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A multigroup random-intercept cross-lagged panel model for Finnish secondary school students in frame of situated expectancy-value theory[☆]

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ABSTRACT

The aim of this study is to examine both within-person and between-person associations of academic self-concept and task values in literacy and mathematics to identify the most promising motivational construct to prevent motivational decline during school transitions. The sample included 3636 students (average age at the start: 15.73 years, SD: 0.32 years) followed up three times from lower secondary school (T1) to the third year (T3) of upper secondary education, either in vocational or academic tracks. Multi-group random intercept cross-lagged panel models detected several spillover (cross-lagged) effects between self-concept and task values in mathematics but not in literacy. There were also marginal but significant differences between students from different educational tracks in both subjects. Overall, utility value and academic self-concept in mathematics were found to be the most promising motivational constructs in changing motivational beliefs, thus presenting important starting points in motivational interventions.

Educational relevance and implications statement: This study highlights that spillover effects are more pronounced in maths than in literacy, emphasising the need for tailored interventions in mathematics education. Moreover, the potential disruption in students' motivational beliefs during school transitions suggests the importance of ensuring continuity in support to help mitigate the impact of these transitions. While our results indicate limited carryover effects, it is possible that school transitions are experienced as breaks in motivational development. The role of utility value in exhibiting spillover effects over school transitions in both maths and literacy suggests the significance of emphasising the practical relevance of academic subjects to sustain students' motivation. Additionally, recognising the superior role of academic self-concept in maths in spillover effects on task values underscores the importance of nurturing students' confidence and beliefs in their own mathematical abilities.

1. Introduction

Expectancy-value theory (EVT; Eccles et al., 1983) and its recent expansion, situational EVT (SEVT; Eccles & Wigfield, 2020, 2023), highlight the role of students' task values and success expectancies for academic achievement or future career choices. The main proposition of EVT is that setting a high value for a task (e.g. achievement in an academic domain) and expecting to be successful in that area contribute to students' motivation and investment of more effort in mastering the required skills (Eccles & Wigfield, 2002; Wigfield & Eccles, 2000). With the shift from EVT to SEVT, the situational character of motivational components has received special attention, accompanied by questions about intra- and inter-individual heterogeneity, state–trait relations and specific learning environments (e.g. different school settings) in the development of success expectancies and task values (see Moeller et al., 2022).

☆ All authors share the research interest in motivational development processes during the school years, and they are particularly interested in intra- and inter-individual differences.

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More specifically, Eccles and Wigfield (2023) and Moeller et al. (2022) raised the question of the possible state and trait shares of the individual components of success expectancies and task values in specific situations (over time) and, thus, of the nature of these components per se. The present study addresses these exact questions to deepen our understanding of the nature and processuality of success expectancies and task values and the possible underlying trait and state dynamics. It is important to disentangle these components, especially with the aim of positively influencing them in various educational settings (e.g. classes in different school forms). Accordingly, the current study has two main objectives. The first aim is to investigate the situated nature of the development of success expectations (i.e. academic self-concept) and task values by exploring the period of school transition from comprehensive school to either general upper secondary school (academic track) or to vocational school (vocational track) in Finland (grades 9, 10 and 12) in different domains (literacy and mathematics). The second aim is to specify possible trait and state components, as only a few existing SEVT studies (e.g. Benden & Lauermann, 2023; Moeller et al., 2022) have differentiated between within-person fluctuations (temporal deviations) and between-person differences (stable trait factors) in the development of success expectancies and task values over time. Overall, the purpose of this study is to identify the most effective motivational construct for changing motivational beliefs and preventing motivational declines.

1.1. The development of success expectancies and task values

According to EVT (Eccles et al., 1983; Wigfield & Eccles, 2000), a student's expectancies of success in a task and the subjective value of that task constitute the basis of the student's motivational beliefs. There are four types of task values: (a) attainment value, encompassing the personal meaning to the student of accomplishing a task; (b) intrinsic value, depicting the pleasure and interest experienced in undertaking and completing a task; (c) utility value, capturing the meaningfulness of a task for one's own future; and (d) cost value, which includes the perceived negative consequences of accomplishing a task, such as negative emotions or stalling other activities. In the current study, we explore only the task values with positive connotations (1–3).

