) as well as our expectations about the relationships being similar for high-ability and average-ability students (RO4b) were largely confirmed. According to Self-Determination Theory, student's intrinsic motivation is fostered through need supportive teaching practices (Deci & Ryan, 2002) The current study showed this to be true within Sample 1, as the profiles highest in intrinsic motivation, namely Good Quality and High Quantity, reported the highest levels of the need supportive teaching practices Autonomy Support and Involvement, with no discernable differences between high-ability and average-ability students. Interestingly, adequate curricular challenge, which can be seen as a form of competence support, was also found to differ across motivational profiles to a similar extent and in similar ways as needs supportive teaching practices. Students in the Good Quality and High Quantity profiles reported the highest levels of adequate curricular challenge, followed by students with Moderate and then students with Low Quantity beliefs. Predictive relationships between challenge and the profiles were consistent between high-ability and average-ability students. These findings echo previous research indicating that lacking "optimally difficult" schoolwork poses a motivational risk not only to high-ability students but also to average-ability students (Lavrijsen et al., 2021). As expected, the high-ability students reported lower mean levels of adequate curricular challenge compared to their average-ability peers, which might partially account for their poorer motivational patterns.

4.5. Strengths, limitations and future directions

As a state-of-the-art study utilizing multiple largescale samples that include high-ability students selected in analogous ways, this study provides unique insight into motivational development among high-ability and average-ability students, demonstrating considerable strengths. Our approach addressed gaps in the literature in several key ways. By utilizing multiple samples, we avoided sample-specific findings, a criticism often levied against person-centered work (Pastor et al., 2007). Additionally, our longitudinal sample spanning compulsory and higher education mitigated concerns about sample comparability between different educational stages.

Second, this study clarified and expanded on previous findings by drawing from large community populations rather than clinically diagnosed high-ability students, ensuring a less biased sample selection. Identifying high-ability students by means of standardized cognitive tests prevents positive or negative selection bias to a larger extent than many studies among high-ability students, for instance studies which use nomination by teachers on one hand or clinical diagnosis on the other hand to select gifted students. Moreover, our study tracked students throughout compulsory and higher education, providing a unique comprehensive view for not only comparisons between high-ability students and their peers, but between high-ability students and themselves across stages of education.

Third, the study incorporated a variety of informants, predictors, and long-term outcomes, enhancing the validity of the motivational profiles and bolstering the robustness of our findings. These outcomes included

reports from students, parents, and teachers, as well as school grades, standardized achievement scores, and administrative school data. The variety of outcome measures provided unique insight into the impact of motivational belief patterns throughout education, and the selected predictors provided preliminary insight on malleable contextual elements that can positively influence student motivation.

Despite these strengths, there are significant limitations that should be acknowledged to guide future research. First, as is the case with longitudinal studies in general, sample attrition was evident in our research, particularly between educational stages. While we addressed missing data in our analyses, there's unavoidable loss of information as the sample size decreases over time, and these analyses should ideally be replicated in other studies.

A particular aspect of sample attrition should be noted regarding the transition from secondary school to higher education. While it was beneficial to be able to compare motivational evolution into higher education among a single sample, the downside of this design is that pursuit of higher education was partially influenced by motivational beliefs, potentially biasing our findings. Our findings don't necessarily give us insight on whether the higher education environment itself is more motivational optimal, or if students with better quality motivation in secondary school were just more likely to pursue higher education studies. Students with Low Quantity motivation were least likely to pursue higher education among the profiles, which means that the subsample of students assessed in higher education did not include those with the lowest degrees of autonomous motivation in secondary school. Future work should consider contextual factors influencing motivational development in late secondary school to better understand how to foster motivation for higher education. Further, research on contextual factors in higher education can lend additional insight on how autonomous motivation can best be sustained within that context.

