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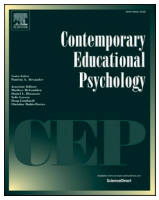

Motivational profiles in mathematics – stability and links with educational and emotional outcomes

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ABSTRACT

Grounding on the situated expectancy-value theory, this study investigated stability and change in adolescent students' (N = 508) motivational profiles in mathematics (self-concept, values, costs) during the last year of comprehensive education, and how these changes relate to relevant educational outcomes (mathematics performance and aspirations) and students' emotional distress (study-related exhaustion and depressive symptoms). Latent profile and latent transition analyses revealed four motivational profiles among students: *Positively ambitious* (high competence and value beliefs, low costs, T1: 34 %/T2: 32 %), *Struggling ambitious* (high competence and value beliefs, high costs, T1: 25 %/T2: 25 %), *Indifferent* (low competence and value beliefs, low costs, T1: 22 %/T2: 21 %), and *Maladaptive* (low competence and value beliefs, high costs, 19 %/22 %). Although some fluctuations were detected in profile memberships within the school year, most of the students (80 %) displayed stable mathematics motivation across ninth grade. Students who remained *Positively ambitious* also performed well, aspired for an education that required high mathematical skills, and experienced the least emotional distress, whereas students in the most negative motivational profile (*Maladaptive*) showed the opposite patterns. However, students who experienced high math-related costs, despite having positive value beliefs, performance, and aspirations (i.e., *Struggling ambitious*), also experienced one of the highest levels of study-related exhaustion and depressive symptoms. Elevated levels of exhaustion and depressive symptoms were systematically associated with negative motivational transitions in general (i.e., moving from *Positively ambitious* to *Struggling ambitious*, or from *Indifferent* to *Maladaptive*), highlighting the importance of reducing perceived study-related costs in schools and supporting students' well-being.

1. Introduction

There has been an ongoing decline in STEM (science, technology, engineering, and mathematics) participation in many countries, and this worrying trend seems to be particularly prevalent among girls (Wang & Degol, 2017). Consequently, understanding the factors influencing students' decision-making processes regarding their future education and occupation is important. Expectancy-value theory (EVT: Wigfield & Eccles, 2000, 2020), being one of the most influential theoretical frameworks seeking to explain students' educational and occupational aspirations and choices, implies that students' competence- and value beliefs are crucial for actual educational and occupational attainment. Recently, the perceived cost of engaging in a task has also been viewed as important for enhancing our understanding of why some students might lower their aspirations, or opt out of pursuing a goal (Conley, 2012). Students set goals and make decisions in complex social environments where some goals must be given up in favor of others, and therefore, focusing only on positive value beliefs may offer limited perspectives of their decision-making processes. In fact, Eccles and Wigfield (2020, 2023) recently renamed EVT to situated expectancy-value theory (SEVT) to highlight that students' expectancies and task values are situation-specific (i.e., they vary across contexts and are influenced by situational characteristics). In other words, SEVT emphasizes that achievement choices occur in specific situations, and reflect the opportunities given in a specific context. Understanding the situative processes in students' motivational beliefs seems particularly important during critical time periods, when students are making decisions about further education and occupation.

Furthermore, both theoretical notions and empirical findings suggest that various achievement motivation-related constructs are linked with

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an individual's emotional experiences and well-being (e.g., Daniels et al., 2008; Dweck, 1986; Roeser et al., 1999; Tuominen et al., 2020; Watt et al., 2019). Considering also current negative trends in adolescents' well-being (Kauhanen et al., 2022; Widlund et al., 2021), it seems important to also include aspects that reflect students perceived emotional distress while studying their motivation during critical decision-making time periods. Still, exceptionally few have studied how students' competence beliefs, values, and costs within one school domain develop and might be related to broader dimensions of students' perceived emotional distress, in and outside of school. Studying students' motivational beliefs, educational outcomes, and emotional factors together may provide a more holistic view of adolescents' academic and emotional functioning and important information for planning individualized interventions to address students' various needs and challenges.

Consequently, the aim of this study was to investigate 1) what kinds of motivational (self-concept, task values, costs) profiles in mathematics can be found among adolescents, 2) how stable such profiles are within the last year of comprehensive school (ninth grade), 3) how gender predicts profile membership and, 4) how stability and change in profile memberships relate to students' educational (mathematics performance and educational aspirations) and emotional (exhaustion and depressive symptoms) outcomes.

1.1. Theoretical framework: situated expectancy-value theory

Grounding on SEVT, expectancies for success have often been described as students' beliefs about how well they will do on a specific task, whereas task values are defined with respect to the qualities of different achievement tasks and how those influence students' desires in wanting to pursue the task (Wigfield & Eccles, 2000). Expectancy of success is closely related to competence-related beliefs, such as academic self-concept. They are, however, not completely overlapping constructs as self-concept has theoretically been described to be more stable, whereas expectancies are viewed as more task- and time-specific (Eccles & Wigfield, 2020). Nevertheless, in empirical research, expectancies of success and self-concept have often been used interchangeably or measured with highly similar or partly overlapping items (Dietrich & Lazarides, 2019; Guo et al., 2015). Studies have also, particularly within SEVT, used self-efficacy (i.e., individuals' perceived capability to obtain a successful outcome while performing a specific task, Wigfield & Eccles, 2020) as a proxy for success expectancies (Jiang & Zhang, 2023; Lee et al., 2022; Perez et al., 2019). Value beliefs, on the other hand, have commonly been divided into four components. Students may value a task or domain because they find it interesting or enjoyable (intrinsic value or interest), because they perceive it as useful for their current or future goals (utility value), or because it is important to them personally and for their identity (attainment value) (Wigfield & Eccles, 2020).

Cost has been the least studied dimension but has recently started to receive increased attention. Cost is often described as a maladaptive motivator, reflecting what is lost or given up, or suffered when engaging in a task (Wigfield & Eccles, 2020). Researchers have further divided cost into several sub-dimensions, most commonly, emotional cost (a negative emotional or psychological state as a consequence of engaging in a task), effort cost (students' perception of the required effort to complete a task and whether it is worth doing so) and, opportunity cost (students' perceptions of what they must give up in order to engage in and complete a task) (Gaspard et al., 2015, 2018; Wigfield & Eccles, 2020). Some also refer to psychological cost, defined as the fear of failure or perceived psychological threat associated with engaging in a task (Perez et al., 2019; Song et al., 2023). Although these sub-dimensions are theoretically distinct, they are often strongly associated (Flake et al., 2015; Part et al., 2020). Nevertheless, some studies have found the distinct cost dimensions to be slightly differently related to students' performance. Perez et al. (2019) found that both effort and opportunity cost, but not psychological cost, predicted students' grades in biology, whereas Part et al. (2020), surprisingly, found a positive effect from opportunity cost on students' achievement test scores, whereas the effects from effort and psychological cost were non-significant.

1.2. A person-centered approach – expectancy-value profiles

Most of the researchers examining the relations of expectancy-value (EV) constructs and their relation to performance and educational aspirations and/or choices have used variable-centered approaches. Although these studies inform us about the general linear associations between these constructs, they do not specify how expectancies, values, and costs are organized within different individuals. A person-centered approach is based on the assumption of population heterogeneity, and it has been suggested to be an especially useful analytical technique to capture students' multifaceted motivation (e.g., inter- and intra-individual hierarchies) and understand the way many motivational factors simultaneously relate to various outcomes (Linnenbrink-Garcia & Wormington, 2019). This information is particularly useful for practice, as within-student relations in, for example, specific cost components provide more detailed information about where and for whom specific interventions to support students' motivational beliefs and prevent feelings of academic strain should be targeted.

