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Profiles of Motivational Beliefs in Math: Exploring Their Development, Relations to Student-Perceived Classroom Characteristics, and Impact on Future Career Aspirations and Choices

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Four topics were investigated in this longitudinal person-centered study: (a) profiles of subjective task values and ability self-concepts of adolescents in the domain of mathematics, (b) the stability of and changes to the profiles of motivational beliefs from Grade 7 to 12, (c) the relationship of changes to student-perceived classroom characteristics, and (d) the extent to which profile membership in early adolescence predicted mathematics achievement and career plans in late adolescence and the choice of math-related college majors and occupations in adulthood. Data were drawn from the Michigan Study of Adolescent and Adult Life Transitions Study. We focused on students who participated in the following 4 waves of data collection ($N = 867$): at the beginning of Grade 7 (Wave 3), at the end of Grade 7, in Grade 10 (Wave 5), and in Grade 12 (Wave 6). Four profiles that were stable across Grades 7 to 12 were identified using Latent Profile Analysis. Student-reported fairness and friendliness and competition in class predicted changes in profile membership. Profile membership in Grade 7 predicted math-related career plans in Grade 12. Profile membership in Grade 12 predicted the choice of math-related college major after finishing school and of math-related occupations in adulthood.

Educational Impact and Implications Statement

Findings of this longitudinal study with 867 students followed from the beginning of Grade 7 to adulthood showed 4 stable motivational subtypes: students with (a) high, (b) medium, (c) low motivational beliefs, and (d) students with moderate math self-concept and importance value, but low interest in math. Negative motivational changes in early adolescence were buffered if students perceived their teachers as friendly and fair. The motivational subtypes predicted the choice of math-related college majors and occupations in adulthood. By identifying different motivational subtypes among adolescents, findings emphasize that classrooms are characterized by high motivational heterogeneity of students that needs to be addressed in instructional settings. If these findings can be replicated in other studies, teachers should consider implementing personalized tasks that match in the motivational orientation of individual students.

Keywords: task value, self-concept, latent profile analysis, classroom characteristics, mathematics

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Although several investigators have shown the predictive importance of motivational beliefs related to ability self-concept and subjective task value for understanding individual differences in school engagement and achievement (Eccles, 1994, 2005a; Eccles, Vida, & Barber, 2004; Lauermann, Tsai, & Eccles, 2017; Watt et al., 2012), they have rarely looked directly at the role of intraindividual patterns of these sets of motivational beliefs simultaneously. Instead, many scholars have used regression type analyses

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to look at the unique associations of each set of motivational beliefs with related academic outcomes. There is now growing interest in the ways in which these two sets of motivational beliefs interact with each other to create profiles of motivational beliefs; for example, some students might have high competence beliefs in domains that they perceive as important for their future but in which they are not interested, while other students may hold high competence beliefs together with high importance value and high interest. However, it is still unclear whether the individual differences in these types of intraindividual patterns matter and, if so, for what outcomes. Research on these questions has just begun (e.g., Bråten & Olaussen, 2005 with college students; Lazarides, Dietrich, & Taskinen, 2019 in secondary school; Viljaranta, Kiuru, et al., 2016 in primary school). More research is needed on the development of such profiles during adolescence, because students face important educational and occupational choices during this period (Schoon & Eccles, 2014), and these motivational beliefs are central predictors of such choices (Lauermann et al., 2017; Watt et al., 2012). As students' motivational beliefs decline particularly strongly in the domain of mathematics (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002), more research is needed focusing on the development of students' motivational beliefs in this domain.

Our study is designed to fill this gap. It contributes to current research in the following ways: (a) we examined the stability and change of student profiles of motivational beliefs in mathematics across adolescence, (b) we investigated the extent to which changes in profile membership were related to student-perceived characteristics of the classroom, (c) we analyzed whether profile membership in early adolescence predicted achievement and career plans in late high school, and (d) we examined whether profile membership in late high school predicted the choices of mathematics-related majors and occupations 22 years later in adulthood.

Profiles of Motivational Beliefs in Specific Domains and Their Development Across Time

In their expectancy-value theory, Eccles and colleagues (Eccles, 2005b; Eccles et al., 1983) hypothesized that motivation, achievement choices and performance are influenced most directly by beliefs related to subjective task values and success expectancies. Subjective task values include the expected enjoyment of a given task (intrinsic value), as well as the personal importance of a task and its relationship to one's identity (attainment value). Further components of subjective task value are the importance of a task for one's short and long-range goals (utility value), and the perceived cost of engaging in a task—the effort required, emotional/psychological cost and opportunity cost. Success expectancies are defined as the beliefs of an individual about how well he or she will do on an upcoming task and are empirically indistinguishable from domain-specific ability self-concept (Wigfield & Eccles, 2002).

In variable-centered analyses with adolescents, subjective task values, particularly intrinsic task value, are related to ability self-concept
AQ: 3 (Bong, 2004; Trautwein et al., 2012). Studies using expectancy-value theory (Eccles et al., 1983) as their theoretical backdrop have increasingly used person-centered approaches to examine patterns of motivational beliefs (Chow, Eccles, & Salmela-Aro, 2012; Chow & Salmela-Aro, 2011; Gaspard, Wille, Wormington, & Hulleman, 2019; Viljaranta, Kiuru, et al., 2016). The specific value of person-centered approaches in motivation research is to examine the relations among motivational constructs at the level of the individual and at the level of groups of individuals (Bergman, Magnusson, & El Khouri, 2003). Person-centered research extends the findings of variable-centered approaches by providing unique insights into unexpected and divergent configurations of motivation in the student population. For example, variable-centered studies show a strong and positive relation between intrinsic value and importance value (i.e., Gaspard et al., 2015) and between intrinsic value and ability self-concept (Bong, 2004; Eccles & Wigfield, 1995). Person-centered findings reveal, however, that individuals and groups of students exist with divergent levels of intrinsic value and ability self-concept (Viljaranta, Aunola, & Hirvonen, 2016; Viljaranta et al., 2017). For example, Viljaranta, Kiuru, et al. (2016) identified a pattern of reading motivational beliefs characterized by high levels of ability self-concept but low levels of interest among elementary school students. Chow et al. (2012) identified, based on data from the Childhood and Beyond Study (CAB), a profile of students with low task values in mathematics and science and high task values in English.

While person-centered research has examined relatively often profiles of ability self-concept and interest (i.e., Patrick, Mantzicopoulos, Samarapungavan, & French, 2008; Viljaranta, Aunola, et al., 2016; Viljaranta et al., 2017), utility and attainment value—or importance value—have rarely been taken into account. Conley (2012) examined profiles of motivation using achievement goal orientations and subjective task values as indicator variables of their profiles. Their results show that each of the identified profiles was characterized by a unique combination of the four components of student task value, but that utility value was less helpful for discriminating among the profiles in their sample. Thus, it might be assumed that there are individuals whose ability self-concept and intrinsic and importance values diverge from each other. However, it is unclear how each of the task value components contributes to individuals' motivational belief profiles.

Another important understudied issue is the stability and change in patterns of motivational beliefs both within and across different academic domains during adolescence. Over the childhood years, the motivational beliefs of students become increasingly stable because students are developing clearer representations of their skills and interests (Krapp, 1999). Therefore, it seems reasonable to expect that membership in specific profiles of motivational beliefs should also be characterized by increasing stability over the childhood and adolescent years. Across the very few person-centered studies, membership in profiles characterized by consistent levels of ability self-concept and values (either both high or both low) is more stable over time than membership in divergent profiles (e.g., high ability self-concept and low intrinsic value; Chow et al., 2012; Chow & Salmela-Aro, 2011; Lazarides et al., 2019; Nurmi & Aunola, 2005). One possible explanation is that teachers actively work to raise the subjective task value of students who have a high ability self-concept but low subjective task value. However, the extent to which teachers' behaviors predict the development of motivational profiles or the extent to which teachers react to the different patterns of motivation of their students' needs to be studied.

Student-Perceived Classroom Characteristics and Profiles of Motivational Beliefs

Teachers and the learning environments that they create are proximal influences on the development of adolescents' motivational beliefs (Eccles & Roeser, 2011). In this study, we focused on two facets of the classroom environment and their relation to changes in student profile membership: the perceived fairness and friendliness of the teacher, and student-perceived competition in class.

Following self-determination theory (Deci & Ryan, 2002) and stage-environment fit theory (Eccles, Midgley, et al., 1993), students are intrinsically motivated to learn in classrooms that fulfill their need for autonomy, competence, and social relatedness. These needs can be fulfilled when students perceive their teachers as respectful, fair, and caring (Skinner & Belmont, 1993; Wang & Eccles, 2012; Wentzel, 1997). Research has shown that students who report that their teachers are fair and caring benefit in terms of higher motivation and achievement (Eccles, Wigfield, et al., 1993). It needs to be noted, however, that reciprocal effects can be assumed—while studies show that students who perceive their teachers to be supportive also report high interest and motivation (Dietrich, Dicke, Kracke, & Noack, 2015; Wentzel, Battle, Russell, & Looney, 2010), it might also be expected that students who are more confident and interested might report that they feel more supported by teachers (Skinner & Belmont, 1993) even if teacher behaviors are the same for all students. We anticipate in this study that student-perceived teacher fairness and friendliness would be particularly beneficial for students with high levels of intrinsic value, importance value, and ability self-concept.

According to stage-environment fit theory (Eccles, Midgley, et al., 1993), the time after the transition to secondary school is a critical developmental stage in children's motivational development—children's motivation strongly declines during this period, which can partially be explained by a mismatch between their needs and the opportunities afforded by their classroom learning environments (Eccles, Midgley, et al., 1993; Eccles & Roeser, 2009). In our study, we assume that students who perceive that their teachers are fair and friendly would be less likely to experience negative shifts in their profile membership.

Another factor that has been shown to be highly relevant for student motivation is student-perceived competition in class. A large amount of literature on classroom goal structures (i.e., E. M. Anderman & Wolters, 2006; Kaplan, Middleton, Urdan, & Midgley, 2002; Meece, Anderman, & Anderman, 2006) has emphasized that classrooms in which students perceive a performance goal structure, that is an emphasis on competition and achievement gains, are associated with negative academic correlates such as low interest and low persistence. L. H. Anderman (1999) showed that, after the transition from elementary to middle school, an increase in performance goal structure in class predicted increased negative affect. However, there are also studies that show positive academic consequences of performance goal structures in class, such as high academic self-efficacy (Wolters, 2004). Furthermore, research describes how performance-approach goals might be beneficial when perceived competence is high (i.e., Linnenbrink-Garcia, Tyson, & Patall, 2008; Midgley, Kaplan, & Middleton, 2001). Thus, one may assume that an emphasis on competition in class might be beneficial for students who already hold high motivational beliefs.

Profiles of Motivational Beliefs: To What Extent Do These Beliefs Relate to Achievement, Math-Related Career Plans, and Choice Behaviors?