Another drawback of this study is that the internal consistency of several of the scales was found to be below the recommended threshold of $\alpha = 0.70$. For the motivational variables in Sample 2, this is likely because each of the scales with lower alphas consisted of only two or three items. Low internal consistency can indicate potential issues with measurement precision, and as such the results including these scales should be interpreted with caution. While the motivational constructs of Grade 7 in Sample 2 were cross-validated by Sample 1 within the current study, further research should be conducted across different groups and in different settings to confirm generalizability of findings.

Regarding the extent to which the current study's findings are generalizable, it is worth reiterating that the study was conducted in Flanders, Belgium, and as such the findings are bound within its particular educational and cultural context. Although consistent motivational profiles were found across multiple samples and in multiple educational stages in Flanders, it is quite possible that different findings would emerge in educational systems that differ structurally from those in Flandres, for instance in non-tracked secondary schools or in higher education settings with stringent application procedures. Ideally this work should be replicated in other countries to confirm the generalizability of the findings.

A final limitation in the current research is the infrequency of assessment of motivational beliefs, which occurred at most once a year, sometimes with multiple years between measurements. While this approach had the benefit of allowing us a birds eye view of how motivational beliefs generally evolve over the span of an educational career, more specific and intensive work is needed to have insight on how to effectively adapt educational contexts to bolster good quality motivation. With the need to narrow in on specific contextual factors influencing motivational development comes the need to assess motivation in more fine-tuned, context-specific ways. This could be done for instance with assessing domain-specific motivation, as previous research has established that there is increased differentiation across domains in the development of motivational beliefs over time (Gaspard et al., 2020). In the current study motivation was assessed in a general way, while in reality student's motivational beliefs often vary in different school subjects and classes. Further insight could also be gleaned from more intensive and in-depth measurements, such as diary studies or experience sampling method. These methods allow for insight on more temporal fluctuations in motivational beliefs, which could be tied to more immediate contextual influences.

4.6. Implications and conclusions

This study, as previous person-centered work, has demonstrated that not only quantity but quality of student motivation matters (Vansteenkiste et al., 2009). Motivation is multidimensional, and combinations of adaptive and maladaptive motivational beliefs can exist within individual students. Moreover, these combinations of motivational beliefs are not static, but they evolve as students become older and progress through the different stages of the educational system. Transitions between different educational stages seem to represent particular periods of malleability in student motivation, which can represent periods of opportunity for researchers and educators alike to hone in on factors that can better meet student educational needs in the context of educational change.

As high-ability students showed a strikingly more maladaptive motivational evolution compared to average-ability students during the transition to and throughout secondary education, secondary school arises as a particular context warranting the attention of researchers and educators. High-ability students tended to migrate away from profiles characterized by high levels of autonomous forms of motivation towards the profile characterized by moderate beliefs, which was marked by higher levels of underachievement and lower levels of engagement and achievement than the more autonomous profiles. Drawing from self-determination theory and stage-environment fit theory, we can tentatively conclude that there is work to be done in better tailoring the learning environment in secondary school to meet the developmental needs of high-ability students of that age, for example through increased attention for providing adequate curricular challenge to these students. Among high-ability students, like their classmates, motivation can be bolstered when learning needs are satisfied.

CRediT authorship contribution statement

Alicia Ramos: Writing – original draft, Visualization, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Maarten Vansteenkiste:** Writing – review & editing, Visualization, Methodology, Investigation, Conceptualization. **Jeroen Lavrijsen:** Writing – review & editing, Investigation, Data curation. **Bart Soenens:** Writing – review & editing, Investigation. **Karine Verschueren:** Writing – review & editing, Supervision, Resources, Project administration, Investigation, Funding acquisition, Conceptualization.

Funding

This work was funded by the Research Funds of the KU Leuven (BOF, project numbers C1420057 and PDMT2/23/022).

Declaration of competing interest

None.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.lindif.2024.102620.