Focusing particularly on STEM-related motivational profiles, Andersen and Chen, (2016), Lazarides et al. (2019), and Lazarides, Rubach, et al. (2016), investigated positive EV constructs, and identified four profiles among adolescent students (ages 13–15) in USA, Finland, and Germany. They identified groups of students with overall positive EV-beliefs (High motivation group), groups with average EV-beliefs (Moderate motivation group), and students with overall negative EV-beliefs (Low motivation group). However, Lazarides, Rubach et al. (2016) identified a fourth group of students with relatively low competence beliefs and intrinsic value, yet average utility value in math. Andersen and Chen (2016), on the other hand, found the opposite patterns: high self-efficacy, attainment, and intrinsic value, but average utility value in science. The fourth profile identified by Lazarides et al. (2019) represented students who were highly confident in their math abilities but showed rather low interest in math. Also, studies investigating EV-profiles across different domains (e.g., Fong et al., 2021; Lazarides, Viljaranta et al., 2016; Lazarides et al., 2021; Olive et al., 2022), have identified some additional domain-specific profiles (e.g., high-math/low science groups: Fong et al., 2021, or high English/low math and science groups: Lazarides et al., 2021) demonstrating the domain-specificity of students' expectancy and value beliefs.

A handful of studies have included cost components when identifying EV-profiles. Perez et al. (2019) identified three EV-profiles among university students while including opportunity and effort cost in the science domain. In addition to finding a moderate motivational profile, they identified two profiles with high competence and value beliefs that differed in how they experienced cost: a large group of highly motivated students (60 %) experienced moderate/low levels of both opportunity and effort cost, whereas the other group (24 %) had significantly higher opportunity cost than effort cost. Lee et al. (2022), on the other hand, identified four motivational profiles among university students, while including an additional, psychological cost component. They found that the group having the most positive self-efficacy and value beliefs, also reported relatively high levels of psychological cost (10 %). In fact, psychological cost differed from the other cost-dimensions in three of the profiles as consistently being significantly higher than the other dimensions. Another interesting finding was that the group experiencing the highest levels of costs in general (particularly opportunity and psychological cost), still reported rather moderate value beliefs (30 %). Also, among Finnish university students, Juntunen et al. (2022) extracted six profiles of expectancy, values, and costs (effort and opportunity): overall positive (positively ambitious, 13 %), moderate (moderately motivated, 25 %), and negative (disengaged, 16 %)

motivational profiles but, also, a profile high on both positive values and costs (struggling ambitious, 9 %), a profile low on intrinsic value but high on utility value and costs (utility-oriented, 22 %), and a profile with moderate values and rather low costs (indifferent, 15 %). Similarly, to the findings by Perez et al. (2019), some differentiation between cost dimensions was also detected: both the Positively ambitious and Struggling ambitious students seemed to display slightly higher opportunity cost compared to effort cost, while for the Disengaged students, effort cost was higher than opportunity cost (Juntunen et al., 2022).

Regarding younger students, many have identified similar profiles of either overall positive (high expectancy and values, low cost), overall negative (low expectancy and values, high cost), or moderate (i.e., average on all constructs) motivational profiles among secondary school students from Germany (Dietrich & Lazarides, 2019), China (Jiang & Zhang, 2023), Australia (Watt et al., 2019), and Finland (Raufelder et al., 2022; Vinni-Laakso et al., 2022). Similarly, to the findings on older students, both Raufelder et al. (2022) and Vinni-Laakso et al. (2022) also identified a fourth profile that was characterized by high self-concept and positive value beliefs, yet elevated levels of cost (31–34 % and 17–18 %, respectively). This pattern also resembles one of the profiles identified by Watt et al. (2019) named Struggling ambitious (14.5 %), including three cost dimensions in math (effort, psychological, and social cost). Jiang and Zhang (2023), on the other hand, included four separate cost dimensions (emotional, effort, opportunity, and ego cost) and identified two additional profiles that were highly consistent across the math and English domains: students who were moderately motivated yet reported high levels on all cost dimensions (High cost, 29 %) and a group with low motivation but also, relatively low costs (Less motivated, 19 %). Students in both the Less motivated and the Maladaptive group (i.e., most negative motivational profiles) reported particularly high emotional cost (compared to the other cost dimensions), indicating some separation in cost-dimensions among this age group as well.

To summarize, it seems important to further examine the multidimensionality of cost while investigating change and stability in students' motivational profiles, as longitudinal studies including cost are rather scarce. Although different cost dimensions seem to be highly correlated, studies that have included several dimensions of cost have still identified some separation between distinct cost dimensions, for example, between emotional and opportunity cost (Jiang & Zhang, 2023; Perez et al., 2019). Including various dimensions of cost while studying students' motivation may provide a more comprehensive overview and a better understanding of potential strains among, for example, highly motivated students, and how these might be related to educational outcomes and broader aspects of their well-being (Watt et al., 2019).

1.3. Stability and change in students' expectancies and values

Previous findings on the development of expectancies and values have demonstrated that on average, motivation for school typically declines across levels of education (Jacobs et al., 2002), even within one semester (Kosovich et al., 2017). Negative changes seem to particularly occur during or after changes in the educational environment (i.e., educational transitions), as these typically involve increased academic demands and changes in social networks, among other things (Eccles & Roeser, 2011; Raufelder et al., 2022). Less is known about the development of cost but, as an exception, Robinson et al. (2019) demonstrated that cost significantly increased among engineering students during the first years of college. Considering also that perceived costs are commonly negatively related to competence-beliefs and values (Conley, 2012; Perez et al., 2019), and that other, domain-general aspects of school-related strain has been found to increase during secondary education (e.g., study-related exhaustion: Widlund et al., 2021), possibly due to increased demands and pressure to achieve, it seems likely that cost increases among adolescents as well.

A few studies have investigated the development in students' expectancy-value beliefs by using person-centered approaches, and although most of them include only positive value beliefs, they suggest that students' motivational profiles remain relatively stable across time (Dietrich & Lazarides, 2019; Lazarides, Dicke, et al., 2019; Lazarides et al., 2018, 2021, 2022). Still, intraindividual differences in the development of students' motivational profiles have been detected. Some findings suggest that low-motivation profiles show greater stability than, for example, initially high-motivation profiles (Lazarides, Dietrich, et al., 2019), and others have found that transitioning from a more positive motivational profile into a more negative one seems more common than the other way around during early adolescence (Raufelder et al., 2022). As an exception, Vinni-Laakso et al. (2022) studied stability in profiles of self-concept, intrinsic value, utility value, and emotional cost in the domains of math, biology, physics, and language (Finnish) across grades seven and eight. Similarly, to previous studies, they found the highest stability among the largest (62 %), moderate motivation, and cost profile, but the remaining profiles were less stable. Students in profiles characterized by high motivation and low cost, low motivation and high cost, and high motivation and high cost were all most likely to transition into the moderate motivation profile over time. Thus, while including cost, and studying stability among lower-secondary students, they found both positive and negative motivational changes to occur.

Furthermore, students have also shown a tendency to develop more domain-specific motivational beliefs during adolescence, particularly around educational transitions. Lazarides and colleagues (2021) found that students initially belonging to profiles with relatively similar levels of motivation in many domains, systematically transitioned into profiles with high motivation in only one domain. Initially, among 10th graders, they also identified a group of students with high motivation in all domains (math, English, science), which was not detected after transitioning to Grade 12 (Lazarides et al., 2021).