Consistent with predictions from expectancy-value theory, ability self-concepts of students in mathematics and science predict domain-specific achievement (Jansen, Schroeders, & Lüdtke, 2014; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005), mathematics-related career plans (Lauermann et al., 2017; Wang, 2012), and occupational choices in adulthood (Lauermann et al., 2017). The components of an individual's subjective task value also predict his or her occupational choices (Lauermann et al., 2017; Lazarides, Rubach, & Ittel, 2017; Watt et al., 2012). Utility value positively predicts mathematics-related career plans in high school quite consistently (Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Lauermann et al., 2017; Watt et al., 2012). Utility value probably predicts later math-related career plans because students who strive for a math-related career tend to think that mathematics is highly important for their future. Previous research has shown such bidirectional relationships, with math-related career plans predicting utility values in mathematics (Lauermann et al., 2017). Evidence is mixed regarding the relationship between intrinsic value and career plans. In Australian data sets (Lazarides & Watt, 2017; Watt et al., 2012), the intrinsic value of mathematics for adolescents positively predicts their mathematics-related career plans at the end of high school. Similar effects are not found in data sets from the United States and Germany (Lauermann et al., 2017; Lazarides et al., 2017). It is important to note, however, that the motivational beliefs in mathematics at the end of high school are related to occupational choices in math-related fields in adulthood indirectly via students' career plans related to mathematics (Lauermann et al., 2017).

Extending these findings, scholars using variable-centered methods have started to investigate the extent to which different configurations of ability self-concept and the components of subjective task value predict academic achievement (Guo et al., 2016; Trautwein et al., 2012) and both career plans and choices (Lauermann et al., 2017; AQ: 4 Nagengast et al., 2011). In these studies, high levels of ability self-concept predict achievement (Guo et al., 2016; Trautwein et al., 2012) and career plans (Lauermann et al., 2017; Nagengast et al., 2011) with high levels of the focused component of subjective task value. Similarly, in person-centered studies, students in profiles with a combination of high intrinsic value and high perceived competence (but low performance avoidance and performance approach goals) were associated with the highest levels of academic engagement and achievement (Linnenbrink-Garcia et al., 2018). Furthermore, profiles with high mathematics task values and self-concept reported higher educational aspirations (Chow & Salmela-Aro, 2011; Lazarides, Viljaranta, Aunola-Aro, Pesu, & Nurmi, 2016) and profiles characterized by high intrinsic or importance value in mathematics were associated with college majors requiring mathematics (Musu-Gillette, Wigfield, Harring, & Eccles, 2015).

When analyzing the relation between individuals' motivation and their career plans and attainment, research often dichotomizes STEM and non-STEM majors and jobs, implicitly assuming that the college majors or jobs can be grouped together into two categories. This approach has been criticized, as it leads to an oversimplification when examining factors related to gendered college major choices (Ganley, George, Cimpian, & Makowski, 2018). In our study, we use a different approach that has been used in a number of studies (Lauermann et al., 2017; Lazarides & Watt, 2015; Watt et al., 2012) by quantifying the open-ended question about college majors and jobs in terms of their math-relatedness.

The Present Study

In this study, we aimed to identify profiles of motivational beliefs related to mathematics among adolescents and to examine the stability and change of these profiles from Grade 7 to 12. We also investigated the extent to which changes in profile membership are related to student-perceived competition in class and student-perceived teacher fairness and friendliness. In these analyses, we controlled for individual and social student variables (gender, age, ethnicity, mathematics standardized test scores in Grade 6, and parent education) that have been shown to be predictive of students' motivational beliefs (Eccles, Wigfield, & Schiefele, 1998). Lastly, we analyzed whether profile membership predicted mathematics achievement and career plans in adolescence and math-related occupations in late adulthood. We used a longitudinal person-centered research approach because it allowed us to (a) identify such divergent patterns of motivational beliefs in the student population, (b) examine their stability and changes, and (c) examine their relation to math-related aspirations and occupations. Longitudinal variable-centered research approaches (i.e., growth models) would enable us to examine the development of motivational variables in the student population, but it would not enable us to look at specific subgroups within this population.

We expected to identify profiles characterized by consistently high, low and medium levels of ability self-concept, intrinsic value and importance value in mathematics *and* we expected to find divergent patterns of motivational beliefs with differing levels of these three factors (Lazarides et al., 2019; Viljaranta et al., 2017, Hypothesis 1a). Referring to previous studies (Nurmi & Aunola, 2005; Viljaranta, Kiuru, et al., 2016), we predicted that profiles characterized by consistent level differences in motivational beliefs would be more stable than the profiles characterized by divergent patterns of motivational beliefs across the school grades (Hypothesis 1b).

We hypothesized that student-perceived classroom characteristics at the beginning of Grade 7 would be related to changes in profiles of students' motivational beliefs. Referring to stage-environment fit theory (Eccles, Midgley, et al., 1993), we hypothesized that student-perceived teacher fairness and friendliness would inhibit students' motivational changes into profiles with low levels of intrinsic value, importance value, and ability self-concept (Hypothesis 2a). Conversely, we predicted that student-perceived competition in class would positively predict changes to profiles characterized by low intrinsic value, importance value, and ability self-concept—however, we expected that students who had high levels intrinsic value, importance value, and ability self-concept would benefit from perceived competition, as it would help them to retain their high levels of motivation across the school year (Hypothesis 2b).

We further hypothesized that profiles with a combination of high ability self-concept, high importance value and high intrinsic value would predict an increased likelihood of high mathematics achievement, college majors and career plans in math-related fields, and the choice of mathematics-related occupations in adulthood compared with profiles with a combination of low ability self-concept and low importance and intrinsic values (Hypothesis 3). We also tested the indirect effects of student profile membership at the end of high school in Grade 10 on their later career attainment 22 years after graduation via their career plans in Grade 12 (Lauermann et al., 2017).

Method

Sample

Data were drawn from the Michigan Study of Adolescent and Adult Life Transitions (Eccles et al., 1989)—a longitudinal, large-scale study examining the development and socialization of educational, academic and role-related choices from adolescence into adulthood, which started in 1983 with a group of 5th and 6th graders recruited from 12 different school districts in southeastern Michigan. In Waves 1–4, the sample comprised 12 school districts. Because of sample attrition, only 10 school districts participated in Wave 5.

School districts were selected in which the adolescent would experience the traditional junior high school transition as they moved from the 6th to the 7th grade. Approximately 96.7% of the students in these districts were European American, 1.5% African American, and 1.8% other minorities (for more information, see http://garp.education.uci.edu/msalt.html). Students were followed over 30 years from early adolescence (Grade 6) to adulthood. In this article, we included students who participated in the following four waves of data collection (N = 867): the beginning of Grade 7 (Wave 3); the end of Grade 7; Grade 10 (Wave 5); and Grade 12 (Wave 6). The target sample (N = 867; 56.4% female) had a mean age of 12.56 (SD = 0.61) at Time 1 (Wave 3). Mothers reported their education level at Wave 1 (beginning of Grade 6): 9.3% had no high school degree, 44.6% had a high school degree, 20.9% answered that they had attended "some college or technical school," 20.1% had at least a college degree, and 4.1% reported that they had done "some graduate work/Masters/PhD" (1% was missing). The majority of the students reported being European American (85.4%), 3.6% of the students reported being African American, 1.8% of the students reported being a member of another ethnic group (Hispanic, Asian, Native American, etc.). To investigate the longitudinal associations of motivational belief profiles with educational and occupational outcomes in adulthood, a subsample of 396 students (62.4% female) out of the 867 targeted students was used. These were the participants who were available for data collection in Wave 10 (22 years after high school; 2013/14). The mean age for this subsample was 41.2 (SD = 0.65). Of the 396 students who were available in Wave 10, 347 students reported their occupation and 210 reported having had a college major. Attrition analyses are reported in the subsequent sections.

Measures

Student-reported subjective task value and ability self-concept in mathematics were assessed at each of the four measurement points in school (Grade 7 Fall to Grade 12). Students' perceptions of their classroom learning environment were assessed only in Grade 7. Data on career plans were assessed in Grade 12. Data on completed college majors were assessed 22 years after high school.

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Means and *SD*s of the variables included in the analyses are T1 reported in Table 1.

Subjective task value. Subjective task value in mathematics was assessed with four items using a 7-point Likert scale. Intrinsic value was assessed with two items: (a) In general, I find working on math assignments . . . . (1 = *very boring* to 7 = *very interesting*), (b) How much do you like doing math? (1 = *a little* to 7 = *a lot*). Attainment value was assessed with one item: For me, being good at math is . . . (1 = *not at all important* to 7 = *very important*). Utility value was assessed with one item: How useful do you think the math you are learning will be for what you want to do after you graduate and go to work? (1 = *not at all useful* to 7 = *very useful*). These measures are well-established and have been widely used in previous research (e.g., Eccles et al., 2004; Jacobs et al., 2002; Nagy et al., 2008). We combined the items assessing attainment and utility value into a global "importance value" factor in line with previous studies (Fredricks & Eccles, 2002; Watt et al., 2012). The Spearman Brown reliability coefficient, which is highly suitable for assessing the reliability of two-item scales (Eisinga, Grotenhuis, & Pelzer, 2013), showed an acceptable reliability for intrinsic and importance value assigned to mathematics at all waves (*intrinsic value*: .86 in Grade 7 Fall; .89 in Grade 7 Spring, .92 in Grade 10 and .94 in Grade 12; *importance value*: .59 in Grade 7 Fall; .67 in Grade 7 Spring; .75 in Grade 10 and .76 in Grade 12).

Ability self-concept. Students' self-concept of their ability in mathematics was measured with a three-item scale. Items were (a) If you were to rank all the students in your math class from the worst to the best in math, where would you put yourself? (1 = *the worst* to 7 = *the best*), (b) How good at math are you? (1 = *not at all good* to 7 = *very good*), and (c) Compared with most of your other school subjects, how good are you at math? (1 = *much worse* to 7 = *much better*). The Cronbach's α reliabilities for mathematics self-concept were .83 at Time 1 (Grade 7, Fall), .85 at Time 2 (Grade 7, Spring), .85 at Time 3 (Grade 10), and .87 at Time 4 (Grade 12).

Mathematics achievement. Standardized test results from the Michigan Educational Assessment Program (MEAP) were available for Grade 6 and Grade 7. Standardized test scores ranged from 1 to 28. Higher scores on the MEAP indicate higher achievement. Students' course grades were obtained from the students' school records at Time 4 (Grade 12). Course grades ranged from 1 (F) to 16 (A+).

Student-perceived classroom characteristics. Student-reported mathematics classroom characteristics were assessed in terms of student-reported fairness and friendliness of the teacher and student-perceived competition. Student-reported fairness and friendliness of the teacher was assessed with a seven-item scale. Response categories ranged from 1 (*not very much*) to 7 (*very much*). Example items are "The teacher grades our math work fairly," and "The teacher is friendly to us." The reliability of the scale in our sample was acceptable at .73. Student-perceived competition in class was assessed with the following three items: "Some kids try to be the first ones to answer math questions the teacher asks," "Some students in this class make fun of kids who answer math questions wrong or make mistakes," and "Some kids try to be the first ones done in math" using the introductory phrase "Think about this classroom and circle whether you think the answer . . . ." Response categories for each item ranged from 1 (*not very often*) to 4 (*very often*). Reliability for this scale at Time 1 (Grade 7 Fall) was acceptable at .64.

Career aspirations. Students' career aspirations were assessed in Grade 12 with the question, "Imagine you are getting ready to start working and are choosing the job or career you will be in for several grades. Look at the following list and rate how likely you would be to consider entering these kinds of jobs." Responses ranged from 1 (*very unlikely*) to 7 (*very likely*). We only included students' answers in the response category "Science or math-related field (like engineer, architect, CPA, science teacher)" in the present analysis.