According to Bong and Skaalvik (2003), Eccles and Wigfield (2020) and Marsh et al. (2019), expectancy beliefs are conceptually related to students' academic self-concept. Additionally, previous studies have shown some overlap between items on expectations of success and academic self-concept, as they often load on a single factor (see Eccles & Wigfield, 2023), which suggests that these constructs are not always empirically distinguishable (see Lazarides et al., 2020). In the current study, we rely on measures of students' academic self-concept, with the aim of further deciphering the proportion of stable traits (i.e. academic self-concept) and states with respect to the development of motivational beliefs. In accordance with Shavelson et al.'s (1976) multidimensional model (Schöne et al., 2003), academic self-concept is a component of general self-concept that depicts an individual's ideas about their own study-related abilities, traits and school activities. Eccles and Wigfield (2020) described this as an individual's more stable self-beliefs, while success expectancies are more task- and time-specific.

Studies have indicated that, in adolescence, task values in key school subjects can influence further academic pathways even more than academic performance (see Guo et al., 2018). The relationship between students' expectancy of success and their task value beliefs is a key mechanism for motivational congruence, as proposed by Eccles et al. While the original SEVT did not explicitly include cross-lagged paths between expectancy and values, it suggested that such bidirectional influences were possible (see Benden & Lauermann, 2023; Eccles, 2005, 2009; Wigfield et al., 1997). Students often value tasks in which they excel due to the intrinsic reward of competence, and conversely, they may devalue tasks in which success seems unlikely to protect their self-worth (see Benden & Lauermann, 2023; Eccles, 2009; Harter, 1990; Wigfield & Eccles, 2020). Similarly, valuing a task can increase engagement and improve skills and future success expectations (Eccles, 2005, 2009). Education researchers have focused on cross-lagged expectancy-value associations to identify which motivational constructs can significantly influence other motivational beliefs and, therefore, should be prioritised in interventions aimed at preventing drops in academic motivation (Marsh et al., 2005; Rosenzweig et al., 2022).

Benden and Lauermann (2023) stated that 'Eccles (2005) pointed out that analyses of the cross-lagged links between students' expectancy and task values must carefully consider (a) which time lags and (b) which types of assessments are best suited to capture such links (see also Dormann & Griffin, 2015)' (p. 2). Some developmental processes unfold over years, while others occur during shorter periods (Benden & Lauermann, 2023; Gaspard et al., 2020). Most evidence has come from long-term studies that showed significant effects of expectancy on task values, but fewer findings have been on reciprocal effects (e.g. Arens et al., 2019; Chung & Kim, 2022; Grigg et al., 2018; Lee & Seo, 2021; Marsh et al., 2005; Trautwein et al., 2012; Viljaranta et al., 2014; Vinni-Laakso et al., 2019; Wigfield et al., 2016). Shorter-term studies have presented mixed results due to varying time lags and motivational assessment types (Beymer et al., 2022; Moeller et al., 2022; Perez et al., 2019).

The results were partly different for different subjects. For example, in the study by Arens et al. (2019), which considered maths, literacy and English as a foreign language in a sample of German students of maths and foreign languages, almost all unidirectional paths from academic self-concept to intrinsic value were found to be significant over five waves (but not vice versa). However, for literacy, it was the other way around; almost every path from intrinsic value to academic self-concept was found to be significant (but not vice versa). In contrast, the associations between academic self-concept and attainment value were found to be reciprocal for all three subjects and over all five waves. The study by Vinni-Laakso et al. (2019) of Finnish elementary school students could not detect any significant cross-lagged path between academic self-concept and intrinsic value or cost from 1st grade to 2nd grade in science. In addition, the study by Trautwein et al. (2012) focused on maths and English as a foreign language and found that some value components (i.e. utility value and cost) were more closely related to expectancy beliefs than with other value facets.

In their recent article, Eccles and Wigfield (2023) raised the question of how task values accumulate and whether there might be a more stable latent factor (trait): 'Second and even more importantly, we have begun to think more specifically about the nature of STV itself. For example, do the subcomponents aggregate additively to form a more stable latent STV for each option, or do the subcomponents aggregate in varying ways to form more unstable STVs for each option depending on what any option is being contrasted with at any given point in time?' (p. 10). The current study takes up this idea by investigating possible trait proportions (between levels) and within-person differences using a random-intercept cross-lagged panel model (RI-CLPM). In doing so, we follow Moeller et al. (2022), who, following dynamical systems theory, raised the question of 'how situated experiences of expectations and values may relate to trait-like motivational dispositions'.