1.4. Relations to gender and educational and emotional outcomes

Students' motivational beliefs are shaped by stereotypical expectations and values of their culture, parents, teachers, and peer groups (Cvencek et al., 2011; Master, 2021; Tomasetto et al., 2015). One of the most influential reference groups students identify with is gender, and math, for example, is still often considered a "male subject", and therefore, both parents and teachers may perceive boys to have higher competence in mathematics (Cvencek et al., 2015). Such assumptions have been confirmed in previous person-centered studies: girls have been overrepresented in groups characterized by low perceived talent and interest, but high costs (Jiang & Zhang, 2023; Watt et al., 2019), and have been found more likely than boys to be in groups with moderate/low self-efficacy, utility value, and interest (Lazarides et al., 2022). Boys, on the other hand, have been found less likely, as compared to girls, to fall into more negative math-motivation profiles, and have been found overrepresented in profiles characterized by high competence and value beliefs in math (Lazarides, Dietrich, et al., 2019; Lazarides, Viljaranta et al., 2016). The effect of gender on specific motivational transitions has rarely been studied, but Olive et al. (2022) found that boys were more likely than girls to transition into a profile characterized by higher math motivation at the end of primary school.

As proposed by the SEVT framework, a relatively large body of research has confirmed that EV-beliefs are strong predictors of different educational outcomes, particularly performance and educational intentions and choices (for a review, see Wigfield & Eccles, 2020). More recently, studies have also found cost to negatively predict adolescents' academic performance, course intentions, and STEM aspirations (Battle & Wigfield, 2003; Jiang et al., 2018; Perez et al., 2014). Jiang et al. (2018) found that cost explained additional variance in math performance goals and negative classroom affect that could be explained by neither expectancy nor value beliefs. These findings suggest that students experiencing high cost might be at risk for lower performance, despite having high expectancy and value beliefs (Barron & Hulleman,

2015; Jiang et al., 2018), and therefore, it seems important to include cost dimensions when trying to understand the underlying factors of adolescents' educational aspirations and performance.

Furthermore, various achievement motivation-related constructs have been linked with an individual's emotional experiences and well-being (e.g., Daniels et al., 2008; Juntunen et al., 2022; Tuominen et al., 2020; Watt et al., 2019). Naturally, achievement striving requires investing time and effort from the student, implying that there always is some subjective cost in play, for example, in terms of how much studying requires giving up other valued alternatives and how much exhaustion or negative emotions are associated with it. Accordingly, cost clearly plays a role in student motivation and engagement and, considering also the negative trends in students' well-being (Kauhanen et al., 2022; Widlund et al., 2021) and motivation (Jacobs et al., 2002) during adolescence, it seems critical to connect students' motivation with not only educational outcomes, but also emotional distress and well-being.

Overall, studies have found competence- and value beliefs to be negatively correlated with depression (Juntunen et al., 2022; Watt et al., 2019) and school burnout (Korhonen et al., 2014; Widlund et al., 2020), whereas cost perceptions have been found to be positively related to depression, stress, anxiety, and study-related exhaustion (Juntunen et al., 2022; Watt et al., 2019). Furthermore, Juntunen et al. (2022) found that students belonging to the most positive motivational profile (Positively ambitious) also had the most positive well-being. Interestingly, cost seemed to be particularly associated with more negative well-being: students who perceived their studies as costly, irrespective of them having high, moderate, or low expectancy- and value beliefs, all experienced relatively high levels of perceived strain and exhaustion in studies. Similarly, Watt and colleagues (2019) found that students reporting the highest cost perceptions, despite relatively positive value-beliefs in math (i.e., Struggling ambitious), also reported the highest levels of both depression, stress, and anxiety.

1.5. The present study

Finishing comprehensive schooling[1] (i.e., graduating from ninth grade in Finland) is a key transitional period for shaping students' educational and occupational choices. Therefore, understanding the situative processes of change in students' motivation during the time period when they are making significant choices regarding their future education and occupation may be especially critical for supporting and retaining students' motivation and achievement (Perez et al., 2014; Wigfield & Eccles, 2020). Thus, grounding on SEVT (Eccles & Wigfield, 2020), situations in the present study were operationalized by short-term change and stability in Finnish students' math-related competence and value beliefs within the last year of comprehensive education. Considering also ongoing declines in students' views and feelings towards school and their well-being in general (Wang et al., 2015; Widlund et al., 2021), it seems important to investigate how individual differences in students' math-specific self-concept, task values, and costs relate to, not only students' math performance and aspirations, but also to students' more general emotional distress, in and outside of school (i.e., school-related exhaustion and depressive symptoms related to their lives in general).

The following research questions and hypotheses were addressed:

1. What kinds of self-concept, task value, and cost profiles in mathematics can be found among adolescent students in ninth grade?

Based on previous findings (Gaspard et al., 2019; Jiang & Zhang, 2023; Juntunen et al., 2022; Lazarides et al., 2021; Perez et al., 2014; Watt et al., 2019), we expected to find motivational profiles characterized by

H1a: overall positive motivation (high self-concept and task values, low costs).
H1b: overall negative motivation (low self-concept and task values, high costs).
H1c: asynchronous motivational patterns (e.g., students with relatively high self-concept and task values yet elevated costs; Juntunen et al., 2022; Lee et al., 2022; Perez et al., 2019; Watt et al., 2019).

2. How stable are students' motivational profiles within the last year of comprehensive education?

H2a: We expected that most students will display stable motivational profiles over time (Lazarides et al., 2019, 2021; Raufelder et al., 2022).
H2b: Considering that motivation typically declines during adolescence, we expected that some students will transition into different motivational profiles over the ninth grade as they are approaching important decisions about further education and occupation. Although longitudinal studies involving cost are scarce, previous studies have found most transitions to be negative (Raufelder et al., 2022) and therefore, we expected to find mostly negative motivational transitions.

3. How is gender associated with students' self-concept, task value, and cost profiles?

H3a: We expected that girls would be more likely than boys to fall into profiles characterized by more maladaptive mathematics motivation (i.e., lower self-concept and task values and high costs) (Jiang & Zhang, 2023; Watt et al., 2019).
H3b: We expected that boys would be more likely to fall into more adaptive motivational profiles (i.e., high self-concept and task values, low costs) (Lazarides et al., 2022).
H3c: Based on the findings by Olive et al. (2022) we expected that boys might be more likely than girls to also transition into more favorable motivational profiles as well within the school year.

4. How are changes in adolescents' self-concept, task value, and cost profiles related to educational (math performance and math-related educational aspirations) and emotional (study-related exhaustion, general depressive symptoms) outcomes?

H4a: we expected that students remaining in more adaptive motivational profiles would perform better in mathematics and aspire for an education that involves more math skills compared to students in more maladaptive profiles (Wigfield & Eccles, 2020).
H4b: We also expected that more adaptive and stable profiles would be related to lower levels of study-related exhaustion and depressive symptoms (Juntunen et al., 2022; Watt et al., 2019).
H4c: Based on findings by Juntunen et al. (2022), and Watt et al. (2019), we also expected that students remaining in motivational profiles characterized by elevated costs would report higher levels of study-related exhaustion and depressive symptoms.

As no previous study to our knowledge has investigated how certain motivational transitions are related to educational or emotional outcomes, no specific hypotheses were set regarding motivational transitions and outcomes.

[1] After a nine-year comprehensive school, adolescents in Finland can choose between general and vocational upper secondary education.

2. Methods

2.1. Participants and procedure

Data came from a longitudinal research project FRAM [Students' well-being and learning in future society] at Åbo Akademi University. Five public lower secondary schools from different regions of Swedish-speaking[2] areas of Finland participated in the data collection. APA ethical standards and the guidelines of the Finnish National Board on Research Integrity (TENK) were carefully followed in the conduct of the whole project. Participation in the study was voluntary, informed consent forms were collected from the students' parents (2 % of the original sample did not obtain research permit), and the participants were assured of the confidentiality of their responses. Data used in this study were collected at the beginning (fall 2018, T1) and the end (spring 2019, T2) of ninth grade (i.e., 15-year-olds), that is, the last year of comprehensive school in Finland. Comprehensive schooling in Finland consists of primary school (Grades 1–6, ages 7–12) and lower secondary school (Grades 7–9, ages 13–15). After ninth grade, students enter upper secondary school (i.e., high school) and can choose between a vocational (leading to an occupation) or an academic (with intentions to continue with higher education) track.