College major and occupation. In 2013/14, 22 years after finishing high school, the participants were asked to report their current occupation and their college major. For the present analysis, the open-ended answers were coded into Occupational Information Network codes (O*Net; National Center for O*NET Development, 2014). To capture the math-relatedness of the reported occupation, the math importance score of the reported occupation in the ONET database was used. The math importance score quantifies the relatedness of ONET occupations to "knowledge of arithmetic, algebra, geometry, calculus, statistics, and their appli-

Table 1
Descriptive Data of the Study Variables

	Grade 6		Grade 7.1		Grade 7.2		Grade 10		Grade 12		After HS	
Variable (range)	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)	*N*
Self-concept (1–7)			5.16 (1.17)	864	5.05 (1.23)	859	4.74 (1.32)	865	4.49 (1.32)	829		
Importance (1–7)			5.91 (1.16)	862	5.73 (1.26)	861	5.26 (1.47)	865	4.99 (1.53)	829		
Intrinsic value (1–7)			4.73 (1.63)	864	4.42 (1.74)	859	3.80 (1.84)	865	3.73 (1.84)	829		
Math test score (1–28)	24.69 (3.96)	665			23.78 (4.26)	756						
Math achiev (1–16)									9.58 (3.33)	440		
Math occ aspir (1–7)									3.82 (2.15)	829		
Math major (0–100)											58.10 (17.49)	210
Math occ (0–100)											55.80 (15.98)	345
Teacher fairness (1–4)			3.39 (.56)	861								
Competition (1–4)			2.48 (.77)	861								

Note. Importance = importance value; Math achiev = mathematics achievement; Math occ aspiration = mathematics-related occupational aspirations; Math occ = mathematics-related occupation; after HS = 22 years after high school; Teacher fairness = student-perceived teacher fairness and friendliness; Competition = student-perceived competition in class.

cations" on a scale ranging from 0 (*not mathematics-related*) to 100 (*completely mathematics-related*). For college majors, the reported majors were first coded using the Classification of Instructional Programs (National Center for Education Statistics, 2017, November 3). Using the crosswalk provided by the National Center for Education Statistics, CIP codes were then translated into ONET codes allowing for the use of the ONET database described above.

Statistical Analysis

Measurement invariance across time (across Grades 7 to 10) was tested for the motivational variables in line with Chen (2007), who defines that a change of ≥−010 in comparative fit index (CFI), supplemented by a change of ≥.015 in root mean square error of approximation (RMSEA) can be interpreted as an indicator of a lack of invariance. We tested whether the factor structure, factor loadings, and intercepts remained the same across the four measurement points. Factor loadings were completely invariant for all scales. Item intercepts were completely time-invariant for intrinsic value and ability self-concept. Item intercepts were partially time-invariant for importance value, as the item intercepts of Items 1 and 2 were equal only across Times 3 and 4 (Grades 10 and 12). Taken together, the results of measurement invariance testing indicate that the variables reflected the same constructs at each measurement occasion. The fit indices of the sequentially tested models are provided in Appendix A.

The first aim of this study was to identify which latent profile solution showed the best fit to the empirical data using the I-States as Objects Analysis (ISOA) procedure (Bergman et al., 2003). The ISOA is a person-centered analysis approach that classifies cases into homogenous groups with similar patterns of variables (Bergman et al., 2003). The ISOA approach assumes that the same typical patterns emerge at all time points—perhaps with different frequencies and with some of the individuals changing their group membership (Bergman, Nurmi, & von Eye, 2012). This assumption is used to improve the power of the classification analysis and to make the findings clearer and more interpretable.

For ISOA, we merged all four time points into one data file resulting in a total of 3,468 i-states (n = 867 at four time points). For the latent profile analyses, those cases were excluded from the analyses, with missing data on all variables resulting in a total of 3,420 i-states. The appropriate number of latent classes was evaluated based on a comparison between several well-established statistical criteria (Nylund, Asparouhov, & Muthén, 2007), including the Akaike information criterion (AIC: lowest; Akaike, 1974), Bayesian information criterion (BIC: lowest; Schwarz, 1978), sample-size-adjusted Bayesian information criterion (aBIC: lowest), entropy (>.80; Rost, 2006), and adjusted Lo-Mendell-Rubin Likelihood Ratio Test (LMR LRT: p value is used to determine whether the null k-1 class model should be rejected in favor of the k class model). Furthermore, theoretical interpretation of the profiles was used as a criterion for model selection. Using cross-tabulation analysis, the relationships between student gender and profile membership were examined for each time point.

In the next step, the stability of and changes in the cluster memberships across the four measurement points were examined using cross-tabulation with standardized residuals. A standardized residual $z < \pm 1.96$ indicates a significantly typical ("more likely than expected by chance") or atypical ("less likely than expected by chance") change in students across profiles. All changes in students across the profiles were dummy-coded for each time point, with stability coded as '0' and change coded as '1.'

Subsequently, in a series of binary logistic regression analyses, the dummy-coded variables were used to examine whether student-perceived competition in class and student-reported teacher fairness and friendliness at the beginning of Grade 7 would predict changes in profile membership from the beginning of Grade 7 to the end of Grade 7. Several authors have recommended a minimum ratio of 10 to 1 (n = 10 per estimated parameter) with a minimum sample size of 100 or 50 (for a detailed discussion of this issue, see Peng, So, Stage, & John, 2002). Therefore, we focused only on those changes that had $n \geq 50$ in the category indicating change across profiles (smaller category). These three changes were the following: (a) *medium motivational beliefs* profile to *low intrinsic value* profile (n = 59); (b) *medium motivational beliefs* profile to *high motivational beliefs* profile (n = 66); and (c) *high motivational beliefs* profile to *medium motivational beliefs* profile (n = 112). We controlled for student gender, mathematics test scores at the end of Grade 6, parent education, age, and ethnicity. In additional analyses, we also tested whether the change in student-perceived classroom characteristics was associated with the three changes that occurred for $n \geq 50$.[1] Fn1

In the next step, using univariate analyses of variance, we examined whether profile membership at the beginning of Grade 7 predicted mathematics test scores (MEAP) at the end of Grade 7 when controlling for student gender, parent education, and previous mathematics achievement in Grade 6 using standardized test scores (MEAP). With the Wald χ^2 test of parameter equalities (Kodde & Palm, 1986), we examined whether math-related occupational plans in Grade 12 depended on the profile membership of students in Grade 10. Using univariate analyses of variance, we examined whether profile membership in Grade 12 predicted the completion of a mathematics-related major and student career attainment in a math-related field 22 years after high school when controlling for gender, parent education, and mathematics score in Grade 12. We additionally tested the indirect effects of student profile membership at the end of high school (Grade 10) on student career attainment in math-related fields 22 years after graduation via career plans related to mathematics in Grade 12 when controlling for gender, parent education, and mathematics score in Grade 12 using path analyses. Student profile membership was dummy-coded and included as a binary predictive variable in the analyses. We conducted latent profile analyses and binary logistic regression analyses in Mplus (Muthén & Muthén, 1998–2015) using full information maximum likelihood estimation.

Missing Data

We used a subsample of 867 students who participated in each of the four targeted waves (Waves 3, 4, 5, and 6, which refer to the beginning and end of Grades 7, 10, and 12) because of the attrition between the waves that were the focus of this study (N_{wave3} = 2,472; N_{wave4} = 2,472; N_{wave5} = 1,425; N_{wave6} = 1,384). The target sample in the current study (N = 867) represents 35% of the

[1] Measurement invariance was also tested for the student-perceived classroom characteristics and results are reported in Appendix A, Tables 4 and 5. Results show scalar measurement invariance for both constructs.

initial longitudinal sample followed into high school of 2,472 students who were surveyed first at the beginning of the 6th grade (Wave 1). This attrition rate is similar to attrition rates found in other large-scale longitudinal studies (Deng, Hillygus, Reiter, Si, & Zheng, 2013; Ribisl et al., 1996). The main reasons for attrition were students moving out of the participating school districts and schools completely, as well as absence during data collection. Attrition analyses showed that the amount of missing data was significantly correlated with student gender for importance and intrinsic value as well as for self-concept in mathematics at each wave. Boys had significantly higher amounts of missing values on the motivational variables than did girls. The amount of missing data was significantly and negatively correlated with student's mathematics test scores at the end of Grade 7 (Wave 4) for each of the motivational variables at each wave. Correlation coefficients are reported in Appendix B. The amount of missing data was not significantly correlated with mothers' education.

To test for robustness of findings, the latent profile analyses and cross-tabulation analyses were also conducted with the initial longitudinal sample followed into high school of 2,472 students who were surveyed first at the beginning of the 6th grade (Wave 1). However, because of the relatively high attrition rate between Wave 1 (beginning of Grade 7) and Wave 3 (Grade 10), we only conducted the additional cross-tabulation for Waves 3 and 4 (beginning of Grade 7 to end of Grade 7). The additional analyses can be found in the online supplemental material.

A subsample of 396 students (62.4% female) out of the 867 targeted students was available for data collection in Wave 10 (22 years after high school; 2013/14). Of these students, 347 students reported their occupation and 210 students reported having had a college major. Missing data analysis indicated that data were missing completely at random when including importance and intrinsic value as well as self-concept in mathematics at Grade 12 (Wave 6) and mathematics occupation in adulthood in the analyses, as Little's MCAR test (Little, 1988) was not significant: $\chi^2(4) = 3.40$, $p = .414$.

Results

Motivational Belief Profiles

We conducted a series of latent profile analyses to identify the latent profile solution that showed the best fit to the empirical data. The model fit criteria for the series of latent profile analyses are displayed in Table 2. The AIC, BIC, and aBIC values consistently declined and, thus, did not identify a profile solution that fit the data best. Nylund et al. (2007) concluded that the BIC is likely to identify the correct number of latent profiles in comparison to the other information criteria. The difference in BIC values was comparably high for the four- versus the five-profile solution (316.98) and, thus, indicated that the four-profile solution fit the data better than the five- and six-profile solutions. The adjusted LMR LR test, however, was highly significant for the five-profile solution. This indicates that the five-profile solution showed a better fit to the data than the four-profile solution. Because of the inconsistency of the model fit indices, we compared the four- and five-profile solutions based on theoretical criteria.

T2, AQ:5

The four-profile solution showed profiles with theoretically expected mean differences in the motivational belief profiles (low, medium, high) and, as expected, a profile with different configurations of intrinsic value, importance value, and ability self-concept.

In the five-profile solution, similar profiles emerged (low, high, medium-high, medium-low, and a profile with different configurations of motivational beliefs). Two similar profiles emerged (medium-high/medium-low), both characterized by medium levels of motivation.