References

Aelterman, N., Vansteenkiste, M., Haerens, L., Soenens, B., Fontaine, J., & Reeve, J. (2019). Toward an integrative and fine-grained insight in motivating and demotivating teaching styles: The merits of a circumplex approach. *Journal of Educational Psychology, 111*(3), 497–521. https://doi.org/10.1037/edu0000293

Asparouhov, T., & Muthén, B. (2021, February 4). Auxilary variables in mixture modeling using the BCH method in Mplus to estimate a distal outcome model and an arbitrary secondary model. Mplus Web Notes, No. 21 https://www.statmodel.com/examples/webnotes/webnote21.pdf.

Assor, A., Vansteenkiste, M., & Kaplan, A. (2009). Identified versus introjected approach and introjected avoidance motivations in school and in sports: The limited benefits of self-worth strivings. *Journal of Educational Psychology, 101*(2), 482–497. https://doi.org/10.1037/a0014236

Belmont, M., Skinner, E., Wellborn, J., & Connell, J. (1988). *Teacher as social context: A measure of student perceptions of teacher provision of involvement, structure, and autonomy support (Tech. Rep. No. 102)*. Rochester, NY: University of Rochester.

Bergman, L. R., & Magnusson, D. (1997). A person-oriented approach in research on developmental psychopathology. *Development and Psychopathology, 9*(2), 291–319. https://doi.org/10.1017/S095457949700206X

Bolck, A., Croon, M., & Hagenaars, J. (2004). Estimating latent structure models with categorical variables: One-step versus three-step estimators. *Political Analysis, 12*(1), 3–27. https://doi.org/10.1093/pan/mph001

Bryan, C. J., Tipton, E., & Yeager, D. S. (2021). Behavioural science is unlikely to change the world without a heterogeneity revolution. *Nature Human Behaviour, 5*(8), 980–989.

Byrne, B. M. (2012). *Structural equation modeling with Mplus: Basic concepts, applications, and programming*. New York: Routledge.

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling, 14*(3), 464–504. https://doi.org/10.1080/10705510701301834

Cook, E., Greenberg, M., & Kusche, C. (1995). People in My Life: Attachment relationships in middle childhood. In *Paper presented at the biennial meeting of the Society for Research in Child Development. Indianapolis, Indiana*.

Corpus, J. H., & Wormington, S. V. (2014). Profiles of intrinsic and extrinsic motivations in elementary school: A longitudinal analysis. *Journal of Experimental Education, 82*(4), 480–501. https://doi.org/10.1080/00220973.2013.876225

Deci, E. L., & Ryan, R. M. (Eds.). (2002). *Handbook of self-determination research*. University of Rochester Press.

Deunk, M. I., Smale-Jacobse, A. E., de Boer, H., Doolaard, S., & Bosker, R. J. (2018). Effective differentiation practices: A systematic review and meta-analysis of studies on the cognitive effects of differentiation practices in primary education. *Educational Research Review, 24*(February), 31–54. https://doi.org/10.1016/j.edurev.2018.02.002

Dong, Y., & Peng, C. Y. J. (2013). Principled missing data methods for researchers. *Springer Plus, 2*(1), 1–17. https://doi.org/10.1186/2193-1801-2-222

Eccles, J., & Roeser, R. (2009). Schools, academic motivation, and stage-environment fit. In *Handbook of adolescent psychology* (pp. 404–434).

Feuchter, M. D., & Preckel, F. (2022). Reducing boredom in gifted education—Evaluating the effects of full-time ability grouping. *Journal of Educational Psychology, 114*(6), 1477–1493. https://doi.org/10.1037/edu0000694

Gagné, F. (2004). Transforming gifts into talents: The DMGT as a developmental theory 1. *High Ability Studies, 15*(2), 119–147. https://doi.org/10.1080/1359813042000314682

Gaspard, H., Lauermann, F., Rose, N., Wigfield, A., & Eccles, J. S. (2020). Cross-domain trajectories of students' ability self-concepts and intrinsic values in math and language arts. *Child Development, 91*(5), 1800–1818. https://doi.org/10.1111/cdev.13343

Geiser, C. (2013). *Data Analysis with MPlus*. New York, New York: The Guilford Press.