The participating students completed self-report questionnaires on mathematics motivation at both time points (T1 and T2), whereas their math performance, aspirations, and well-being were assessed at the end of ninth grade (T2). All measures were conducted online during school hours in students' own classrooms. Trained research assistants were present during all data collections and read the directions out loud for the students. All students who participated at least once across the time points were included in this study, resulting in a total of 508 students. Little's MCAR tests revealed that the missing data patterns between the two time points (T1: 10 % and T2: 12 %) were missing completely at random for all positive motivational variables (MCAR) ($\chi^2(78) = 81.338$, $p = 0.376$), except for the cost-variables (MCAR) ($\chi^2(50) = 88.822$, $p = 0.001$). The maximum likelihood approach with robust standard errors were therefore implemented in Mplus to deal with missing data in the analyses.

2.2. Measures

2.2.1. Mathematics motivation

Attainment value (importance of achievement), utility value (usefulness for one's future job) and all cost components (emotional, effort, and opportunity cost) were assessed by utilizing subscales of an instrument (Gaspard et al., 2015, 2017) developed to capture the multidimensionality of value beliefs. Attainment value consisted of four items (e.g., *It is important to me to be good at math*), utility value of five items (e.g., *Knowing the contents of math will be helpful for my future career*), emotional cost of four items (e.g., *Doing math makes me really nervous*), required effort of four items (*Learning mathematics exhausts me*), and opportunity cost of three items (e.g., *I have to give up a lot to be good at math*). All items used a four-point Likert scale ranging from one (completely disagree) to four (completely agree) as the response format.

Since the study was part of a larger research project, intrinsic value and expectancies of success were represented by individual interest and self-concept in mathematics, assessed with Marsh's (1992) Self Description Questionnaire I (SDQ I, see also Arens & Hasselhorn, 2015; Pinxten et al., 2010). Three items captured students' individual interest (e.g., *I like mathematics*) and three items captured students' self-concept (e.g., *I am good at math*). Although intrinsic value and individual interest are theoretically distinct concepts, they overlap in the literature and are similarly related to educational outcomes (Linnenbrink-Garcia & Wormington, 2019; Wigfield & Eccles, 2000). Similarly, although competence beliefs are conceptually distinct from the expectancy construct of the SEVT framework, the two concepts are highly correlated and often overlap empirically (Eccles & Wigfield, 1995; Wigfield & Eccles, 2000). Two out of three items intended to capture students' individual interest, and two out of three items intended to capture students' self-concept in math are identical to the ones used in the instrument by Gaspard et al. (2015) to assess intrinsic value and expectancies for success. In the present study, items used to represent interest and self-concept were assessed by a five-point Likert-type scale ranging from one (completely false) to five (completely true).

2.2.2. Mathematics performance

Students' mathematics performance was assessed with a standardized online assessment test (KTLT; Räsänen et al., 2013, see also Widlund et al., 2018) at the end of ninth grade. The test consists of adaptive questions on basic arithmetic, applied problem-solving, and algebra. It is intended for Grades 7–9 (13–16 years). The score students obtain in the test is based on an item response theory model calculated from a nationally representative sample of students ($M = 100$, $SD = 15$).

2.2.3. Aspirations

Students' math-related educational aspirations was assessed by one statement representing students' aspirations for studying a subject that requires good mathematical skills (*In the future, I would like to study a subject that requires good mathematical skills)*, by using a seven-point Likert-scale (1 = not at all true, 7 = very true).

2.2.4. Emotional distress

Study-related exhaustion was assessed by the School Burnout Inventory (Salmela-Aro et al., 2009), using a six-point Likert-type scale ranging from 1 (completely disagree) to 6 (completely agree). The measure is divided into three subscales measuring exhaustion, cynicism, and inadequacy. In this study, we included the four items measuring emotional exhaustion related to school and studying (e.g., *I feel overwhelmed by my schoolwork*).

In addition to study-related exhaustion, students' more general emotional distress was represented by depressive symptoms and was assessed by an instrument (Salokangas et al., 1994), consisting of 10 questions concerning participants' depressive mood during the last month (e.g., I felt sad; I felt that my future was hopeless), which were rated on a four-point scale (1 = not at all; 4 = very much).

2.3. Data analysis strategy

2.3.1. Preliminary analyses

Descriptive statistics, correlations, and internal consistencies of all measures at each time point are reported in Table S1 and S2 in the online supplemental material. Cross-sectional confirmatory factor analyses (CFA) were conducted on all measures to verify the factor structure of the constructs, and measurement invariance of self-concept-task value-cost constructs over time was confirmed through longitudinal CFAs.

2.3.2. Main analyses

The model building using LTA started by identifying the best fitting solution of latent profiles by conducting a series of latent profile analyses, separately for each time point (i.e., fall and spring in ninth grade). To choose the best fitting model, Bayesian information criterion (BIC), Vuong–Lo–Mendell–Rubin (VLMR) likelihood ratio test, and class size were used as the statistical criteria (Nylund et al., 2007). The model with a lower BIC value is considered to provide a better fit to the data, and a resulting p-value of less than 0.05 for VLMR suggests that the estimated model is preferable over the reduced model (Lo et al., 2001). Furthermore, parsimony, classification quality (entropy value >0.70; Marsh et al., 2009), the meaningfulness and interpretableness of the latent

[2] Swedish is the second official language in Finland, spoken by 5.3% of the population. Finnish- and Swedish-speaking schools follow the same national curriculum.

classes in the solutions as well as the conformity of the solutions in relation to theory and previous research were considered when comparing different models.

In a second step, changes in profile membership within a school year (i.e., from the beginning to the end of the ninth grade) were examined by conducting latent transition analyses (Collins & Wugalter, 1992; Ryoo et al., 2018). The profile solutions identified in the cross-sectional LPAs were used to determine model selection in the subsequent latent transition analysis.

In a third step, the covariate (gender) and outcomes (math performance and aspirations, study-related exhaustion, and depressive symptoms) were included in the mixture model. Gender was added as a covariate by following the BCH-LTA approach described by Asparouhov and Muthen (2021). The BCH method uses weights that reflect the standard errors of the latent class variable and follows a two-step process: first the latent class measurement model is estimated, and the BCH weights are saved. In the second step, a general auxiliary model is estimated conditional on the latent class variable using the BCH weights. To examine whether stability and changes in profile membership were related to educational and emotional outcomes, we compared mean differences in the outcomes between each transition pattern identified in the initial LTA by first calculating a mean for each outcome, for each transition pattern. Then, a series of model constraints were specified to compute pairwise differences in means of each outcome across transition patterns with Wald's test (for syntax see Syntax B and C in the Supplemental material) (McLarnon et al., 2019). In all models, default starting values (204) and stiterations (10) were used in Mplus.

3. Results

3.1. Preliminary results

LCFAs indicated sufficient measurement invariance over time. Both cross-sectional and longitudinal CFAs are reported in Tables S3 and S4 in the supplemental material.

3.2. Motivational profiles in mathematics

Based on saved factor scores from initial CFAs, LPA models with up to 6 profiles were tested and the four-profile solution fitted the data best, both at the beginning and at the end of ninth grade (see Table 1). We stopped the model testing at 6 profiles as additional profiles seemed to be highly similar to the ones already detected in previous profile solutions and were relatively small. Although BIC continued to decrease, the decrease started to stabilize when more classes were added. Also, additional profiles resulted in relatively small class sizes and were hard to justify theoretically and, according to the VLMR value, did not result in a better fit to the data. The Entropy values of the 4-class solutions at both time points (0.87 and 0.90, respectively) also pointed to clear classifications.