We selected the four-profile solution because of its theoretically meaningful profiles and because it was the most parsimonious profile solution. Group differences in the criteria variables of the four-profile solution are shown in Figure 1. Figure 1 is based on a total of 3,420 i-states as explained in the method section. Multivariate analyses of variance results for the mean values of the i-states in the four-profile solution are depicted in Table 3 and show that the profiles differed statistically significantly in the criterion variables, $F(9, 8294.33) = 1584.80$, $p < .001$; Wilk's $\Lambda = .09$; $\eta_p^2 = .56$. Multivariate analyses of the variance analyses were also conducted for each time point separately. These analyses are reported in Appendix C, Tables 1–4. F1 T3

The four-profile solution included two large profiles of motivational beliefs: Almost half of the students (Grade 7 beginning: 40.16%; Grade 7 end: 41.21%; Grade 10: 37.94%; Grade 12: 39.10%) displayed a *high motivation beliefs* profile. Students in this profile were characterized by overall high levels of self-concept, intrinsic value, and importance value. The other large profile was the *medium motivation beliefs* profile (Grade 7 beginning: 45.49%; Grade 7 end: 38.42%; Grade 10: 27.73%; Grade 12: 25.18%). Students in this profile reported moderate levels of self-concept, intrinsic value and importance value. Approximately

Table 2
Model Fit Criteria of the One- to Eight-Class Solutions in Latent Profile Analysis (N of I-States = 3,420)

	Number of classes							
Model fit indices	1	2	3	4	5	6	7	8
AIC	37231.37	34491.05	33851.5	33509.96	33288.12	33137.51	33004.22	32870.69
BIC	37268.19	34552.42	33937.42	33620.44	33423.14	33297.08	33188.34	33079.36
aBIC	37249.13	34520.65	33892.93	33563.24	33353.24	33214.47	33093.01	32971.33
aLMR		2666.4	628.24	339.11	223	154	137	137
p aLMR		.00	.01	.001	.001	.05	.11	.14
BIC difference value		2715.77	615.00	316.98	197.30	126.06	108.74	108.98

Note. AIC = Akaike's Information Criteria; BIC = Bayesian Information Criteria; aBIC = sample-size-adjusted Bayesian information criterion; aLMR = Lo-Mendell-Rubin adjusted likelihood ratio test.

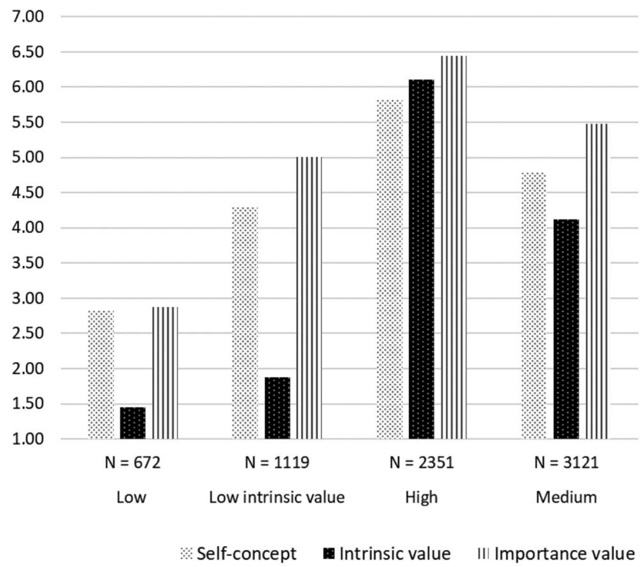

Figure 1. The mean levels of self-concept, intrinsic value, and importance value in mathematics in the four latent profiles using the I-States as Objects Analysis (ISOA) data set with 3,420 i-states. Further details are provided in the Method and Results sections.

15% of the students (Grade 7 beginning: 11.46%; Grade 7 end: 15.13%; Grade 10: 21.46%; Grade 12: 17.80%) displayed a *low intrinsic value* profile. The students in this profile were characterized by low levels of mathematics intrinsic value, but medium to high levels of mathematics self-concept and importance value. The smallest profile was the *low motivation beliefs* profile (Grade 7 beginning: 2.89%; Grade 7 end: 5.24%; Grade 10: 12.88%; Grade 12: 17.92%). Students in this profile reported low levels of mathematics self-concept, intrinsic value, and importance value.

Stability and Change in Profile Membership

The results of the cross-tabulation that examined stability and change in profile membership across Grades 7 and 12 are reported
T4-7 in Tables 4 to 7. Changes that were more likely than expected by chance ("typical changes") and the valid percentage of cases per
F2 profile per time point are depicted in Figure 2. A standardized residual $z > \pm 1.96$ indicates a significantly typical ("more likely than expected by chance") or atypical ("less likely than expected by chance") change in students across profiles or the stability of profiles.

The results for stability and changes across Grade 7 are reported in Table 4. From the beginning of Grade 7 to the end of Grade 7, profiles were relatively stable. It was more likely than expected by chance to remain in the *low motivational beliefs* profile (44% of the students remained; $z = 8.5$), in the *low intrinsic value* profile (46.5% remained; $z = 8.0$), in the *high motivational beliefs* profile (66.2% of the students remained; $z = 8.9$) and in the *medium motivational beliefs* profile (58.7% of the students in this profile remained in this profile; $z = 5.1$). A move from the *low motivational beliefs* profile or from the *low intrinsic value* profile at the beginning of Grade 7 to the *medium motivational beliefs* profile at the end of Grade 7 was no more or less likely than expected by chance, but students were less likely than expected by chance to move from the *high motivational beliefs* profile at the beginning of Grade 7 to the *medium motivational beliefs* profile at the end of Grade 7 ($z = -3.9$). Students were also less likely than expected by chance to move from the *high motivational beliefs* profile to the *low intrinsic value* profile ($z = -5.5$). Students were less likely than expected by chance to move from the *low motivational beliefs* profile ($z = -3.1$), from the *low intrinsic value* profile ($z = -5.4$) or from the *medium motivational belief* profile ($z = -5.8$) at the beginning of Grade 7 to the *high motivational beliefs* profile at the end of Grade 7. It was more likely than expected by chance to move from the *low motivational beliefs* profile at the beginning of Grade 7 to the *low intrinsic value* profile at the end of Grade 7 (32% experienced this change; $z = 2.2$). Students were also more likely than expected by chance to move from the *low intrinsic value* profile at the beginning of Grade 7 to the *low motivational beliefs* profile at the end of Grade 7 (14.1% experienced this change; $z = 3.9$).

The results for changes and stability in student motivational belief profiles from the end of Grade 7 to Grade 10 are reported in Table 5. From the end of Grade 7 to Grade 10, students were more likely than expected to remain in the *low motivational beliefs* profile (48.9% remained; $z = 6.8$), in the *low intrinsic value* profile (36.2% remained; $z = 3.6$) and in the *high motivational beliefs* profile (42.1% remained; $z = 4.9$). Students were less likely than expected by chance to move from the *low motivational beliefs* profile at the end of Grade 7 to the *high motivational beliefs* profile at Grade 10 ($z = -2.4$). Students were also less likely than expected by chance to move from the *low intrinsic value* profile at Grade 7 to the *medium motivational beliefs* profile at Grade 10 ($z = -3.3$) or to move from the *high motivational beliefs* profile to the *low intrinsic value* profile ($z = -2.4$) or to the *low motivational beliefs* profile ($z = -4.7$). Students were more likely than expected by chance to move from the *low intrinsic value* profile at

Table 3
Multivariate Analyses of Variance: Means and SDs of Motivational Variables and Performance as a Function of Latent Profiles (N of I-States = 3,423)

Variables	Low motivation (N = 392)	Low intrinsic value (N = 561)	High motivation (N = 1,168)	Medium (N = 1,356)	F(3, 3410)	η_p^2
Self-concept	2.82 (1.09)	4.29 (1.19)	5.81 (.74)	4.78 (.94)	972.67	.461
Intrinsic value	1.45 (.62)	1.88 (.68)	6.10 (.67)	4.12 (.66)	7278.07	.865
Importance value	2.87 (1.05)	5.01 (1.12)	6.44 (.76)	5.48 (1.09)	1162.20	.506

Note. All means significantly different at the level of $p < .001$ (for pairwise comparisons, Hochberg's GT2 was used). All F values are significant at $p < .001$.

Table 4
Cross Tabulation: Profiles of Motivational Beliefs From Beginning of Grade 7 to End of Grade 7

Profile g7 beg	Total *N* in %	Profile g7 end	*N* (obs)	% of g7 beg	*N* (expected)	*z*
Low		Low	11	44.0	1.3	8.5*
		Low intrinsic value	8	32.0	3.8	2.2*
		High	0	.0	9.6	−3.1*
	2.9	Medium	6	24.0	10.3	−1.3
Low intrinsic value		Low	14	14.1	5.2	3.9*
		Low intrinsic value	46	46.5	15.0	8.0*
		High	5	5.1	38.0	−5.4*
	11.5	Medium	34	34.3	40.8	−1.1
High		Low	3	.8	20.5	−3.9*
		Low intrinsic value	17	4.3	59.2	−5.5*
		High	259	66.2	150.2	8.9*
	45.5	Medium	112	28.6	161.1	−3.9*
Medium		Low	17	4.9	18.0	−.2
		Low intrinsic value	59	17.2	52.1	1.0
		High	66	19.2	132.2	−5.8*
	40.0	Medium	202	58.7	141.8	5.1*
$\chi^2(9, N = 857) = 151.92, p < .001$						

Note. obs = observed; % of g7 beg = % of profile at beginning of grade 7.
* $p < .05$.

the end of Grade 7 to the *low motivational beliefs* profile at Grade 10 (23.8% of the students who were in the profile at Grade 7 experienced this change; $z = 3.5$).

The results for changes and stability in student motivational beliefs profiles from the end of Grade 10 to Grade 12 are reported in Table 6. From Grade 10 to Grade 12, profiles were again relatively stable, as students were more likely than expected to remain in the *low motivational beliefs* profile (61.6% of the students remained in this profile; $z = 10.3$), in the *low intrinsic value* profile (30.9% remained in this profile; $z = 4.1$), in the *high motivational beliefs* profile (49.6% remained in this profile; $z = 7.4$) and in the *medium motivational beliefs* profile (48.7% remained in this profile; $z = 2.7$). Changes that were significantly less likely than expected (untypical changes) were those from the *low motivational beliefs* profile at Grade 10 to the *high motivational beliefs* profile in Grade 12—only 14.1% of the students who were in the *low motivational beliefs* profile in Grade 10 experienced this change ($z = -4.2$). It was also less likely than expected by chance to move from the *low motivational beliefs* profile in Grade 10 to the *medium motivation beliefs* profile in Grade 12 ($z = -4.0$). Students were further less likely than expected by chance to move from the *low intrinsic value* profile at Grade 10 to the *high motivational beliefs profile* at Grade 12 ($z = -3.9$) and to move from the *medium motivational beliefs* profile in Grade 10 to the *low motivational beliefs* profile in Grade 12 ($z = -3.2$). Fewer students than expected by chance moved from the *high motivational beliefs* profile in Grade 10 to the *low motivational beliefs* profile ($z = -4.7$) and to the *low intrinsic value* profile in

Table 5
Cross Tabulation for Profiles of Motivational Beliefs From the End of Grade 7 to Grade 10

Profile end g7	Total *N* in %	Profile grade 10	*N* (obs)	% g7 end	*N* (expected)	*z*
Low		Low	22	48.9	5.8	6.8*
		Low intrinsic value	9	20.0	9.7	−.2
		High	4	8.9	12.5	−2.4*
	5.3	Medium	10	22.2	17.0	−1.7
Only low interest		Low	31	23.8	16.7	3.5*
		Low intrinsic value	47	36.2	28.1	3.6*
		High	16	12.3	36.1	−1.9
	15.2	Medium	36	27.7	49.1	−3.3*
High		Low	12	3.6	42.2	−4.7*
		Low intrinsic value	51	15.5	71.2	−2.4*
		High	139	42.1	91.6	4.9*
	38.5	Medium	128	38.8	124.8	.3
Medium		Low	45	12.8	45.2	.0
		Low intrinsic value	78	22.2	76.0	.2
		High	79	22.4	97.8	1.5
	41.1	Medium	150	42.6	133.1	−1.9
$\chi^2(9, N = 857) = 151.92, p < .001$						

Note. obs = observed; % g7 end = % of profile at end of grade 7.
* $p < .05$.