However, most existing research is based on traditional CLPM on students' expectancy-value beliefs over time and does not account for both within- and between-person variability (e.g. Arens et al., 2019; Chung & Kim, 2022; Vinni-Laakso et al., 2019), which can lead to substantially biased estimates of cross-lagged associations (Berry & Willoughby, 2017; Hamaker et al., 2015). To our knowledge, only two studies have differentiated between within- and between-person variability in academic self-concept and task values (Benden & Lauermann, 2023; Moeller et al., 2022). Benden and Lauermann (2023) examined using RI-CLPM within-person variations in the connections between students' course-specific (summative) or week-specific (situated) expectancies and task values in gateway maths courses for students studying maths, physics or maths teacher education. The findings showed that during a semester, there was an increasing within-person alignment between students' course-specific expected success and intrinsic/utility values (but not cost), according to RI-CLPMs. Unidirectional spillover—or cross-lagged—effects from expectancy to intrinsic/utility values were associated with this alignment. The study by Moeller et al. (2022) investigated using a multilevel CLPM whether task values, cost and success expectancies, measured in a learning situation (time point t) during a weekly university lecture, predicted each other and themselves in the subsequent situation (t + 1; 27 min later). They could not identify any significant cross-lagged effects from one situation to the next in any of the measured situated expectancy-value components. As both studies were based on a sample of university students, it was difficult to draw conclusions about adolescent students and the school context.

Overall, while previous research has consistently indicated a positive association between task motivation and academic self-concept, which strengthens with age (Jacobs et al., 2002; Vinni-Laakso et al., 2019; Wigfield et al., 1997), there is no clear evidence of how students' academic self-concept and task values develop and associate with one another over the span from middle to late adolescence and during school transitions and of how within-person fluctuations (temporal deviations) can be separated from stable between-person differences (stable trait factors). The present study aims to shed light on these associations by considering tree measurement waves (grades 9, 10 and 12), two domains (math and literacy), various school types before and after the transition and both within- and between-person differences.

1.2. The role of school type

An important gap in the existing literature on the developmental dynamics between the self-concept of ability and task values is the scant information on the effect of moderating contextual factors. SEVT (Eccles & Wigfield, 2020, 2023) incorporates the key proposition in stage–environment fit theory that emphasises the role of the context. There is evidence of a high likelihood of a negative impact of school transitions on adolescent students' motivational beliefs (Eccles et al., 1993; Rosenzweig et al., 2019). To our knowledge, no studies have focused on school transition in middle adolescence (from lower secondary to further education) and the differences among students attending vocational and academic tracks. The examination of the motivational development of students attending different school types is of key interest in the present study.

In Finland, basic education (grades 1 to 9) does not involve selection, tracking or streaming (Antikainen & Luukkainen, 2008). After 9th grade, students apply either for general upper secondary school (3-year academic track, providing the basis for further education at universities/polytechnics) or vocational education (vocational track, after which adolescents proceed with work life). A person-orientated subgroup analysis conducted approximately a decade ago (Viljaranta et al., 2009) suggested that students who aim for a vocational track are more likely to belong to profiles characterised as ‘practical skills and language–motivated’ or ‘practical skills–motivated’, while those who aim for an academic track are more likely to belong to profiles characterised as ‘multimotivated’ or ‘maths and science–motivated’. Based on SEVT, students' motivational beliefs are formed during their school careers, so students who attend general upper secondary schools and vocational schools may differ in their motivational beliefs prior to the school transition. However, this assumption has not yet been investigated.

Furthermore, of interest is the interplay of different dimensions of SEVT in the course of the three years of secondary education, considering different school tracks after the 9th grade. It is possible that for students in vocational schools, more significant cross-lagged pathways from utility value to the other components can be identified, since instruction is specifically geared to future professions (Finnish National Agency of Education, 2018). One could also assume that the associations between the constructs for general upper secondary school students show the same patterns at T1 (grade 9) and T2 (grade 10), as well as between T2 (grade 10) and T3 (grade 12), since the learning environment and instructional design do not differ much. In turn, for students from vocational schools, differences can be assumed between T1 and T2 in comparison to T2 and T3.

1.3. The current study

The purpose of this study is to address intra- and interindividual heterogeneity, state–trait relations and specific learning environments (e.g. different school and classroom settings) in the development of academic self-concept and task values (cf. Moeller et al., 2022). In detail, it empirically examines the development of academic self-concept and three task values in two subjects (literacy and mathematics), different grades (grades 9, 10 and 12) and different school types (joint comprehensive schools in grade 9, general upper secondary schools vs. vocational schools in grades 10 and 12), considering both the within-person variations (temporal variances) and the stable between-person differences (stable trait factors). Traditional cross-lagged panel models used in previous studies (e.g. Arens et al., 2019; Chung & Kim, 2022) were not able to differentiate between the between-person and the within-person effects (Berry & Willoughby, 2017; Hamaker et al., 2015; Mund & Nestler, 2019). Therefore, it is unclear what kinds of effects (within-person or between-person) these panels actually explored. It has recently been argued that between-person associations may only (fully) converge with within-person associations under specific circumstances (e.g. in terms of the presence, magnitude and sign of detected effects) and that investigating both types of associations may provide illuminating but conceptually distinct insights (e.g. Fisher et al., 2018; Hamaker et al., 2015; see Kryshko et al., 2022; Murayama et al., 2017; Orth et al., 2021) To overcome the shortcomings of the traditional CLPM, we use the longitudinal random intercept cross-lagged panel model (RI-CLPM) approach to explore both the within-person and between-person effects and find answers to the following research questions (RQs) and hypotheses (Hs):

(RQ1a) Are differences between individual students' academic self-concepts in literacy and mathematics associated with differences in their task values (between-person level)?