Table 1
Information Criteria Values for Different Profile Solutions.

Time point	Number of classes	Entropy	BIC	p_{VLMR}	Smallest class (%)
1	1	–	7118.548		
	2	0.897	5867.334	0.000	49 %
	3	0.897	5463.651	0.0038	19 %
	4	0.886	5265.612	0.0271	16 %
	5	0.905	5085.778	0.1065	9 %
	6	0.903	4953.436	0.4781	6 %
2	1	–	7656.338		
	2	0.865	6531.791	0.000	46 %
	3	0.901	6065.311	0.0079	19 %
	4	0.904	5799.232	0.0179	13 %
	5	0.898	5666.847	0.4201	7 %
	6	0.908	5545.661	0.2279	4 %

The profiles found at both time points were highly similar and were named *Positively ambitious* (high self-concept and task values, low costs, T1: 34 %/ T2: 32 %), *Struggling ambitious* (relatively high self-concept and task values, high costs, T1: 25 %/T2: 25 %), *Indifferent* (relatively low self-concept and task values, low costs, T1: 22 %/T2: 21 %), and *Maladaptive* (low self-concept and task values, high costs 19 %/22 %).

3.3. Stability and change across the school year

Based on the LPAs, we continued with the four-profile solution in the subsequent LTA. Time-invariant motivational profiles (standardized means) are presented in Fig. 1 (unstandardized means for each time point are presented in Table S6, and SES differences between profiles in Table S7 in the Supplemental materials). Transition probabilities and the final class counts and proportions for the latent transition patterns based on estimated posterior probabilities are depicted in Table 2 and Fig. 2. The results indicated that motivational profiles were relatively stable over time: the highest transition probabilities (0.63–0.82) were found among those who stayed in the same profile over time. The majority of the students (80 %) displayed a stable profile over time, and membership to the *Positively ambitious* profile was revealed to be the most stable (stability: 82 %). Some changes were observed between measurement points with relatively high transition probabilities ($p \geq 0.10$) as well. Some students experienced declines in their motivation: 10 % of students who initially were *Positively ambitious* transitioned to the *Struggling ambitious* profile, 16 % of the *Struggling ambitious* students transitioned to the *Indifferent* profile, and 13 % from *Indifferent* to *Maladaptive*. However, some positive changes were observed as well, as 19 % of students who were *Struggling ambitious* became *Positively ambitious* across the school year, whereas up to 27 % of students in the *Maladaptive* profile transitioned to the *Indifferent* group.

3.4. Associations with gender

Initial cross-tabulation analyses were conducted to examine gender differences in the profile at each time point. As adjusted residuals indicated that there were no significant differences in the proportions of boys and girls in the *Indifferent* group at neither time points (T1: $z = 0.1$, $p < 0.05$; T2: $z = 0.9$, $p < 0.05$), the *Indifferent* profile was used as reference group while investigating the effect of gender in the mixture model.

From the LTA model with gender as a covariate, the odds ratio (OR) revealed that girls, as compared to boys, were significantly more likely to be in the *Maladaptive* profile (OR = 2.24, $p < 0.05$) than in the *Indifferent* profile in Fall of Grade 9. In the Spring of Grade 9, girls were, in turn, less likely than boys to be in the *Positively ambitious* profile (OR = 0.58, $p < 0.05$). Gender did not have significant effects on any of the transitions with probabilities ≥ 0.10.

3.5. Associations with educational and emotional outcomes

In the final step, based on the LTA results, we investigated whether students with stable or changing motivational patterns (transition probability ≥ 0.10) differed in math performance, math-related educational aspirations, study-related exhaustion, and depressive symptoms by comparing mean differences in the outcomes across different transition patterns within the mixture model (see Tables 3 and 4).

Students who remained in the *Positively ambitious* group across ninth grade performed the highest in mathematics out of all groups. Next came students in the stable *Struggling ambitious* and *Indifferent* profiles, whereas students who remained in the *Maladaptive* profile performed the lowest. No transitions between profiles were associated with lower/higher math performance.

Interestingly, stable *Positively ambitious* and *Struggling ambitious*

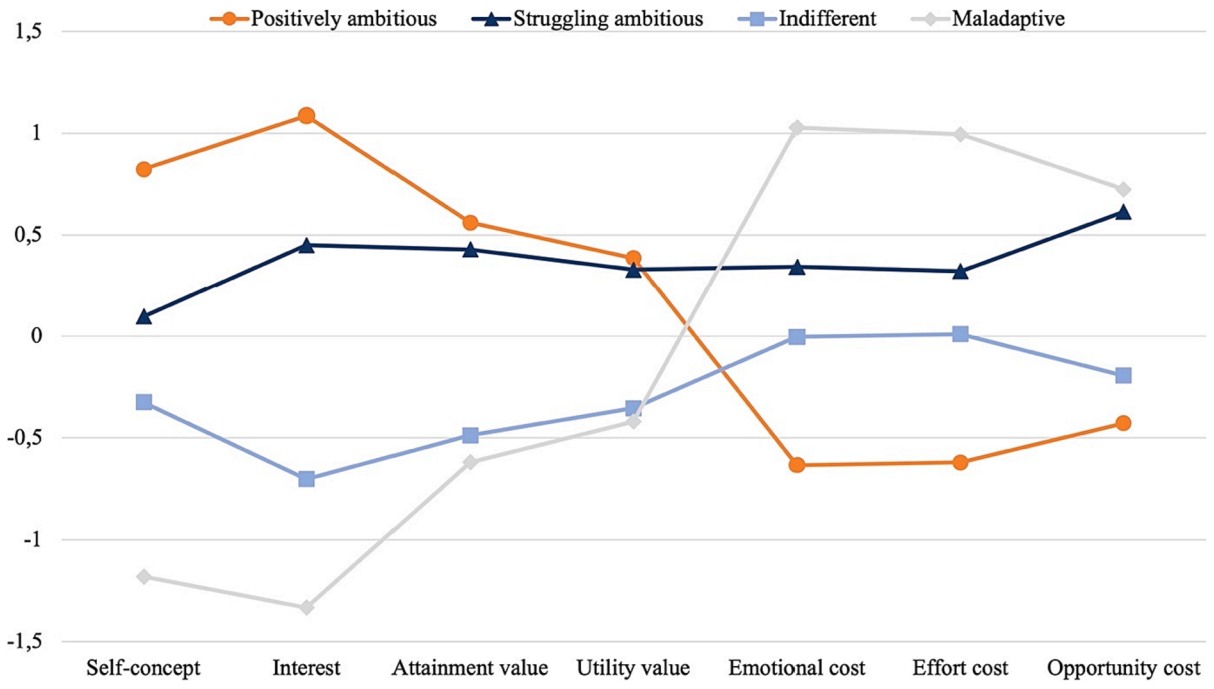

Fig. 1. Time-Invariant Motivational Profiles in Mathematics among 9th Graders.

Table 2
Transition Probabilities for the Latent Transition Analysis.

	Time 2			
Time 1	Positively ambitious	Struggling ambitious	Indifferent	Maladaptive
Positively ambitious	0.82	0.10	0.06	0.02
Struggling ambitious	0.19	0.63	0.16	0.03
Indifferent	0.09	0.07	0.71	0.13
Maladaptive	0.00	0.04	0.27	0.69

students did not differ in their math-related educational aspirations. No significant differences in math-related educational aspirations were found between students in the stable *Indifferent* and *Maladaptive* profiles either, but both groups reported significantly lower aspirations than *Positively ambitious* and *Struggling ambitious* students. Also, transitioning between profiles was not related to students' math-related aspirations.