Table 6
Cross Tabulation for Profiles of Motivational Beliefs From Grade 10 to Grade 12

Profile grade 10	Total *N* in %	Profile grade 12	*N* (obs)	% g10	*N* (expected)	*z*
Low		Low	61	61.6	17.7	10.3*
		Only low interest	20	20.2	17.7	.6
		High	4	14.1	24.9	−4.2*
	12	Medium	14	4.0	38.8	−4.0*
Low intrinsic value		Low	42	24.0	31.2	1.9
		Low intrinsic value	54	30.9	31.2	4.1*
		High	18	10.3	44.0	−3.9*
	21.2	Medium	61	34.9	68.6	−.9
High		Low	11	4.7	41.4	−4.7*
		Low intrinsic value	13	5.6	41.4	−4.4*
		High	115	49.6	58.3	7.4*
	38.6	Medium	93	40.1	90.0	.2
Medium		Low	33	10.4	56.7	−3.2*
		Low intrinsic value	60	18.9	56.7	.4
		High	70	22.0	79.9	−1.1
	28.2	Medium	155	48.7	124.7	2.7*
$\chi^2(9, N = 824) = 292.30, p < .001$						

Note. obs = observed; % g10 = % of profile at grade 10.
* $p < .05$.

Grade 12 ($z = -4.4$). No changes across profiles were identified that were more likely than expected.

The results for changes and stability in student motivational belief profiles from the end of Grade 7 to Grade 12 are reported in Table 7. From the beginning of Grade 7 to Grade 12, profiles were stable, as students were more likely than expected to remain in the *low motivational beliefs* profile (63.6% of the students remained; $z = 5.1$), in the *low intrinsic value* profile (34.5% remained in the profile; $z = 3.7$), and in the *high motivational beliefs* profile (42.1% remained in the profile; $z = 3.9$). Stability was, however, not more likely than expected by chance for students in the *medium motivational beliefs* profile. Changes that were significantly less likely than expected (untypical changes) were those from the *low motivational beliefs* profile at Grade 7 to the *high motivational beliefs* profile in Grade 12 ($z = -2.4$). Students were also less likely than expected by chance to move from the *low intrinsic value* profile at Grade 7 to the *high motivational beliefs* profile at Grade 12 ($z = -2.8$) and to move from the *medium motivational beliefs* profile in Grade 7 to the *high motivational beliefs* profile in Grade 12 ($z = -2.2$). Fewer students than expected by chance moved from the *high motivational beliefs* profile in Grade 7 to the *low motivational beliefs profile* ($z = -3.2$) and to the *low intrinsic value* profile in Grade 12 ($z = -2.9$). The change from the *low intrinsic value* profile in Grade 7 to the *low motivational beliefs* profile in Grade 12 was more likely than expected by chance—27.6% of the students who were in the *low intrinsic value* profile in Grade 7 experienced this maladaptive motivational shift ($z = 2.1$).

Table 7
Cross Tabulation for Profiles of Motivational Beliefs From Grade 7 to Grade 12

Profile grade 7	Total *N* in %	Profile grade 12	*N* (obs)	% g7	*N* (expected)	*z*
Low		Low	14	63.6	3.9	5.1*
		Low intrinsic value	4	18.2	3.9	.0
		High	0	.0	5.5	−2.4*
	2.9	Medium	4	18.2	8.6	−1.6
Low intrinsic value		Low	24	27.6	15.6	2.1*
		Low intrinsic value	30	34.5	15.5	3.7*
		High	9	10.3	21.9	−2.8*
	11.5	Medium	24	27.6	34.0	−1.7
High		Low	43	11.1	41.4	−3.2*
		Low intrinsic value	45	11.6	41.4	−2.9*
		High	163	42.1	58.3	3.9*
	45.5	Medium	136	35.1	90.0	.9
Medium		Low	67	20.3	59.1	1.0
		Low intrinsic value	68	20.6	58.7	1.2
		High	63	19.1	151.3	−2.2*
	40.0	Medium	132	40.0	97.5	.3
$\chi^2(9, N = 824) = 104.25, p < .001$						

Note. obs = observed; % g7 = % of profile at grade 7.
* $p < .05$.

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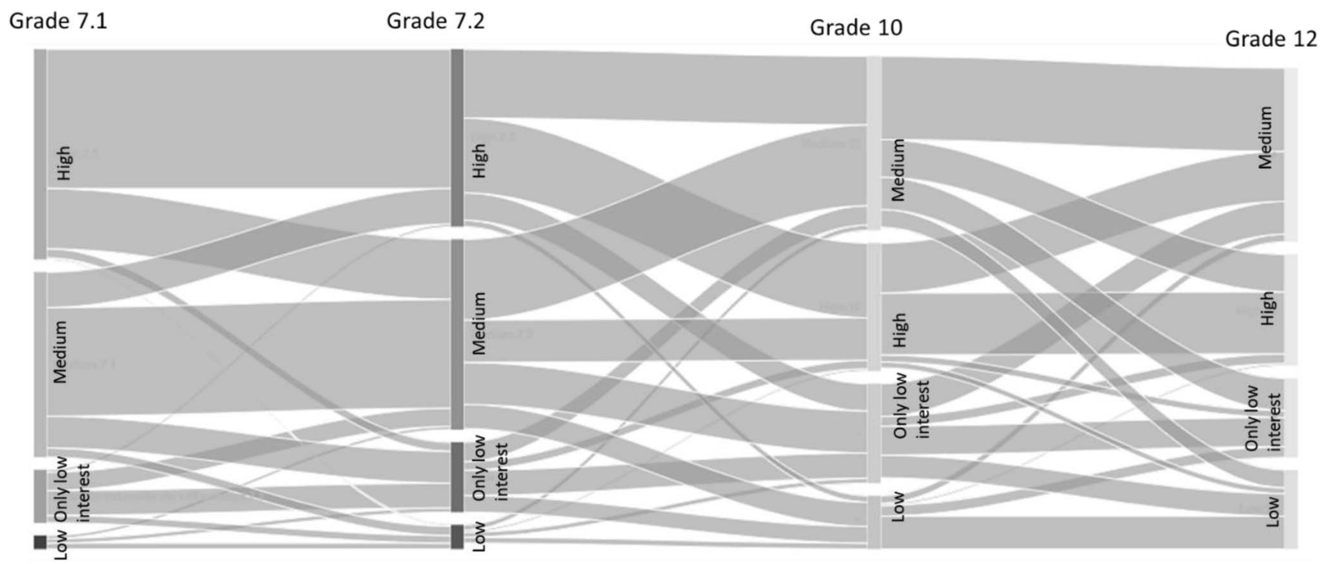

Figure 2. Changes across profiles that are more likely than expected by chance are indicated by arrows.

Taken together, all motivational belief profiles were relatively stable across the school grades from Grade 7 to Grade 12. On a descriptive level, motivational belief profiles that were characterized by empirically expected differences in mean levels were more stable, as a higher percentage of students tended to remain in these profiles across time than students in profiles with the empirically unexpected configuration of low intrinsic value. Stability occurred even when examining long time spans raging from Grade 7 to Grade 12. To test for the robustness of the findings, the latent profile analyses were also conducted with the initial longitudinal sample followed into high school of 2472 students who were surveyed first at the beginning of 6th grade (Wave 1). The identified patterns of motivational beliefs in the larger sample mirrored the same patterns that were identified in the smaller sample.

Student-Perceived Classroom Characteristics and Changes in Profile Membership

We focused on three changes in profile membership across Grade 7 that pertained to $n \geq 50$ of the students. In the following section, we report the results of the logistic regression analyses with multiple predictor variables. The reference class of the dependent variable in our analyses is "no change/stability" (coded as 0) versus "change" (coded as 1). We provide odds ratios as a measure of effect size. Odds ratios are defined as the ratio of the probability that an event will occur and the probability that an event will not occur.

Change from the *medium motivational beliefs* profile at the beginning of Grade 7 to the *low intrinsic value* profile at the end of Grade 7 ($n = 59$). Student-perceived competition in class ($\beta = 0.08$, $SE = .11$, $p = .94$, odds ratio [OR] = 1.02), student-perceived fairness and friendliness of the teacher ($\beta = 0.11$, $SE = .13$, $p = .39$, $OR = 1.66$), and the control variables of student gender ($\beta = -0.07$, $SE = .07$, $p = .33$, $OR = 0.77$), parent education ($\beta = -0.13$, $SE = .08$, $p = .11$, $OR = 0.78$), mathematics standardized test scores in Grade 6 ($\beta = 0.01$, $SE = .09$, $p = .99$, $OR = 1.00$), students' age ($\beta = 0.03$, $SE = .08$, $p = .75$, $OR = 1.08$), and their ethnicity ($\beta = -0.16$, $SE = .13$, $p = .22$, $OR = 1.08$) were not significantly related to this change.

Change from the *medium motivational beliefs* profile at the beginning of Grade 7 to the *high motivational beliefs* profile at the end of Grade 7 ($n = 66$). Student-perceived competition in class ($\beta = 0.18$, $SE = .09$, $p = .04$, $OR = 1.54$) was positively and significantly related to this change. This indicates that when students' rating on perceived competition increases by one point on the Likert scale, the odds of changing from the *medium motivational beliefs* profile to the *high motivational beliefs* profile increase by 54% (1–1.54) when holding student-perceived teacher fairness and friendliness and the control variables at a fixed value. Student-perceived fairness and friendliness of the teacher ($\beta = 0.18$, $SE = .11$, $p = .09$, $OR = 2.31$) and the control variables of student gender ($\beta = -0.10$, $SE = .07$, $p = .18$, $OR = 0.69$), parent education ($\beta = -0.08$, $SE = .07$, $p = .29$, $OR = 0.87$), mathematics standardized test scores in Grade 6 ($\beta = 0.15$, $SE = .15$, $p = .31$, $OR = 1.08$), age ($\beta = 0.08$, $SE = .07$, $p = .24$, $OR = 1.30$), and ethnicity ($\beta = 0.12$, $SE = .07$, $p = .10$, $OR = 2.51$) were not significantly related to this change.