Gottfried, A. E., Fleming, J. S., & Gottfried, A. W. (2001). Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study. *Journal of Educational Psychology, 93*(1), 3–13. https://doi.org/10.1037/0022-0663.93.1.3

Gottfried, A. E., & Gottfried, A. W. (1996). A longitudinal study of academic intrinsic motivation in intellectually gifted children: Childhood through early adolescence. *The Gifted Child Quarterly, 40*, 179–183.

Hayenga, A. O., & Corpus, J. H. (2010). Profiles of intrinsic and extrinsic motivations: A person-centered approach to motivation and achievement in middle school. *Motivation and Emotion, 34*(4), 371–383. https://doi.org/10.1007/s11031-010-9181-x

Hendrikx, K., Maes, F., Magez, W., Ghesquière, P., & Van Damme, J. (2008). *Longitudinaal onderzoek in het basisonderwijs: Intelligentiemeting (schooljaar 2005–2006) [Longitudinal research in primary school: Intelligence measure (school year 2005–2006)]*. Leuven, Belgiun: Steunpunt SSL.

Hornstra, L., Bakx, A., Mathijssen, S., & Denissen, J. J. A. (2020). Motivating gifted and non-gifted students in regular primary schools: A self-determination perspective. *Learning and Individual Differences, 80*. https://doi.org/10.1016/j.lindif.2020.101871

Hornstra, L., Mathijssen, A. C. S., Denissen, J. J. A., & Bakx, A. (2023). Academic motivation of intellectually gifted students and their classmates in regular primary school classes: A multidimensional, longitudinal, person- and variable-centered approach. *Learning and Individual Differences, 107*, Article 102345. https://doi.org/10.1016/j.lindif.2023.102345

Howard, J., Bureau, J., Guay, F., Chong, J., & Ryan, R. (2021). Student motivation and associated outcomes: A meta-analysis from self-determination theory. *Perspectives on Psychological Science, 16*(6), 1300–1323. https://doi.org/10.1177/1745691620966789

Howard, M. C., & Hoffman, M. E. (2018). Variable-centered, person-centered, and person-specific approaches: Where theory meets the method. *Organizational Research Methods, 21*(4), 846–876.

Institute for Research and Reform in Education. (1998). *Research assessment package for schools (RAPS) manual*. Tom Rivers, New Jersey: Institute for Research and Reform in Education.

Landis, R., & Reschly, A. (2013). Reexamining gifted underachievement and dropout through the lens of student engagement. *Journal for the Education of the Gifted, 36*, 220–249. https://doi.org/10.1177/0162353213480864

Lavrijsen, J., Preckel, F., Verachtert, P., Vansteenkiste, M., & Verschueren, K. (2021). Are motivational benefits of adequately challenging schoolwork related to students' need for cognition, cognitive ability, or both? *Personality and Individual Differences, 171*, Article 110558. https://doi.org/10.1016/j.paid.2020.110558

Lavrijsen, J., Ramos, A., & Verschueren, K. (2020). Detecting Unfulfilled Potential: Perceptions of Underachievement by Student, Parents, and Teachers. *The Journal of Experimental Education.*. https://doi.org/10.1080/00220973.2020.1852523

Lavrijsen, J., Sypre, S., Soenens, B., Vansteenkiste, M., Camerman, E., Ramos, A., & Verschueren, K. (2024). Fostering excellence: Nurturing motivation and performance among high- and average-ability students through need-supportive teaching. *Journal of School Psychology, 105*, Article 101322. https://doi.org/10.1016/j.jsp.2024.101322

Lavrijsen, J., & Verschueren, K. (2023). High cognitive ability and mental health: Findings from a community sample of adolescents. *Journal of Intelligence, 11*(38). https://doi.org/10.3390/jintelligence11020038