(H1a) There are between-person associations between success expectancies and task values. For example, it is expected that students with higher scores in academic self-concepts may also have higher scores in task values.

(RQ1b) Are differences between the task values of individual students in literacy and mathematics associated with differences in their other task values (between-person level)?

(H1b) There are between-person associations between the different task values. It is expected, for example, that students with higher scores in attainment value may also have higher scores in intrinsic value. The study by Trautwein et al. (2012) showed that the values themselves differ in their nature; while attainment value and intrinsic value define ‘intrinsic’ values, utility value and cost constitute ‘extrinsic’ factors.

(RQ2) To what extent are academic self-concept and task values in literacy and mathematics associated with each other at the within-person level over time (cross-lagged associations)?

(H2) There are within-person associations between the different components of success expectancies and task values. It might be possible for a person to change their appreciation of a particular task over time, for example, as they experience success or become more deeply involved in the topic.

(RQ3) Are individuals' deviations from their expected scores in all four variables (academic self-concept and the three task values) likely to carry over from one measurement wave to the next (autoregressive associations)?

(H3) There are carryover effects on students' academic self-concept and task values over time, such as an individual's changes in academic self-concept having a cumulative effect on their academic self-concept development. In other words, students who have scored above (or below) their average scores also tend to have scores above (or below) their average at the subsequent time point.

Whether group differences between students attending general upper secondary education or vocational education exist in lagged regression coefficients can be thought of as moderation or interaction effects, which can be investigated by a multiple-group version of the RI-CLPM, as suggested by Mulder and Hamaker (2021).

2. Methods

2.1. Transparency and openness

In this section, we indicate how the data were collected and the schools recruited, as well as all data exclusions (if any) and all measures in the study. We followed JARS (Kazak, 2018). All data, analysis codes, and research materials are available upon request. The data were analysed using Mplus 8.8 (Muthén & Muthén, 1998–2015). The current study design and analyses were not preregistered on any specific platform.

2.2. Sample and procedure

The sample (N = 3636; M_{age} at the outset = 15.73 years, SD = 0.32 years; 54.5 % female; $n_{vocational}$ = 1669; n_{upper} = 1967) was drawn from the comprehensive longitudinal X1 (*removed for review purposes*) study and its extension, X2 (*removed for review purposes*). In the X1 study, approximately 2000 students were followed from kindergarten to the end of lower secondary school (grade 9). In X2, the participants and their classmates (N = 3636) were followed during upper secondary education. The participating students came from four municipalities (two medium-sized, one big and one rural) in different parts of Finland. At the start of the present study (9th grade; final year of comprehensive school), the students attended 34 lower secondary schools. After the transition (from lower secondary school to upper secondary education), the students attended 72 different upper secondary education institutions (36 general upper secondary schools and 36 vocational schools).

The Ethical Committee of the University of X3 (*removed for review purposes*) approved the study and the research design in 2006 and 2018. Before collecting data at the lower secondary schools, written consent was collected from parents or guardians. In upper secondary education, the participating students confirmed their voluntary participation in the study. Classroom-administered questionnaires were used for data collection on normal school days by trained research assistants or teachers during three waves: spring 2016 (Time 1, T1, 9th grade of lower secondary school), spring 2017 (Time 2, T2, the first year of upper secondary education), and spring 2019 (Time 3, T3, the final year of upper secondary education). In Finland, school transition takes place after the 9th grade. According to Finnish educational statistics (Official Statistics of Finland, 2021), 54 % of Finnish students continue studying in general upper secondary schools and 40 % choose vocational schools, while other options are rare. The normative time to complete upper secondary education lasts three years.

2.2.1. Academic self-concept

To assess students' academic self-concept, scales developed by Eccles and Wigfield (1995) and Spinath and Steinmayr (2008) were used. The scale used to assess academic self-concept in mathematics consists of two questions ('How good are you at mathematics?' and 'How good are you at mathematics compared to other students in your group?'). For each measurement point, a composite score was calculated as the mean of the items measuring the construct. The Cronbach reliability coefficients were good for both the whole sample and the subsamples (α = 0.87 to 0.92). The scale used to assess students' academic self-concept in literacy consists of two questions ('How good are you in your mother tongue?' and 'How good are you in your mother tongue compared to other students in your group?'). For each measurement point, a composite score was calculated by computing the mean of the items. The scale showed good reliability for both the whole sample and the subsamples (α = 0.80 to 0.89). The students responded using a five-point Likert scale (1 = 'poor/not very good' to 5 = 'very good').