Change from the *high motivational beliefs* profile at the beginning of Grade 7 to the *medium motivational beliefs* profile at the end of Grade 7 ($n = 112$). Student-perceived fairness and friendliness of the teacher ($\beta = -0.17$, $SE = .08$, $p = .04$, $OR = 0.46$) and student age ($\beta = -0.11$, $SE = .05$, $p = .04$, $OR = 0.72$) were negatively and significantly related to this change. This indicates that when students' rating on perceived teacher fairness and friendliness increases by one point on the Likert scale, the odds of changing from the high motivational belief profile to the medium motivational belief profile decreases by 54% (1–0.46) when holding student-perceived competition and the control vari-

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ables at a fixed value. Mathematics standardized test scores in Grade 6 were positively and significantly related to this change ($\beta = 0.18$, $SE = .08$, $p = .02$, $OR = 1.09$). Student-perceived competition in class ($\beta = -0.01$, $SE = .07$, $p = .87$, $OR = 0.97$) and the control variables of student gender ($\beta = -0.08$, $SE = .07$, $p = .22$, $OR = 0.73$), parent education ($\beta = 0.05$, $SE = .06$, $p = .35$, $OR = 1.10$), and ethnicity ($\beta = -0.01$, $SE = .05$, $p = .83$, $OR = 0.92$) were not significantly related to this change.

Additional analyses: Change in student-perceived classroom characteristics and changes in profile membership. The descriptive data show that student-reported teacher fairness and friendliness ($M_{T1} = 3.39$, $SD = 0.56$; $M_{T2} = 3.21$, $SD = 0.68$) and competition ($M_{T1} = 2.48$, $SD = 0.77$; $M_{T2} = 2.43$, $SD = 0.80$) declined over the school year. The results of a paired *t* test showed that only student-reported teacher fairness and friendliness significantly decreased, $t(855) = 9.02$, $p < .001$, $d = -0.29$. Student-perceived competition in class did not significantly decrease, $t(856) = 0.14$, $p = .888$–.064. Therefore, we tested in the next step whether the significant decrease in student-reported teacher fairness and friendliness is associated with the observed changes in motivational beliefs. Using a standardized difference score for student-perceived teacher fairness and friendliness in multinomial logistic regression analyses, we tested whether the standardized difference score was associated with any of the three change variables. Results showed that the likelihood of changing from the *medium motivational beliefs* profile to the *low intrinsic value* profile ($\beta = -0.34$, $SE = .09$, $p < .001$, $OR = 0.49$) and the likelihood of changing from the *high motivational beliefs* profile to the *medium motivational beliefs* profile ($\beta = -0.36$, $SE = .14$, $p = .012$, $OR = 0.70$) was lower at positive values of the difference score (that would be an increase in student-perceived teacher fairness and friendliness or at least no decline). The change from the *medium motivational beliefs* profile to the *high motivational beliefs* profile was not significantly related to the difference score ($\beta = 0.11$, $SE = .16$, $p = .49$, $OR = 1.12$).

Prediction of Math-Related Outcomes

In the first step, we examined whether profile membership at the beginning of Grade 7 predicted mathematics test scores (MEAP) at the end of Grade 7. In the second step, we examined whether math-related occupational plans in Grade 12 depended on the profile membership of students in Grade 10. In the third step, we examined whether profile membership in Grade 12 predicted the completion of a mathematics-related major and student career attainment in a math-related field 22 years after high school.

Profile membership at the beginning of Grade 7 and mathematics achievement at the end of Grade 7. The results of a univariate analysis of variance (ANOVA) showed that mathematics test scores (MEAP) at the end of Grade 7 varied significantly across the profiles of motivational beliefs when controlling for student gender, parent education and mathematics test scores in Grade 6, $F(3, 571) = 3.39$, $p = .018$; $\eta_p^2 = .02$. For pairwise multiple comparisons with unequal sample sizes in the profiles, a post hoc GT2 Hochberg test (Hochberg, 1974) with Bonferroni correction was applied. The adjusted level of significance was $p \leq .01$. Results showed that students in the *low motivational beliefs* profile at the beginning of Grade 7 ($n = 24$, $M = 21.83$, $SD = 4.27$) had significantly lower mathematics test scores at the end of Grade 7 than students in the *high motivational beliefs* profile ($n = 337$, $M = 27.24$, $SD = 3.74$, $d = 1.35$). There were no other significant differences between the motivational profiles. The results are reported in detail in Appendix D.

Profile membership at Grade 10 and math-related occupational plans at Grade 12. The Wald χ^2 test of parameter equalities (Kodde & Palm, 1986) with Bonferroni correction was applied. The adjusted level of significance was $p \leq .01$. Results are reported in Table 8. Students who were in the *low motivational beliefs* profile in Grade 10 reported a significantly lower level of math-related career plans in Grade 12 than students in all other profiles of motivational beliefs. Students in the *low intrinsic value* profile and students in the *medium motivational beliefs* profile in Grade 10 both reported a lower level of math-related career plans in Grade 12 than students in the *high motivational beliefs* profile. There were no other significant differences between the motivational profiles regarding math achievement. T8

Profile membership at the end of high school, math-related college major, and occupation 22 years after high school. Multivariate analyses of variance showed that the completion of a mathematics-related major as well as entrance into a mathematics-related occupation as reported 22 years after high school depended

Table 8
Wald χ^2 Tests for Comparison of Means of Mathematics-Related Career Plans in Grade 12 Across Profiles of Motivational Beliefs at Beginning of Grade 7

Low ($N = 25$)	Low intrinsic value ($N = 89$)	Medium ($N = 334$)	High ($N = 381$)	Results of Wald Chi-Square Tests
Reference group = Low motivation profile				
2.20	3.38			Wald $\chi^2(1) = 8.80$, $p = .003$
2.20		3.64		Wald $\chi^2(1) = 16.52$, $p < .001$
2.20			4.19	Wald $\chi^2(1) = 31.95$, $p < .001$
Reference group = Low intrinsic value profile				
	3.38	3.64		Wald $\chi^2(1) = 1.12$, $p = .290$
	3.38		4.19	Wald $\chi^2(1) = 11.09$, $p = .001$
Reference group = Medium motivation profile				
		3.64	4.19	Wald $\chi^2(1) = 11.45$, $p = .001$

on the motivational profile membership in Grade 12 when controlling for gender, parent education, and mathematics score in Grade 12, $F(6, 248.00) = 3.73$, $p = .001$; Wilk's $\Lambda = .38$; $\eta_p^2 = .09$.

A post hoc GT2 Hochberg test with Bonferroni correction was applied. The adjusted level of significance was $p \leq .01$. Results showed that students in the *low motivational beliefs* profile at Grade 12 ($n = 40$, $M = 45.89$, $SD = 14.52$) reported significantly lower math-relatedness in their college major than students in the *high motivational beliefs* profile ($n = 53$, $M = 68.77$, $SD = 15.66$, $d = 1.52$) and students in the *medium motivational beliefs* profile ($n = 68$, $M = 58.82$, $SD = 15.74$). Students in the *low intrinsic value* profile at the beginning of Grade 7 ($n = 34$, $M = 55.10$, $SD = 17.58$, $d = 0.85$) reported a significantly lower math-relatedness of their college major than students in the *high motivational beliefs* profile. Students in the *medium motivational beliefs* profile reported significantly lower math-relatedness in their college major than students in the *high motivational beliefs* profile and a significantly higher math-relatedness of their college major than students in the *low motivational beliefs* profile. There were no other significant differences between the motivational profiles regarding college majors related to mathematics.

Students in the *low motivational beliefs* profile at Grade 12 ($M = 51.75$, $SD = 13.59$) reported a significantly lower math-relatedness of their most recent occupation than those in the *high motivational beliefs* profile ($M = 65.26$, $SD = 15.63$, $d = 0.92$). Students in the *low intrinsic value* profile ($M = 57.59$, $SD = 15.92$) and the *medium motivational beliefs* profile ($M = 57.43$, $SD = 16.70$) did not differ significantly from the other profiles regarding the math-relatedness of their occupations in adulthood. There were no other significant differences between the motivational profiles regarding math-related occupations.

We also tested whether student profile membership at the end of high school in Grade 10 predicted the math-relatedness of their occupations in adulthood via their career plans in Grade 12. Path analyses showed that student membership in the *low motivational beliefs* profile in Grade 10 indirectly and negatively predicted the math-relatedness of their occupations in adulthood ($\beta_{ind} = -.04$, $SE = 0.02$, $p = .022$, 95% CI [−0.07, −.01]). Membership in the *low intrinsic value* profile in Grade 10 ($\beta_{ind} = -.01$, $SE = 0.01$, $p = .861$, 95% CI [−0.57, .48]), in the *high motivational beliefs* profile ($\beta_{ind} = .04$, $SE = 0.02$, $p = .064$, 95% CI [−0.01, .08] and in the *medium motivational beliefs* profile in Grade 10 ($\beta_{ind} = -.01$, $SE = 0.01$, $p = .473$, 95% CI [−0.02, .007]) did not significantly predict the math-relatedness of their occupations in adulthood via student career plans in Grade 12.

Discussion

Building on previous research that investigated the profiles of motivational beliefs of students (Alexander & Murphy, 1998; Chow et al., 2012; Chow & Salmela-Aro, 2011; Lazarides et al., 2019; Viljaranta, Kiuru, et al., 2016), this study focused on the profiles of motivational beliefs of adolescents in mathematics, their development across adolescence, their relation to student-perceived classroom characteristics and association with math-related choices in adulthood. We identified four mathematics motivational belief profiles in adolescence that were stable from Grade 7 to Grade 12: *high*, *medium*, and *low* motivation belief profiles and a *low intrinsic value* profile. We showed that student-reported teacher fairness and friendliness at the beginning of Grade 7 negatively predicted changes from the high to the medium motivation beliefs profile. Student-perceived competition in class positively predicted changes from the medium to the high motivation beliefs profile. The findings of this study further showed that profile membership at the beginning of Grade 7 predicted mathematics test scores at the end of Grade 7. Profile membership in Grade 10 predicted career plans in Grade 12, and profile membership in Grade 12 predicted the math-relatedness of students' college major and occupation in adulthood. Membership in a *low intrinsic value* profile predicted a reduced likelihood of choosing math-intensive majors.

Profiles of Motivational Beliefs in Mathematics and Their Development

In line with previous findings (Chow & Salmela-Aro, 2011; Lazarides et al., 2019; Viljaranta, Kiuru, et al., 2016) and with our expectations (Hypothesis 1a), we identified profiles that were characterized by level differences (high, medium, and low) and a profile that was characterized by differing intraindividual levels of motivational beliefs. By identifying this *low intrinsic value* profile, our findings showed that students who feel competent in a domain and who value this domain as useful for their lives are not necessarily interested in the domain. Despite variable-centered research showing high intercorrelations between intrinsic value and ability self-concept (Bong, 2001; Gaspard et al., 2017), and between intrinsic value and utility value (Gaspard et al., 2015), students in this profile were characterized by moderate competence beliefs and moderate to high utility value, but low interest in mathematics. This finding contributes to research based on Eccles's expectancy value framework (Eccles et al., 1983), as it shows by means of person-centered research that importance value and intrinsic value are two distinct components of task value that can manifest differently within one person. However, this cluster was relatively small, as 11.5% ($n = 99$) of the students at the beginning of Grade 7, 15.1% ($n = 130$) of the students at the end of Grade 7, 21.5% ($n = 185$) of the students in Grade 10 and 17.8% ($n = 145$) of the students in Grade 12 were in this cluster. It is important to note that person-centered research from other educational systems has shown a similar motivational profile for Finnish primary school students in reading (Viljaranta et al., 2017) and for German secondary school students in mathematics (Lazarides et al., 2019).