Regarding emotional factors, students who remained *Positively ambitious* had the lowest levels of study-related exhaustion, followed by students in the stable *Indifferent* profile. Lastly, *Struggling ambitious* and *Maladaptive* students both reported equally high levels of exhaustion in school. Transitioning into a more negative motivational profile (from *Positively ambitious* to *Struggling ambitious*, or from *Indifferent* to *Maladaptive*) across ninth grade was also associated with elevated levels of exhaustion, compared to staying in the initial profile. However, transitioning from the *Maladaptive* to the *Indifferent* profile was associated with lower levels of exhaustion (compared to staying in the *Maladaptive* profile).

Similar differences were found for depressive symptoms. Students who remained *Positively ambitious* reported the lowest levels of depressive symptoms, followed by the *Indifferent* group, whereas students in the *Struggling ambitious* and *Maladaptive* profiles had the highest levels of such symptoms. Also, moving into a more negative motivational profile (*Positively ambitious* to *Struggling ambitious*, and from *Indifferent* to *Maladaptive*) was associated with higher levels of depressive symptoms compared to staying in the initial profile.

4. Discussion

This study contributes to research and SEVT by using a person-centered longitudinal approach to investigate stability and change in adolescents' self-concept, task value, and cost profiles across ninth grade and, by investigating how such situative processes relate to both educational and emotional outcomes. One of the main contributions was that, by also considering various costs as profile indicators, we were able to identify students with both synchronous (i.e., overall positive, or negative motivation) as well as asynchronous (students displaying both positive and negative motivational beliefs) profiles, demonstrating the multidimensionality of students' motivational beliefs. In addition, we found that the majority of students had quite stable motivation across the ninth grade, despite approaching the significant educational transition toward upper secondary education. Nevertheless, both positive and negative changes occurred that seemed to be particularly related to students' overall emotional distress.

4.1. Self-concept, task value, and cost profiles

Corresponding with previous findings indicating that competence- and value-beliefs correlate negatively with cost, the largest profile represented students who felt highly confident in their abilities, viewed math as interesting, meaningful, and useful, and did not consider math to be costly (H1a, *Positively ambitious*). Yet, 25 % of students exhibited similar positive values in math, but also thought math was emotionally draining and required high effort and giving up other activities (H1c, *Struggling ambitious*). Groups of highly motivated students who struggle with the required costs related to math have been found previously in various contexts, age groups, and levels of education (Juntunen et al., 2022; Perez et al., 2019; Lee et al., 2022; Raufelder et al., 2022; Watt et al., 2019). In most cases, these profiles have been relatively similar in

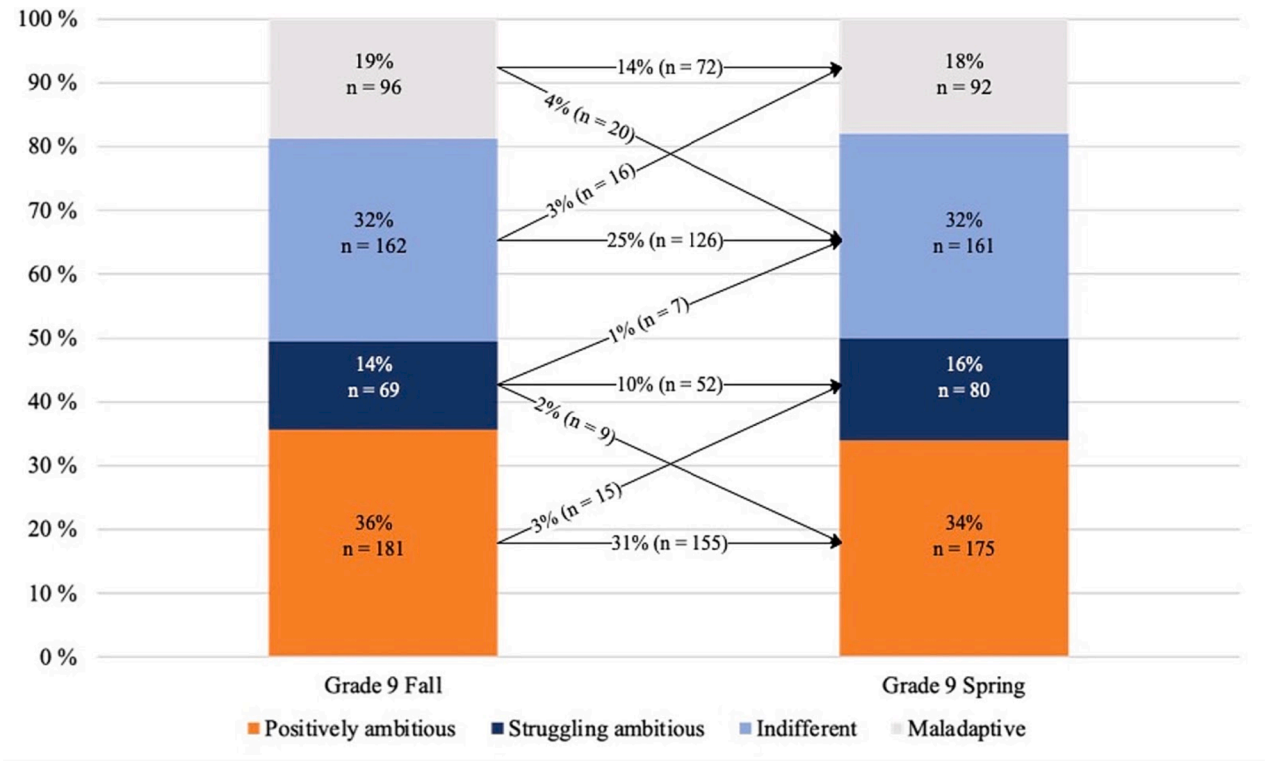

Fig. 2. *Proportions of Students in Latent Profiles and for each Transition. Note*. Only transitions with probabilities ≥0.10 are depicted. The percentages represent the proportion of students with respect to the total sample ($N = 508$). The odds ratios (OR) for transitioning into a different profile, as compared to staying in the same profile across time, were statistically significant for all transitions (see Table S5 in supplemental material).

Table 3
Mean Differences in Educational Outcomes Across Transitions.

		$M_{performance}$ (SD)	$M_{aspirations}$ (SD)	1	2	3	4	5	6	7	8	9
1	Stable Positively ambitious	122.24 (10.75)	5.80 (1.49)	-	0.46	0.43	−0.23	0.15	2.73*	3.68*	2.93*	2.74*
2	Positively ambitious → Struggling ambitious	116.66 (8.67)	5.34 (1.41)	5.58	–	−0.03	−0.69	−0.30	2.27*	3.22*	2.48*	2.28*
3	Stable Struggling ambitious	112.68 (10.33)	5.37 (1.42)	9.56*	3.98	–	−0.66	−0.27	2.30*	3.25*	2.51*	2.31*
4	Struggling ambitious → Positively ambitious	106.07 (15.69)	6.03 (1.12)	16.17	10.59	6.61	–	0.39	2.96*	3.91*	3.17*	2.97*
5	Struggling ambitious → Indifferent	103.17 (7.16)	5.64 (0.24)	19.07*	13.49*	9.51	2.90	–	2.57*	3.52*	2.78*	2.56*
6	Stable Indifferent	105.91 (14.05)	3.07 (2.21)	16.33*	10.75*	6.77	0.16	−2.74	–	0.95	0.21	0.01
7	Indifferent → Maladaptive	103.34 (13.68)	2.12 (1.63)	18.90*	13.32*	9.34	2.72	−0.17	2.57	–	−0.74	−0.94
8	Stable Maladaptive	97.52 (13.73)	2.87 (2.93)	24.72*	19.14*	15.16*	8.55	5.65	8.39*	5.82	–	−0.19
9	Maladaptive → Indifferent	97.20 (16.94)	3.06 (2.45)	25.04*	19.46*	15.48*	8.87	5.97	8.71	6.15	0.33	–