2.2.2. Task values

Based on an adapted version of the scale developed by Eccles et al. (1983), the three task values (i.e. attainment, intrinsic and utility value) were assessed with two items for each dimension of task value. The items were as follows: attainment values in mathematics and literacy (e.g. 'How important is it for you that you do well in mathematics/literacy?' and 'How important is it for you to get good grades in mathematics/literacy?'), intrinsic values in mathematics and literacy (e.g. 'How much do you like mathematics/literacy in school?' and 'How readily do you do mathematics/literacy?') and utility values in mathematics and literacy (e.g. 'How useful with regard to your future plans do you consider mathematics/literacy?' and 'How useful are the following school subjects in your daily life?'). The students responded using a five-point Likert scale (1 = 'not at all…' to 5 = 'very… much/readily/important/useful'). A composite score was calculated separately for the attainment, intrinsic and utility values for each measurement point as the mean of the items measuring the constructs. The reliability of each measurement point for both the whole sample and the two subsamples was acceptable for attainment values (literacy: α = 0.81 to 0.94; mathematics: α = 0.88 to 0.91), intrinsic values (literacy: α = 0.79 to 0.85; mathematics: α = 0.88 to 0.90) and utility values (literacy: α = 0.74 to 86; mathematics: α = 0.67 to 0.81).

2.3. Statistical analysis

All statistical analyses were conducted with Mplus 8.8 using the robust maximum likelihood (MLR) estimator with robust standard errors, which is considered robust to nonnormality (Muthén & Muthén, 1998–2015). Initially, descriptive statistics were calculated and measurement invariance for all SEVT constructs was tested over three steps to check whether the magnitudes of the item factor loadings and intercepts were consistent over time (configural, metric and scalar measurement invariance). Measurement invariance was approved when applying equality constraints to the item factor loadings and intercepts did not substantially deteriorate model fit in terms of change in Comparative Fit Index (ΔCFI = decrease of $\leq$0.010) and Root Mean Square Error of Approximation (ΔRMSEA = increase of $\leq$0.015; Chen, 2007). To examine longitudinal associations from T1 to T2 and from T2 to T3, we conducted multiple-group random-intercept cross-lagged panel models (RI-CLPM). Both the data and study material are not available in any open source but can be accessed by contacting the authors.

2.4. Multiple-group random-intercept cross-lagged panel model

Two cross-lagged panel models were fitted to assess the extent to which academic self-concept and task values (for mathematics and literacy, separately) predicted each other at each time point. An autoregressive cross-lagged panel model can identify potential causal associations between variables over time, controlling for the autoregressive influence of each variable over time (Kenny, 1975). However, the traditional autoregressive cross-lagged panel model approach has been criticised for not adequately considering within- and between-person associations (Berry & Willoughby, 2017; Hamaker et al., 2015; Mund & Nestler, 2019). We conducted RI-CLPM, which allowed us to consider both the dynamic changes within an individual (within-person process) and the stable differences between individuals (stable between-person differences) by including random intercepts, leading to more accurate estimations of changes over time (Hamaker et al., 2015). In doing so, each construct was split into a constant between-student component and a variable within-student component. The values that represent how much the variables influence one another within students are thus understood as cross-lagged effects (see Fig. 1).

Four overarching random intercept factors—one for each measure—were incorporated to reflect persistent trait-like differences across students in academic self-concept, attainment value, intrinsic value and utility value. The four random intercept factors showed the trait characteristics of task values and academic self-concepts across time. With all factor loadings limited to 1, the three observed scores for each time point served as indicators of each random intercept. Regressing each observed score on its own latent factor allowed us to identify within-student variability. The latent variables were then utilised to specify within-time associations, autoregressive paths and cross-lagged paths (i.e. one for each construct for each of the three measurement waves). The extent to which within-person deviations from predicted scores in one variable might predict later within-person deviations from expected scores in the same variable (i.e. carryover effects) was shown by the autoregressive effects. The cross-lagged effects, which revealed the extent to which a within-person deviation from the expected score in one variable could predict a subsequent change in the within-person deviation from the expected score in the other variable, and vice versa (i.e. spillover effects), while controlling for autoregressive effects, referred to the potential reciprocal associations between the four variables within individuals over time (see Kryshko et al., 2022). The within-person and between-person latent factor structures were able to account for all variations in the observed measures, since the error variances of the observed scores were restricted to zero.