One possible explanation for the configuration of motivational beliefs in the divergent pattern is that students who have a moderate to high ability self-concept often also have a relatively high level of performance in mathematics (Marsh et al., 2005)—if these students feel unchallenged by the tasks in their mathematics classrooms, their interest in mathematics might decline, which fits with the pattern that we identified in this study.

The implication of our findings is that students have different motivational patterns in mathematics classrooms, which teachers should address. For example, some students with a low level of intrinsic value might benefit from interest-enhancing tasks that refer to their everyday lives (Eccles et al., 1998). Making personal connections is one way to enhance students' intrinsic value in mathematics classrooms, however, other students with low intrinsic value might benefit from other teaching approaches such as, for example, actively exploring the academic content. By showing the existence of different groups of students with different motivational belief patterns, our findings point to the need to differentiate from a motivational perspective, not just a skills-based perspective, when designing motivating learning environments (Kaplan & Patrick, 2016; Kaplan, Sinai, & Flum, 2014).

Our results showed only this divergent profile and no other divergent profile in students. One possible explanation might be the sample size. More patterns of motivation could emerge when using a large sample because divergent patterns are likely to only be held by a small number of students. Another reason for the coupling of high levels of importance value with high levels of ability self-concept might be the extrinsic character of these constructs. Compared with intrinsic value, utility value is more "extrinsic"—when students value an activity as important for their own goals, they engage in this activity for extrinsic reasons and not for the activity itself (Eccles, 2005b). Accordingly, utility value is responsive to external intervention (Harackiewicz et al., 2012). Similarly, ability self-concept is a cognitive aspect of motivational beliefs and can be enhanced by interventions (Craven, Marsh, & Debus, 1991). Consequently, it might be easier for teachers to enhance the importance value and ability self-concept of their students, for example, by providing information about the relevance of activities and by applying attributional feedback. However, it seems difficult to directly enhance students' enjoyment of tasks. This could explain why we found one pattern of low intrinsic value.

Our findings confirmed our expectations (Hypothesis 1b) that the profiles of motivational beliefs would all be relatively stable. Students were more likely than expected by chance to remain in the profile they were in earlier. This finding is also applicable when examining the stability and changes of motivational belief profiles from Grade 7 to Grade 12. We find that three out of four profiles—the high, low, and low intrinsic value profiles are stable—in other words, students were more likely than expected by chance to remain in these profiles across time. Interestingly, a greater number of students remained in profiles that were characterized by intraindividually consistent levels of motivational beliefs (low, medium, and high motivation belief profile). For example, 61.6% of the students remained in the *low motivation beliefs* profile, but only 30.9% remained in the *low intrinsic value* profile. These findings show that although the task values and competence beliefs of students in mathematics stabilize as students get older (Fredricks & Eccles, 2002; Watt, 2004), this high stability in motivation seems not to apply to the few students in profiles with intraindividually differing patterns of motivation. A possible explanation for the low stability of the *low intrinsic value* profile is that developmental changes in intrinsic and importance value do not necessarily follow the same pattern—while intrinsic value consistently declines in adolescence, the importance value related to math increases (Fredricks & Eccles, 2002).

When interpreting the results of this study, it is important to note that we used the ISOA analysis approach that assumes the existence of the same typical patterns across time. Previous person-centered research showed a high stability of student motivational profile membership in adolescence (Bråten & Olaussen, 2005; Marcoulides, Gottfried, Gottfried, & Oliver, 2008). Using latent-transition analysis, Marcoulides et al. (2008) showed that transitions between motivational patterns occurred mainly during childhood, whereas stability ensued by age 13 and strong stability after that. If students' membership in motivational profiles is stable, the size and shape of their profiles will also not change extensively across time. One possible theoretical explanation for the increasing stability of individuals' motivational profile membership might be related to their different experiences in the classroom learning environment depending on their existing level of motivation. For example, highly engaged students also perceive their teachers to be more supportive, and high perceived teacher support is related to high engagement (Hughes, Luo, Kwok, & Loyd, 2008). Consequently, students who are highly motivated and, thus, highly engaged in learning, also seem to receive more support from their teachers, which in turn could result again in high motivation, engagement, and achievement (Wentzel et al., 2010). Internal processes might also explain the high stability of profile membership in adolescence. For example, individuals high in achievement motivation have been shown to attribute success to themselves in achievement-oriented situations more than individuals low in achievement motivation (Weiner & Kukla, 1970). Such psychological mechanisms may, in turn, lead to a high stability of motivational configurations across time. Based on the empirical findings and theoretical assumptions that we described, we decided to use the ISOA approach in our study.

Our results showed that students in the *low intrinsic value* profile were "at risk" in their further academic development. They were likely to move to the *low motivational beliefs* profile between Grade 7 and 12 and, thus, to experience a decrease in competence beliefs and importance value over time. In terms of educational implications, these findings emphasize the need to support these students by helping them to maintain their moderate level of ability self-concept and importance value. Ability self-concept, for example, can be enhanced by providing a combination of internally focused performance feedback and attributional feedback (Craven et al., 1991; Marsh & Seaton, 2013). Interventions that aim to increase utility value in mathematics or science provide information about the importance of these domains in daily life and for various careers (Harackiewicz et al., 2012). It is important to note that there was a relatively small number of students who made the shift from the *low intrinsic value* profile to the *low motivational beliefs* profile during Grade 7 (n = 14). However, the question of how teachers can address such motivational shifts is still highly relevant, as the number of students who experience this shift increased over time (n = 31 from the end of Grade 7 to the beginning of Grade 10). Our findings point to a need to address the patterns of students' motivational beliefs using methods of personalized instruction and adaptive teaching (Vogt & Rogalla, 2009). To help teachers identify motivational belief profiles in a classroom setting, knowledge about patterns of student motivational beliefs should be conveyed in teacher education. The next steps would then be an early motivational assessment (Gottfried, Fleming, & Gottfried, 2001) and differentiation in class based on students' motivation, and not only on their skills (Kaplan et al., 2014).

In this study, students were likely to change from the *low intrinsic value* pattern to the *low motivational beliefs* pattern between Grade 7 and Grade 12, but were unlikely to change from any other profile to the *high motivational beliefs* profile. Thus, while students' motivation tends to decline—particularly when they report low intrinsic value in mathematics already early on in secondary school—it is unlikely that their motivation will increase. This finding points to the need to enhance the motivation of all students in adolescence, particularly of those who display low intrinsic value in mathematics already after the transition to junior high school even if these students perceive themselves as competent and mathematics as useful.

Student-Perceived Classroom Characteristics and Changes in Profile Membership

In line with our expectations (Hypothesis 2a), student-reported fairness and friendliness of teachers in mathematics classes were negatively related to the change from the high motivational belief profile to the medium motivational belief profile. Consequently, student-perceived teacher fairness and friendliness seem to inhibit motivational changes from profiles with high motivational beliefs to profiles with lower levels of intrinsic value, importance value, and ability self-concept. This finding can be explained by the theoretical tenets of stage-environment fit theory, which proposes increases in intrinsically motivated learning behaviors with high levels of social relatedness (Eccles, Midgley, et al., 1993). However, our findings show that student-perceived teacher fairness and friendliness seems to be particularly beneficial for those students who already have high levels of motivational beliefs. This might be explained by a reciprocal interrelation between student-perceived teacher support and student motivation. Highly motivated students may also perceive high levels of fairness and friendliness by the teacher either because the teacher supports them more strongly or because students with high achievement infer teacher expectations and competence beliefs from their teacher's behavior in class, resulting in higher motivational beliefs (Weinstein, 2002).

Our expectations regarding perceived competition were only partially confirmed, (Hypothesis 2b) as student-perceived competition in class at the beginning of Grade 7 did not predict changes to profiles characterized by low intrinsic value, importance value, and ability self-concept. However, students who already had moderate levels of intrinsic value, importance value, and ability self-concept benefitted from perceived competition in class. Students in the medium motivational belief profile at the beginning of Grade 7 were more likely to change to the high motivation profile at the end of Grade 7 when they perceived a focus on competition in class. A possible explanation here might be that these students were engaged in activities in the mathematics classroom because of their moderate levels of intrinsic value, importance value, and ability self-concept and, therefore, perceived the emphasis on competition as an opportunity to show their engagement—which in turn might enhance an increase in intrinsic value, importance value and ability self-concept. This assumption is in line with the findings of Elliott and Dweck (1988), who describe how children with high competence beliefs responded to performance-oriented learning environments by persisting in attempts to find solutions and by not attributing failure or expressing negative affect. However, other studies could not replicate these findings (for an overview, see Midgley et al., 2001) and research should further investigate the interrelationship between student-perceived competition in class and motivational change.

For educational practice, our findings suggest that only specific groups of students seem to benefit from an implementation of social comparison and competition in class. This finding emphasizes the importance of adaptive teaching methods, which, in our case, refer to providing competition for learners with already relatively high levels of motivation.

Prediction of Math-Related Outcomes

This study applied Eccles et al.'s model of achievement-related choices (Eccles, 2005b) to the context of person-centered research and showed that mathematics-related motivational belief profile membership in adolescence predicted mathematics achievement, career plans, and achievement-related choices in adulthood. We built on previous person-centered research that referred to this theoretical framework (Chow et al., 2012; Chow & Salmela-Aro, 2011) and investigated how different configurations of motivation contributed to achievement-related choices at different developmental stages. Based on variable-centered research investigating interaction effects of task values and self-concept (Lauermann et al., 2017; Nagengast et al., 2011; Trautwein et al., 2012), we had expected that profiles with a combination of high ability self-concept and high intrinsic value would be particularly relevant for mathematics achievement, math-related career plans in adolescence and the choices of math-intensive majors and occupations in adulthood (Hypothesis 3). Partially corresponding to this hypothesis, our results showed that students in profiles with a combination of low intrinsic value and moderate ability self-concept and importance value in math (*low intrinsic value* profile) were less likely to strive for math-related career plans in adolescence and, accordingly, pursued a math-intensive major in early adulthood less often than students in all other profiles. This finding is in line with previous research showing that interest, rather than self-concept, in mathematics predicted course level choices in a U.S. sample, once actual achievement was controlled for (Nagy et al., 2008). Extending such variable-centered findings, we showed that a combination of low intrinsic value and high importance value and self-concept did significantly contribute to choices of math-intensive college majors, but not to actual occupations in math-related fields in adulthood. One possible method-based explanation might be the small sample size (n = 396 out of the 867 targeted students) and consequently a lack of power that might be associated with the nonsignificant effects. However, Lauermann et al. (2017) who worked with the Childhood and Beyond (CAB) study also did not find direct or significant effects of motivational beliefs in mathematics at the end of high school on math-related career attainment approximately 15 years after graduation. The authors found indirect effects of motivational beliefs in mathematics on career attainment via students' career plans in Grade 12. Our analyses confirmed these indirect effects and showed that membership in the low motivation profile in Grade 10 indirectly and negatively predicted career attainment in math-related fields 22 years after graduation through its effect on math-related career plans in Grade 12.