Note. Values represent mean differences across the different transition types. Values for mathematics performance are depicted on the left side of the diagonal, and math-related educational aspirations are on the right side.
* $p < 0.05$.

size, representing approximately 9–25 % of the samples among both older (i.e., university: Perez et al., 2019; Juntunen et al., 2022) and younger (i.e., secondary school: Vinni-Laakso et al., 2022; Watt et al., 2019) students. Also, although the cost dimensions seemed to be related within the profiles, there was a relative emphasis on opportunity cost within both profiles (as compared to effort and emotional cost), particularly among the *Struggling ambitious* students. Interestingly, the same patterns of particularly high opportunity cost (as compared to other cost dimensions) were identified in the studies by both Juntunen et al. (2022) and Perez et al. (2019) among the corresponding group of students (i.e., students with both high motivation and high cost). Taken together, these findings demonstrate that high competence- and value-beliefs may not always be a completely positive experience, as even highly motivated and ambitious students can be vulnerable to experiencing negative consequences of engaging with math.

Two profiles with lower competence- and value-beliefs were also identified. For many, low self-concept and struggles with finding math interesting or meaningful seem to go together with high costs of

Table 4
Mean Differences in Emotional Outcomes Across Transitions.

		$M_{exhaustion}$ (SD)	$M_{depressive\ symptoms}$ (SD)	1	2	3	4	5	6	7	8	9
1	Stable Positively ambitious	2.28 (1.21)	1.48 (0.29)	-	−0.85*	−0.67*	−0.60	−0.45	−0.06	−0.82*	−0.80*	−0.40
2	Positively ambitious → Struggling ambitious	3.51 (1.47)	2.33 (0.78)	−1.23*	–	0.18	0.25	0.40	0.79*	0.03	0.05	0.45
3	Stable Struggling ambitious	3.61 (0.96)	2.14 (0.64)	−1.33*	−0.1	–	0.07	0.22	0.61*	−0.15	−0.14	0.26
4	Struggling ambitious → Positively ambitious	3.64 (1.45)	2.08 (0.74)	−1.37*	−0.14	−0.04	–	0.15	0.54	−0.22	−0.20	0.20
5	Struggling ambitious → Indifferent	3.80 (1.28)	1.92 (0.21)	−1.53*	−0.29	−0.20	−0.15	–	0.39	−0.37	−0.36	0.04
6	Stable Indifferent	2.51 (0.89)	1.53 (0.30)	−0.24	1.00	1.09*	1.13	1.28	–	−0.76*	−0.74*	−0.35
7	Indifferent → Maladaptive	3.27 (0.94)	2.29 (0.72)	−0.99*	0.24	0.34	0.38	0.53	−0.75*	–	0.02	0.41
8	Stable Maladaptive	4.01 (1.30)	2.28 (0.76)	−1.73*	−0.50	−0.40	−0.36	−0.20	−1.49*	−0.74*	–	0.40
9	Maladaptive → Indifferent	2.94 (0.86)	1.88 (0.35)	−0.67*	0.57	0.67	0.71	0.86	−0.42	0.33	1.06*	–

Note. Values represent mean differences across the different transition types. Values for exhaustion are presented on the left side of the diagonal, and depressive symptoms are on the right side.
* $p < 0.05$.

engaging with math, particularly effort and emotional cost (H1b, *Maladaptive*). However, we identified another asynchronous pattern like the one identified by Raufelder et al. (2022), also among Finnish adolescents, representing students who seemed particularly disinterested in math, yet did not report high costs associated with the subject (i.e., *Indifferent*). Roeser et al. (1998) identified a similar group of students with low and decreasing school value and competence-beliefs, but no psychological distress. Later, they identified a group reporting relatively positive academic efficacy and mental health, but low academic value (Roeser et al., 2002). It could be that students who increasingly feel incompetent may start to devalue school to protect their self-worth (Eccles, 2009). Such a protective attitude might hinder some students from investing in schoolwork, and consequently, function as a buffer from emotional costs associated with studying. Another explanation could be that, if a student does not find math important or useful for their specific career goals, they might not become as stressed when faced with challenges in that domain (e.g., low performance), and may not feel that they need to put in more effort in math (e.g., due to low math-related aspirations). Thus, considering that motivational beliefs tend to become more domain-specific around educational transitions (Lazarides et al., 2021), the *Indifferent* students might simply value and put more effort into other subjects or things outside of school. Therefore, one should be careful not to generalize our findings across domains.

4.2. Stability and change

As expected, (H2a) most students seem to hold rather stable motivation over time (Lazarides et al., 2019, 2021; Raufelder et al., 2022). Still, 20 % of students changed their profile membership during the last year of comprehensive school (H2b). Considering the specific context of this study and notions by SEVT (Eccles & Wigfield, 2020), changes in students' motivation during this time are not surprising: as students' task values grow increasingly more distinct (Wigfield & Eccles, 2020), some may experience a positive change in their motivation (e.g., increased utility value) if they realize the importance of mathematics for their career goals (Wigfield et al., 2015). Others might start to devalue it if it doesn't align with their educational and occupational aspirations. Previously, Raufelder et al. (2022) found that most changes in students' competence and value beliefs were negative when following adolescents during and after the educational transition from primary to lower secondary school. However, in line with the results by Vinni-Laakso et al. (2022) who studied stability between grades seven and eight in Finland, while also including cost, a relatively equal amount of both positive (increased self-concept and value beliefs, lowered cost) and negative (decreased self-concept and value beliefs, increased cost) changes occurred among our ninth-grade sample facing the forthcoming transition to upper secondary education (i.e., high school). Although approaching educational transitions often entail increased uncertainty and stress regarding one's future (Eccles & Roeser, 2009), students in the present study had not yet transitioned, and were still surrounded by the familiar educational and social environment of lower secondary school. Also, transitioning from lower to upper secondary education has previously been found to be a positive experience for many (e.g., increased study engagement: Widlund et al., 2021), possibly as it often involves increased autonomy (e.g., greater choice regarding one's educational track and curriculum), while many have also passed the worst turmoil related to entering puberty.

The context should be considered when interpreting the findings, as the admission systems in Finland (particularly among the Swedish-speaking minority) are relatively uncompetitive where only 2–3 % of students are not accepted into further education after ninth grade (Statistics Finland, 2022). This may also explain why the *Positively ambitious* group was the largest among all profiles in the present study (32–34 %), while it was the smallest one (15 %) among ninth graders (majority Finnish-speaking students) in the study by Raufelder et al. (2022).

Nevertheless, considering that we were able to identify both positive and negative changes in students' motivation even during a rather short time period, suggests that the school environment and the time period before making significant decisions about one's future is important, as these may not only impair, but also, provide opportunities for positive changes in students' motivation (Eccles & Roeser, 2009; Widlund et al., 2021).

4.3. Relations to gender, educational and emotional outcomes

Our findings regarding gender differences resonate with previous cross-sectional and person-centered studies having consistently found girls to report lower self-concept in math in comparison to boys (Mejía-Rodríguez et al., 2021), and that girls tend to be overrepresented in more maladaptive math motivation profiles (H3a: Jiang & Zhang, 2023; Watt et al., 2019). Boys, on the other hand, were overrepresented in the positively ambitious group (H3b: Lazarides et al., 2019; Raufelder et al., 2022). Although no gender differences exist in boys' and girls'

mathematics performance in Finland (OECD, 2019), our findings generally align with the assumptions proposed by the SEVT suggesting that gender-role socialization processes may still lead to gender differences in students' motivational beliefs, particularly in stereotyped domains such as mathematics (Wigfield et al., 2015). Indeed, although Finland has been ranked second (out of 146 countries) on the global gender gap index (World Economic Forum, 2022), approximately 73 % of STEM graduates from Finland are still male. However, contrary to the findings by Olive et al. (2022) and what we expected (H3c), gender did not have effects on the motivational transitions in the present study. It is possible that gender differences are relatively persistent at the end of comprehensive school, considering that gendered motivational beliefs have been identified already at the beginning of primary school (Wigfield et al., 2015). In the findings by Olive et al. (2022), while also studying Finnish students, they focused on students in primary education (i.e., grades five and six). Thus, taken together, these findings highlight the importance of targeting interventions to support girls' lower math motivation at an early stage.