To test whether there were substantial differences in the lagged regression coefficients between students from general upper secondary schools and students from vocational schools, a multiple-group approach was followed. This approach enables the detection of group differences in lagged regression coefficients as moderation or interaction effects (Mulder & Hamaker, 2021). More precisely, a multiple-group RI-CLPM with no constraints across the groups is compared to a model in which the lagged regression coefficients are constrained to be identical across the groups. Using the chi-square difference test, it can be identified whether (some of) the lagged coefficients differ across the groups (Mulder & Hamaker, 2021). However, because the interpretation of differences simply based on significant vs. non-significant chi-square differences from the unconstrained model is highly inaccurate, since it only tests if there are differences in the complete models but not in single paths, we additionally conducted the Wald test for each path between both groups.

To indicate the model fit of each structural equation model, the following parameters were considered (e.g. Hu & Bentler, 1999; West et al., 2012): in addition to the χ^2 statistic, which is sensitive to sample size (Kline, 2016), we used the comparative fit index (CFI), the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR).

2.5. *Missing data*

Initially, students with missing values on the school form variable were excluded from the study ($n = 674$). In other words, there were no missing values on school form (0 %). Furthermore, Mplus excluded missing cases for all variables ($n = 26$). In the remaining cases ($n = 3636$), the percentage of missing data (item level) varied between 13.3 % (e.g. utility value at T2) and 55.5 % (e.g. utility value in literacy at T3), which resulted from $n = 1998$ incomplete cases. The most prominent missing data pattern resulted from those students who did not participate in all three waves of data collection. That is, the T2 sample consisted of participants of the X1 study and their new classmates; therefore, the sample size at T2 was larger than at T1. Moreover, we focused on students who entered either vocational or general upper secondary schools after comprehensive school; thus, approximately 6 % of students who made some other choice were excluded from the study. Not all students completed upper secondary education, with some

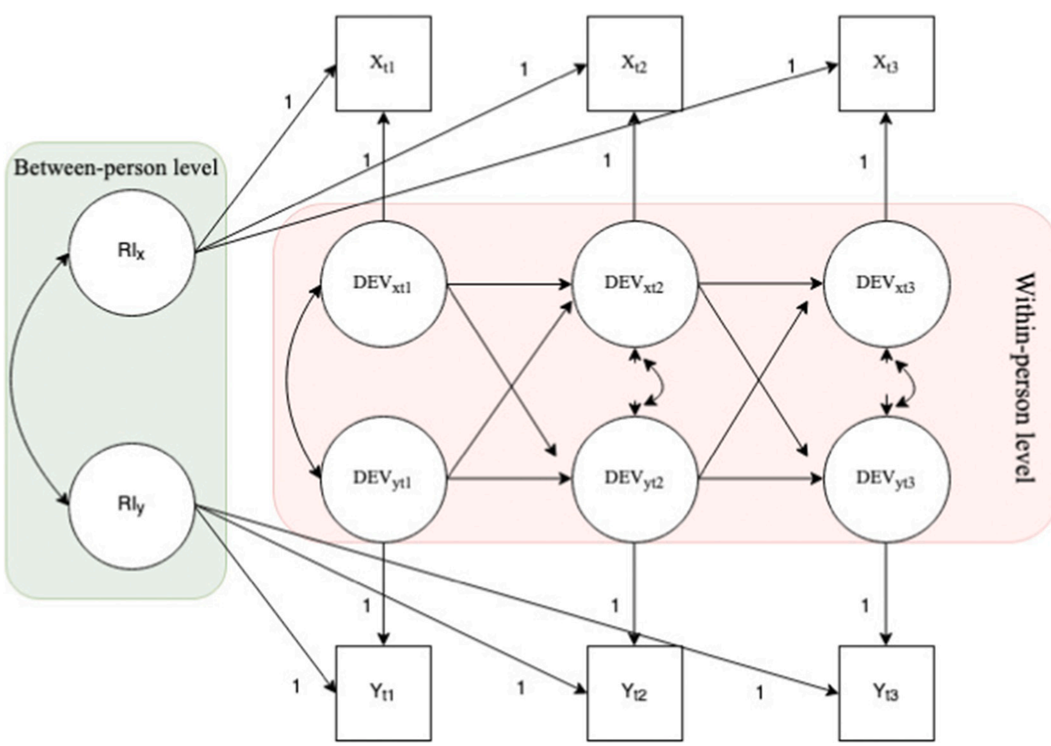

Fig. 1. A graphical Representation of a bivariate, three-wave Random Intercept Cross-Lagged Panel Model (RI-CLPM).
Note. Adapted from "A Critique of the Cross-Lagged Panel Model," by E. L. Hamaker, R. M. Kuiper, & R. P. P. P. Grasman, 2015, Psychological Methods, 20(1), pp. 102–116 (https://doi.org/10.1037/a0038889). Copyright 2015 by the American Psychological Association.