When discussing the findings of this study, it needs to be considered that, because of measurement constraints, we were not able to consider the individual contributions of utility value and attainment value in our investigation of patterns of motivational beliefs. More specifically, by using a global importance value factor, we were not able to detect how attainment value and utility value separately contribute to student profiles and how these profiles differently relate to career attainment. Although both constructs are closely interrelated on a theoretical level (Eccles, 2005b), one might expect different effects on career attainment because of their different conceptualization. Empirically, in our study, both items were moderately to strongly correlated, reflecting theoretical overlaps (Time 1: .41***; Time 2: .57***; Time 3: .60***; Time 4: .61***). Thus, on an empirical level, creating one combined importance value factor was acceptable. Future research, however, should take into account the contribution of all task value facets—also including perceived cost—to profiles of motivational beliefs, as this approach would allow for a more detailed understanding of the configuration of student profiles of motivational beliefs and their prediction of career-related outcomes.

Limitations

This study had several limitations that need to be considered when interpreting its findings. First, because of the design of the study, we only investigated unidirectional paths and did not take into account bidirectional links between mathematics-related task values, ability self-concepts, and choice intentions. Previous research has shown such bidirectional relationships, with math-related career plans predicting utility values in mathematics (Lauermann et al., 2017; Lazarides et al., 2017). Further research needs to examine how the career plans of adolescents contribute to changes in their profiles of motivational beliefs.

Second, the generalizability of the findings needs to be tested by conducting further studies on motivational belief profiles in mathematics in different educational systems. Previous findings comparing motivational belief profiles in different domains in the United States and Finland showed different profiles related to mathematics and science in the two countries (Chow et al., 2012). Furthermore, our sample consisted of students located in working and middle-class communities in southeastern Michigan. Given the specificities of this sample, more research is needed to compare profiles across countries, educational systems, urban and nonurban areas, and across samples with a greater diversity of students.

Third, our operationalization of task values is a weakness of the study, because there are more elaborate measures that have been used in recent research (i.e., Conley, 2012; Linnenbrink-Garcia et al., 2018). In this study, only two items are used to measure each of the task value components, as this is the data available from the Michigan Study of Adolescent and Adult Life Transitions. While these items have been used in previous research (e.g., Eccles et al., 2004; Jacobs et al., 2002; Nagy et al., 2008), a two-item measure for each task value subcomponent can be problematic. Thus, further studies should be conducted to validate our findings using more current data sets.

Fourth, our measures assessing student-perceived competition in class had a relatively low reliability ($\alpha = .64$), which might be related to the age of the sample as well as to the characteristics of the measure. Students reported perceived classroom characteristics at the beginning of Grade 7, which is the first year after the transition from elementary school to middle school. In this period, students and teachers may not know each other very well yet, as classrooms were newly configured after the transition. Furthermore, the measure to assess competition was a combination of items related to general aspects of social interaction with the teacher ("Some kids try to be the first ones to answer math questions the teacher asks") and problematic social interaction between peers ("Some students in this class make fun of kids who answer math questions wrong or make mistakes"). More refined measures might be needed to assess the role of classroom characteristics in students' motivational beliefs.

Conclusions

The special value of this study was its developmental perspective, as we examined how motivational profile membership predicted mathematics test scores across Grade 7, career plans in Grade 12 and math-intensive majors and occupations in adulthood. The theoretical contribution to previous work based on Eccles et al.'s model of achievement-related choices (Eccles, 2005b) was to show that different configurations of motivation are differently related to achievement-related choices. Students in a *low intrinsic value* profile and a *low motivational beliefs* profile had a particularly low likelihood of choosing a math-intensive college major. Interventions aimed at enhancing students' importance value (Harackiewicz, Canning, Tibbetts, Priniski, & Hyde, 2016; Harackiewicz et al., 2012) may, therefore, be particularly effective when also enhancing intrinsic value and self-concept in the school subject (Hulleman, Godes, Hendricks, & Harackiewicz, 2010). In terms of educational implications, our findings emphasize that classrooms in which students experience friendly and fair teachers effectively enhance an adaptive motivational development in early adolescence.

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(*Appendices follow*)

Appendix A

Measurement Invariance Tests

Table A1
Measurement Invariance Test for Intrinsic Value Across Four Measurement Points

Step	χ^2	*df*	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR
1	55.99	14	.99		.06		.02
2	67.34	17	.99	.001	.06	.001	.02
3	297.28	22	.97	−.020	.04	−.020	.05

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; 1 = measurement model variant; 2 = loadings invariant; 3 = loadings and intercepts completely invariant.

Table A2
Measurement Invariance Test for Self-Concept Across Four Measurement Points

Step	χ^2	*df*	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR
1	400.15	48	.93		.09		.04
2	428.97	54	.92	.010	.09	.001	.05
3	630.66	61	.88	−.040	.10	.010	.08
3a	409.81	53	.93	−.010	.09	.001	.04

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; 1 = measurement model variant; 2 = loadings invariant; 3 = loadings and intercepts completely invariant; 3a = loadings completely and intercepts partially invariant—only item intercepts of Item 2, Times 1 and 2 are fixed to be equal across time.

Table A3
Measurement Invariance Test for Importance Value Across Four Measurement Points

Step	χ^2	*df*	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR
1	110.80	14	.93		.09		.03
2	112.49	17	.93	.001	.08	.010	.04
3	330.92	23	.77	−.160	.12	.040	.11
3a	137.46	19	.91	−.060	.09	.005	.04

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; 1 = measurement model variant; 2 = loadings invariant; 3 = loadings and intercepts completely invariant; 3a = loadings completely and intercepts partially invariant—item intercepts of Item 2, Times 3 and 4 are fixed to be equal across time.

(*Appendices continue*)

Table A4
Measurement Invariance Test for Student-Reported Teacher Fairness Across Grade 7

Step	χ^2	*df*	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR
1	237.74	69	.93		.05		.04
2	238.01	75	.94	.003	.05	−.003	.05
3	310.96	82	.91	−.027	.06	.007	.06

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; 1 = measurement model variant; 2 = loadings invariant; 3 = loadings and intercepts completely invariant.

Table A5
Measurement Invariance Test for Student-Reported Competition in Class Across Grade 7

Step	χ^2	*df*	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR
1	12.18	5	.99		.04		.02
2	12.20	7	.99	.002	.03	−.012	.02
3	27.10	10	.98	.012	.04	.015	.03

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; 1 = measurement model variant; 2 = loadings invariant; 3 = loadings and intercepts completely invariant.

Appendix B

Correlation Coefficients for Attrition Analyses

Variables	1	2	3
1. Boy			
2. MEAP Grade 7	−.032		
3. Mother education	.105	.123**	
4. Missing variable intrinsic value Grade 7.1	.056**	−.161***	−.005
5. Missing variable importance value Grade 7.1	.054**	−.161***	−.003
6. Missing variable self-concept Grade 7.1	.056**	−.161***	−.005
7. Missing variable intrinsic value Grade 7.2	.057**	−.163***	−.010
8. Missing variable importance value Grade 7.2	.055**	−.165***	−.012
9. Missing variable self-concept Grade 7.2	.057**	−.163***	−.010
10. Missing variable intrinsic value Grade 10	.056**	−.168***	−.004
11. Missing variable importance value Grade 10	.056**	−.168***	−.004
12. Missing variable self-concept Grade 10	.056**	−.168***	−.004
13. Missing variable intrinsic value Grade 12	.046*	−.166***	−.019
14. Missing variable importance value Grade 12	.046*	−.166***	−.019
15. Missing variable self-concept Grade 12	.046*	−.166***	−.019

Note. MEAP = Michigan Educational Assessment Program; Imp = importance value; Self = self-concept.
* $p < .05$. ** $p < .001$. *** $p < .001$.

(*Appendices continue*)

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Appendix C

Means and *SDs* of Motivational Variables and Performance as a Function of Latent Profiles for Each Time Point

Table C1
Multivariate Analyses of Variance: Grade 7 Beginning (Time 1)

Variables	Low motivation (N = 25)	Low intrinsic value (N = 99)	Medium (N = 346)	High motivation (N = 392)	F(3, 858)	η_p^2
Self-concept	2.93 (1.02)	4.29 (1.37)	4.83 (1.02)	5.82 (.74)	149.34	.343
Intrinsic value	1.92[a] (.89)	1.84[a] (.67)	4.16 (.62)	6.14 (.65)	1503.92	.840
Importance value	2.86 (.96)	5.32 (1.17)	5.64 (1.06)	6.48 (.72)	161.22	.360

Note. Variables with the same superscript do not show significant mean differences at $p < .05$ (for pairwise comparisons, Hochberg's GT2 was used). All F values are significant at $p < .001$.

Table C2
Multivariate Analyses of Variance: Grade 7 Beginning (Time 2)

Variables	Low motivation (N = 44)	Low intrinsic value (N = 130)	Medium (N = 354)	High motivation (N = 327)	F(3, 851)	η_p^2
Self-concept	3.05 (1.40)	4.51 (1.31)	4.80 (1.02)	5.81 (.78)	138.77	.328
Intrinsic value	1.52 (.68)	1.88 (.66)	4.11 (.66)	6.13 (.67)	1643.34	.853
Importance value	2.81 (1.13)	5.26 (1.09)	5.64 (1.02)	6.43 (.78)	206.63	.421

Note. All means significantly different at the level of $p < .05$ (for pairwise comparisons, Hochberg's GT2 was used). All F values are significant at $p < .001$.

Table C3
Multivariate Analyses of Variance: Grade 10 Beginning (Time 3)

Variables	Low motivation (N = 111)	Low intrinsic value (N = 185)	Medium (N = 327)	High motivation (N = 239)	F(3, 858)	η_p^2
Self-concept	2.78 (1.10)	4.30 (1.11)	4.88 (.88)	5.81 (.77)	280.95	.496
Intrinsic value	1.38 (.57)	1.88 (.68)	4.07 (.66)	6.03 (.69)	1928.64	.871
Importance value	2.84 (1.06)	4.93 (1.09)	5.44 (1.08)	6.41 (.76)	331.48	.537

Note. All means significantly different at the level of $p < .05$ (for pairwise comparisons, Hochberg's GT2 was used). All F values are significant at $p < .001$.

Table C4
Multivariate Analyses of Variance: Grade 12 Beginning (Time 4)

Variables	Low motivation (N = 148)	Low intrinsic value (N = 147)	Medium (N = 323)	High motivation (N = 208)	F(3, 822)	η_p^2
Self-concept	2.76 (.98)	4.09 (1.05)	4.62 (.82)	5.79 (.68)	368.66	.574
Intrinsic value	1.41 (.56)	1.94 (.72)	4.11 (.71)	6.05 (.68)	1772.61	.866
Importance value	2.94 (1.04)	4.67 (1.06)	5.17 (1.12)	6.40 (.81)	337.17	.552

Note. All means significantly different at the level of $p < .05$ (for pairwise comparisons, Hochberg's GT2 was used). All F values are significant at $p < .001$.

(*Appendices continue*)

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Appendix D

Multivariate Analyses of Variance: Means and SDs of Performance as a Function of Latent Profiles (Without Covariates)

Variables	*M* (*SD*) Low motivation ($N = 24$)	Low intrinsic value ($N = 88$)	Medium ($N = 307$)	High motivation ($N = 337$)	$F(3, 756)$	partial η^2
Math achievement	21.83[a] (4.27)	23.01 (4.67)	23.64 (4.59)	24.24[a] (3.74)	4.39	.02

Note. Means sharing the same superscript are significantly different at $p < .05$ (Hochberg's GT2 was used). All other mean values are significantly different. F value is significant at $p < .01$.

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