In line with what we expected (H4a, H4b), we found that students with positive and stable motivational beliefs (Positively ambitious) also performed higher, had high math-related educational aspirations and did not experience emotional distress in or outside of school (study-related exhaustion, depressive symptoms). However, simply high self-concept and task values may not be enough to buffer against emotional distress: higher levels of both study-related exhaustion and depressive symptoms were found among students who also felt math to be costly, irrespective of their self-concept and task value levels (confirming H4c). Considering that the students are approaching an educational transition and that the perceived loss off opportunity was particularly high among the *Struggling ambitious* students (see also Juntunen et al., 2022; Perez et al., 2019), these students likely put in a lot of time and cognitive resources in their schoolwork during this time, which likely allows for less available time to spend on other tasks or with people. While this might maintain high performance and aspirations (Part et al., 2020), it may also increase the risk of emotional exhaustion and broader problems in one's mental health. Thus, in a way, aligning with the discussions by Eccles & Wigfield, some aspects of cost may be viewed as both a cost and a benefit (Wigfield & Eccles, 2023). Although it is challenging to draw causal conclusions about these findings as students' motivation and well-being were measured at the same time (T2) in spring of ninth grade, it could be that domain-specific experiences of cost in math spill over to other domains of life, such as school or life in general. However, problems in students' well-being may also start outside of school, and transfer to their domain-specific motivational beliefs.

To summarize, short-term changes in students' motivational beliefs did not seem to be related to higher or lower mathematics performance or aspirations. Rather, changes in motivation played a role in emotional outcomes: irrespective of the initial level of mathematics motivation (i.e., higher or lower self-concept and value beliefs), both positive and negative changes were systematically related to students' levels of school-related exhaustion and depressive symptoms.

4.4. Implications

Our study adds to SEVT by combining a developmental and person-centered perspective to study stability in short-term motivational beliefs (self-concept, positive values, and costs) during the last year of comprehensive school in Finland. The inclusion of multidimensional aspects of both task values and costs adds to the EV literature as it allows for a more detailed understanding of the configuration of student profiles of motivational beliefs, their development, and relation to relevant educational and emotional outcomes. By including several cost-dimensions, we were able to identify motivational profiles among students that would not be detected solely by using positive motivational beliefs (e.g., *Struggling ambitious*). In addition, our findings highlight the importance of considering emotional outcomes while studying changes in students' motivational beliefs, as short-term changes in students' math motivation seemed to be systematically related to exhaustion, and depressive symptoms rather than to their performance or aspirations in math.

From a practical perspective, this study informs us that students, irrespective of their self-concept and value beliefs, can be receptive to experiencing negative costs of engaging with math and, also, experience changes in their motivation that may relate to their emotional distress and well-being. The school provides an important developmental context for both adolescents' motivation and well-being, and therefore, schools may both hinder or provide opportunities for positive or negative changes to take place. Being aware of the inter- and intraindividual differences that exist in students' motivation, helps to better identify students with different types of challenges, and implement individualized support for their various needs. Previous intervention-studies have mainly intervened in students' task-values, particularly utility-value by, for example, making the content more personally meaningful for students, and relating and explaining the usefulness of it for everyday tasks (Rosenzweig et al., 2022). This approach might be particularly beneficial for students struggling with low value beliefs in math (i.e., *Indifferent*). Only a limited amount of research has focused on reducing perceived costs among students (Rosenzweig et al., 2022), an approach that might be particularly helpful for students who struggle with the effort required and emotional aspects of engaging with math (i.e., *Struggling ambitious*). Furthermore, previous studies have also suggested that girls seem to be particularly engaged by activities they perceive as socially meaningful and important (Watt et al., 2012). Considering that girls were overrepresented in the profile exhibiting problems with both low competence and values-beliefs coupled with high costs in math (i.e., *Maladaptive*), this is something that should be acknowledged in schools, particularly in the mathematics domain as it is often considered a rather skill-based and abstract subject.

4.5. Limitations and future directions

This study also has some limitations that need to be considered when interpreting the results. Although an important contribution of this study was linking individuals' motivational transitions to educational and emotional outcomes instead of merely investigating differences between student profiles, future studies should examine these relations over a longer time period and try to clarify the causal relationship between motivation and emotional factors, and also, use variable-centered approaches. As stated earlier, it is challenging to draw clear causal conclusions from our findings, as the outcome variables in this study were measured at the same time as students' motivational beliefs. A limitation of this study was also that we used only negative emotional outcomes (i.e., study-related exhaustion and depressive symptoms). Future studies should therefore include positive aspects of students' well-being as well, such as engagement, positive emotions, or life satisfaction.

While we believe that examining stability in students' motivation within a time period that likely is perceived as increasingly stressful for many students, as it involves important decision-making processes regarding one's future education and occupation, future studies should cover development during longer time periods (e.g., over the transition to further education) and also, by adding more measurement waves. It would also be important, as recommended by SEVT (Eccles & Wigfield, 2020), to consider the situative processes (e.g., in-the-moment-measures of motivation) more closely in future work.

Furthermore, although our findings (e.g., identified profiles) largely align with previous results from various educational contexts and countries, the relatively small sample and the Finnish (i.e., Swedish-speaking sample in Finland) context should be taken into account when interpreting and generalizing the findings. Similarly, it should be acknowledged that we used self-concept as a proxy for success

expectancies. While self-concept, expectancy for success, and self-efficacy are similar in nature, they are not completely overlapping constructs. Using self-concept to represent expectancy beliefs while focusing on the situative processes in students' motivation (i.e., stability within one school year) may have some limitations, as self-concept is believed to be relatively stable and general in nature (as compared to, for example, self-efficacy).

Lastly, we want to point out that students' motivational beliefs, educational aspirations, and emotional distress were assessed using student self-reports and students' mathematics performance through standardized tests. Although the purpose was specifically to look into adolescents' own experiences of their academic and emotional functioning, ratings by others (e.g., teachers, parents, or peers) could also be collected in future work.

5. Conclusion

The findings demonstrate that adolescent students hold various patterns of motivational beliefs in mathematics, and that these are quite stable within ninth grade. Still, 20 % of students transitioned to nearby motivational profiles. Some experienced increased costs associated with math and lowered competence and value beliefs but, interestingly, some still displayed favorable changes in their math motivation just before an important educational transition. Overall, students with both positive and stable motivational patterns experienced the most favorable outcomes: they performed well, had high math-aspirations and more positive well-being. Yet, some students struggle with the required effort and emotional costs associated with math, despite having relatively positive value beliefs, aspirations, and performance. In fact, negative short-term changes in students' motivational profiles did not seem to be associated with lower math performance or aspirations, but rather, with higher levels of study-related exhaustion and depressive symptoms. Consequently, schools should put more effort into reducing students' perceived costs in schools and supporting their well-being, particularly at times when they are making significant choices regarding their future.

CRediT authorship contribution statement

Anna Widlund: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft. **Heta Tuominen:** Conceptualization, Writing – review & editing. **Johan Korhonen:** Conceptualization, Project administration, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cedpsych.2024.102256.

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