Legault, L., Green-Demers, I., & Pelletier, L. (2006). Why do high school students lack motivation in the classroom? Toward an understanding of academic amotivation and the role of social support. *Journal of Educational Psychology, 98*(3), 567–582. https://doi.org/10.1037/0022-0663.98.3.567

Linnenbrink-Garcia, L., Wormington, S. V., Snyder, K. E., Riggsbee, J., Perez, T., Ben-Eliyahu, A., & Hill, N. E. (2018). Multiple pathways to success: An examination of integrative motivational profiles among upper elementary and college students. *Journal of Educational Psychology, 110*(7), 1026–1048. https://doi.org/10.1037/edu0000245

Lo, Y., Mendell, N. R., & Rubin, D. B. (2001). Testing the Number of Components in a Normal Mixture. *Biometrika, 88*(3), 767–778. http://www.jstor.org/stable/2673445.

Maes, F., Van Damme, J., & Verschueren, K. (2005). *Leerlingvragenlijst tweede leerjaar (schooljaar 2003–2004) [Student questionnaire second grade (school year 2003–2004)] (LOA-report number 36)*. Leuven: Steunpunt "Loopbanen doorheen Onderwijs naar Arbeidsmarkt", Cel "Schoolloopbanen in het basisonderwijs" (SiBO).

Magez, W. (2015). *Biografische testvaliditeit CoVaT-CHC Basisversie [Biographical test validity of the CoVat-CHC Basic Version]*. P.H.C. More.

Molenaar, P. C. M. (2004). A Manifesto on Psychology as Idiographic Science: Bringing the Person Back Into Scientific Psychology, This Time Forever. *Measurement: Interdisciplinary Research and Perspectives, 2*(4), 201–218. https://doi.org/10.1207/s15366359mea0204_1

Muthen, B., & Asparouhov, T. (2022). Latent transition analysis with random intercepts (RI-LTA). *Psychological Methods, 27*(1), 1–16. https://doi.org/10.1037/met0000370

Muthén, L. K., & Muthén, B. O. (2017). *Mplus User's Guide* (Eighth Edition). Los Angeles, CA: Muthén & Muthén.

Nagin, D. S. (1999). Analyzing developmental trajectories: A semiparametric, group-based approach. *Psychological Methods, 4*(2), 139–157. https://doi.org/10.1037/1082-989X.4.2.139

Niemiec, C., & Ryan, R. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and Research in Education, 7*, 133–144. https://doi.org/10.1177/1477878509104318

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling, 14*(4), 535–569. https://doi.org/10.1080/10705510701575396

OECD. (2013). *PISA 2012 assessment and analytical framework: Mathematics, reading, science, problem solving, and financial literacy*. OECD Publishing. https://doi.org/10.1787/9789264190511-en

Pastor, D. A., Barron, K. E., Miller, B. J., & Davis, S. L. (2007). A latent profile analysis of college students' achievement goal orientation. *Contemporary Educational Psychology, 32*(1), 8–47. https://doi.org/10.1016/j.cedpsych.2006.10.003

Patall, E. A., Yates, N., Lee, J., Chen, M., Bhat, B. H., Lee, K., … Hanson, D. J. (2024). A meta-analysis of teachers' provision of structure in the classroom and students' academic competence beliefs, engagement, and achievement. *Educational Psychologist, 59*(1), 42–70. https://doi.org/10.1080/00461520.2023.2274104

Pinxten, M., Wouters, S., Preckel, F., Niepel, C., De Fraine, B., & Verschueren, K. (2015). Academic self-concept in elementary education: A unifying model for external and internal comparisons. *Contemporary Educational Psychology, 41*, 124–132. https://doi.org/10.1016/j.cedpsych.2014.12.003

Ratelle, C. F., Guay, F., Vallerand, R. J., Larose, S., & Senécal, C. (2007). Autonomous, controlled, and amotivated types of academic motivation: A person-oriented analysis. *Journal of Educational Psychology, 99*(4), 734–746. https://doi.org/10.1037/0022-0663.99.4.734

Raven, J., Raven, J. C., & Court, J. H. (2000). Manual for Raven's progressive matrices and vocabulary scales. In *Section 3: Standard progressive matrices including the parallel and plus versions*. Oxford: OPP.