dropping out of school between T2 and T3. Due to the partly missing values, we followed the recommendation of handling missing values with the full information maximum likelihood (FIML) approach. FIML is well equipped for addressing even large amounts of missing data (>50 %) with minimal bias (Enders & Bandalos, 2001; Newsom, 2018). As this approach is based on the missing at random assumption, Little's missing completely at random (MCAR) test was conducted to confirm the MCAR condition for the literacy items ($\chi^2(78) = 98.40$; $p > .05$) and the maths items ($\chi^2(78) = 74.07$; $p > .05$). Previous research has revealed that FIML tends to yield unbiased parameter estimates when the type of missingness is either MCAR or MAR (Enders & Bandalos, 2001).

3. Results

3.1. Descriptive statistics

The bivariate correlations, means (Ms) and standard deviations (SDs) of the study variables are shown in Table A1 and Table A2 of the Appendix. The results of the measurement invariance testing are shown in Table A3 of the Appendix. Full scalar invariance over groups and waves is given for the literacy model and partial scalar invariance over groups and waves is given for the maths model.

3.2. Multiple-group random-intercept cross-lagged panel model

3.2.1. Literacy RI-CLPM

To test whether the reciprocal effects between academic self-concept and task values in literacy were the same for students in general upper secondary schools versus students in vocational schools, a multiple-group analysis was performed. First, a multiple-group RI-CLPM for literacy without constraints across the groups was computed. The model fit was good ($\chi^2(12) = 12.35$, $p > .05$; CFI = 1.00, RMSEA = 0.00 (0.00–0.02); SRMR = 0.01). Subsequently, a model in which lagged parameters are invariant across groups was run, which also showed acceptable fit indices ($\chi^2(44) = 50.44$, $p > .05$; CFI = 1.00, RMSEA = 0.01 (0.00–0.02); SRMR = 0.02). The chi-square difference test of these two nested models yielded $\Delta\chi2(32) = 38.09$ ($p > .05$), which implied that imposing the constraints was tenable, with the lagged effects for students from different school types appearing to be the same (Mulder & Hamaker, 2021). However, using the Wald test to compare each path in the model between the two groups subsequently, we could identify the following four paths in the model that should allow for freedom between both groups (calculating the effect size with Cohen's d): the autoregressive path from self-concept at T1 to self-concept at T2 ($\chi^2(1) = 9.64$, $p = .002$; $d = 0.04$), the autoregressive path from self-concept at T2 to self-concept at T3 ($\chi^2(1) = 4.34$, $p = .037$; $d = 0.50$), the cross-lagged path from interest value at T1 to utility value at T2 ($\chi^2(1) = 3.94$, $p = .047$; $d = 0.31$) and the autoregressive path from utility value at T2 to utility value at T3 ($\chi^2(1) = 7.07$, $p = .008$; $d = 0.62$). Accordingly, we allowed these four paths to be freely estimated in the final constrained model, which showed a good model fit ($\chi^2(40) = 49.90$, $p > .05$; CFI = 1.00, RMSEA = 0.01 (0.00–0.02); SRMR = 0.02).

3.2.1.1. Between-person associations (testing Hypotheses H1a and H1b). All between-person associations between all four variables were positively significant for both students in general upper secondary schools and students in vocational schools, representing stable, between-person levels of academic self-concept and all three task values. This means that, on average, students who had a higher academic self-concept overall in literacy also experienced higher levels of all three task values (and vice versa) than students who had a lower academic self-concept (H1a was confirmed). Further, on average, students who had one task value higher in literacy also had the other two values (and academic self-concept) higher than students who had lower task values (H1b was confirmed; see Table 1).

Table 1
Between-person associations and within-person within-time associations of the constrained multigroup RI-CLPMs in literacy with four paths free.