Reeve, J., & Cheon, S. H. (2021). Autonomy-supportive teaching: Its malleability, benefits, and potential to improve educational practice. *Educational Psychologist, 56*(1), 54–77. https://doi.org/10.1080/00461520.2020.1862657

Reis, S., & McCoach, D. B. (2000). The underachievement of gifted students: What do we know and where do we go? *The Gifted Child Quarterly, 44*(3), 152–170. https://doi.org/10.1177/001698620004400302

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology, 57*(5), 749–761. https://doi.org/10.1037/0022-3514.57.5.749

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, Article 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Saqr, M. (2023). Group-level analysis of engagement poorly reflects individual students' processes: Why we need idiographic learning analytics. *Computers in Human Behavior, 150*, 1–12. https://doi.org/10.1016/j.chb.2023.107991

Schaufeli, W. B., Salanova, M., González-romá, V., & Bakker, A. (2002). The Measurement of Engagement and Burnout: A Two Sample Confirmatory Factor Analytic Approach. *Journal of Happiness Studies, 3*, 71–92. https://doi.org/10.1023/A:1015630930326

Scherrer, V., & Preckel, F. (2019). Development of motivational variables and self-esteem during the school career: A meta-analysis of longitudinal studies. *Review of Educational Research, 89*(2), 211–258. https://doi.org/10.3102/0034654318819127

Shernoff, D. (2013). Optimal learning environments to promote student engagement. http://www.springer.com/series/7284.

Siegle, D., McCoach, D. B., & Roberts, A. (2017). Why I believe I achieve determines whether I achieve. *High Ability Studies, 28*(1), 59–72. https://doi.org/10.1080/13598139.2017.1302873

Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic? *Journal of Educational Psychology, 100*(4), 765–781. https://doi.org/10.1037/a0012840

Smits, J. A. E., & Vorst, H. C. M. (1990). *Schoolvragenlijst voor basisonderwijs en voortgezet onderwijs: SVL. Handleiding voor gebruikers [School questionnaire for primary and secondary school: SVL. Guidebook for users]*. Berkhout: Nijmegen, Netherlands.

Snyder, K. E., & Adelson, J. L. (2017). The development and validation of the perceived academic underachievement scale. *Journal of Experimental Education, 85*(4), 614–628. https://doi.org/10.1080/00220973.2016.1268087

Snyder, K. E., & Linnenbrink-Garcia, L. (2013). A developmental, person-centered approach to exploring multiple motivational pathways in gifted underachievement. *Educational Psychologist, 48*(4), 209–228. https://doi.org/10.1080/00461520.2013.835597

Sypre, S., Waterschoot, J., Soenens, B., Verschueren, K., & Vansteenkiste, M. (2024). Do teachers use distinct motivational styles for cognitively gifted learners? The role of effectiveness beliefs, fixed mindset, and misconceptions about giftedness. *European Journal of Psychology of Education, 39*, 999–1025. https://doi.org/10.1007/s10212-023-00716-2

Tóth-Király, I., Morin, A. J. S., Litalien, D., Valuch, M., Bőthe, B., Orosz, G., & Rigó, A. (2022). Self-determined profiles of academic motivation. *Motivation and Emotion, 46*(2), 152–170. https://doi.org/10.1007/s11031-021-09918-x

Vandecandelaere, M., Vansteelandt, S., De Fraine, B., & Van Damme, J. (2016). The effects of early grade retention: Effect modification by prior achievement and age. *Journal of School Psychology, 54*, 77–93. https://doi.org/10.1016/j.jsp.2015.10.004

Vandenberghe, N., Cortois, L., de Bilde, J., Van Petegem, P., & Van Damme, J. (2011). *Longitudinaal onderzoek in het basisonderwijs: Leerlingperceptievragenlijst zesde leerjaar (schooljaar 2008–2009) [Longitudinal research in primary education: Student perception questionnaire Grade 6 (school year 2008–2009)]*. Leuven: Steunpunt SSL.

Vansteenkiste, M., & Mouratidis, A. (2016). Emerging trends and future directions for the field of motivation psychology: A special issue in honor of Prof. Dr. Willy Lens. *Psychologica Belgica, 56*(3), 317–341. https://doi.org/10.5334/pb.354

Vansteenkiste, M., Niemiec, C. P., & Soenens, B. (2010). The Development of the Five Mini-Theories of Self-Determination Theory: An Historical Overview, Emerging Trends, and Future Directions. In T. C. Urdan, & S. A. Karabenick (Eds.), *Advances in Motivation and Achievement, v. 16A—The Decade Ahead: Theoretical Perspectives on Motivation and Achievement* (pp. 105–165). London: Emerald Group Publishing Limited. https://doi.org/10.1108/S0749-7423(2010)000016A007.

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

Vansteenkiste, M., Sierens, E., Soenens, B., Luyckx, K., & Lens, W. (2009). Motivational profiles from a self-determination perspective: The quality of motivation matters. *Journal of Educational Psychology, 101*(3), 671–688. https://doi.org/10.1037/a0015083

Vansteenkiste, M., Soenens, B., & Waterschoot, J. (2024). Catalyzing intrinsic and internalized motivation: The role of basic psychology needs and their support. In J. M. Reeve (Ed.), *The Oxford handbook of educational psychology*. Oxford University Press (in press).

Vansteenkiste, M., Zhou, M., Lens, W., & Soenens, B. (2005). Autonomy and control among Chinese learners: Vitalizing or immobilizing? *Journal of Educational Psychology, 97*(3), 468–483. https://doi.org/10.1037/002-0663.97.3.468

Vanwynsberghe, G., & Van Damme, J. (2014). *SiBO-Onderzoek 2014 Toetsen Wiskunde: Instrumentontwikkelingsrapport en respons [SiBO Study 2014 Math Assessments: Instrument Development Report and Response]*. Leuven: Steunpunt Studie- en Schoolloopbanen.

Vanwynsberghe, G., Vanlaar, G., Van Damme, J., & De Fraine, B. (2017). Long-term effects of primary schools on educational positions of students 2 and 4 years after the start of secondary education. *School Effectiveness and School Improvement, 28*, 167–190. https://doi.org/10.1080/09243453.2016.1245667

Vasconcellos, D., Parker, P. D., Hilland, T., Cinelli, R., Owen, K. B., Kapsal, N., … Lonsdale, C. (2020). Self-determination theory applied to physical education: A systematic review and meta-analysis. *Journal of Educational Psychology, 112*(7), 1444–1469. https://doi.org/10.1037/edu0000420

Vermunt, J. K., & Magidson, J. (2002). Latent class cluster analysis. In J. A. Hagennars, & A. L. McCutcheon (Eds.), *Applied latent class analysis* (pp. 89–106). Cambridge, UK: Cambridge University Press.

White, S., Graham, L., & Blaas, S. (2018). Why do we know so little about the factors associated with gifted underachievement? A systematic literature review. *Educational Research Review, 24*, 55–66. https://doi.org/10.1016/j.edurev.2018.03.001

Wormington, S. V., Corpus, J. H., & Anderson, K. G. (2012). A person-centered investigation of academic motivation and its correlates in high school. *Learning and Individual Differences, 22*(4), 429–438. https://doi.org/10.1016/j.lindif.2012.03.004

Wormington, S. V., & Linnenbrink-Garcia, L. (2017). A new look at multiple goal pursuit: the promise of a person-centered approach. *Educational Psychology Review, 29*, 407–445. https://doi.org/10.1007/s10648-016-9358-2