	Students from general upper secondary schools		Students from vocational schools	
	$r_{ust.}$	$r_{std.}$	$r_{ust.}$	$r_{std.}$
Between-person associations (covariances/correlations between the RI factors)				
RI-SC ⇔ RI-AV	0.17***	0.82***	0.15**	0.66***
RI-SC ⇔ RI-IV	0.14**	0.64***	0.12*	0.72***
RI-SC ⇔ RI-UV	0.12**	0.52***	0.11*	0.50***
RI-AV ⇔ RI-IV	0.16**	0.72***	0.23***	0.88***
RI-AV ⇔RI-UV	0.15***	0.63***	0.24***	0.72***
RI-IV ⇔ RI-UV	0.14*	0.55***	0.18**	0.70***
Within-person within-time associations				
SC t1 ⇔ AV t1	0.14***	0.37***	0.15**	0.43***
SC t1 ⇔ IV t1	0.25***	0.48***	0.23***	0.49***
SC t1 ⇔ UV t1	0.14***	0.30***	0.12*	0.27**
AV t1⇔ IV t1	0.25***	0.47***	0.24***	0.49***
AV t1 ⇔ UV t1	0.25***	0.49***	0.21***	0.44***
IV t1 ⇔ UV t1	0.33***	0.50***	0.29***	0.44***
SC t2 ⇔ AV t2	0.11***	0.34***	0.17***	0.39***
SC t2 ⇔ IV t2	0.21***	0.54***	0.22***	0.45***
SC t2 ⇔ UV t2	0.08**	0.23***	0.15***	0.33***
AV t2⇔ IV t2	0.31***	0.63***	0.41***	0.72***
AV t2 ⇔ UV t2	0.28***	0.60***	0.41***	0.75***
IV t2 ⇔ UV t2	0.27***	0.51***	0.40***	0.67***
SC t3 ⇔ AV t3	0.16***	0.40***	0.12***	0.27***
SC t3 ⇔ IV t3	0.21***	0.48***	0.16***	0.36***
SC t3 ⇔ UV t3	0.14***	0.33***	0.12***	0.28***
AV t3⇔ IV t3	0.28***	0.52***	0.39***	0.64***
AV t3 ⇔ UV t3	0.28***	0.56***	0.32***	0.55***
IV t3 ⇔ UV t3	0.25***	0.47***	0.30***	0.49***

Note. RI = Random Intercept factor; SC = self-concept; AV = attainment value; IV = intrinsic value; UV = utility value; t1 = Time1; t2 = Time2; t3 = Time3.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

3.2.1.2. Within-person associations (testing Hypotheses H2 and H3). Table 1 reports the 'state-like' within-person associations (correlations) within a given time point between academic self-concept and task values in literacy for students from both general upper secondary schools and vocational schools.

Table 2 reports the within-person auto-regressive (H3) and cross-lagged associations (H2) between academic self-concept and task values in literacy for students from both general upper secondary and vocational schools over time.

Based on testing H2, the following cross-lagged effects were found to be significant. Students who perceived a higher (lower) utility value (relative to their own means) at each measurement wave were likely to perceive an increase (decrease) in intrinsic value from T1 (grade 9) to T2 (grade 10) as well as an increase (decrease) in attainment value from T1 (grade 9) to T2 (grade 10) and from T2 (grade 10) to T3 (grade 12) in relation to their expected scores. There was also a positive cross-lagged effect from intrinsic value to academic self-concept and attainment value from the first to the last year of upper secondary school, indicating that students who perceived higher (lower) intrinsic value in relation to their expected scores were likely to perceive a subsequent increase (decrease) in their academic self-concept and attainment value in relation to their expected scores. In turn, students with higher (lower) academic self-concept at T2 (grade 10) were likely to report higher (lower) intrinsic value from T2 (grade 10) to T3 (grade 12). The results partially confirmed H2. The significant auto-regressive and (cross-)lagged associations between the within-person values of the measures from the RI-CLPM for literacy are shown in Fig. 2.

Based on testing H3, both student groups differed significantly in the autoregressive paths of academic self-concept, which reflected the amount of within-person carryover effect, although Cohen's d was low

Table 2
Estimates for the constrained RI-CLPM in literacy with four paths hold free between groups.

	Unstandardized estimates equally constrained across both groups			Standardized estimates for students in general upper secondary schools			Standardized estimates for students in vocational schools			
	B	*SE B*	*p*	ß	*SE* ß	*p*	ß	*SE* ß	*p*	*Cohen's d*
SC t1 → SC t2* GU	0.21	0.09	<. 05	0.24	0.10	< 0.05	–	–	–	0.04
SC t1 → SC t2* VO	0.21	0.16	> 0.05	–	–	–	0.19	0.15	> 0.05	
SC t2 → SC t3* GU	0.38	0.10	< 0.001	0.32	0.09	< 0.001	–	–	–	0.50
SC t2 → SC t3* VO	0.43	0.10	< 0.001	–	–	–	0.42	0.09	< 0.001	
AV t1 → AV t2	0.07	0.09	> 0.05	0.06	0.09	> 0.05	0.05	0.07	> 0.05	
AV t2 → AV t3	0.14	0.08	> 0.05	0.12	0.07	> 0.05	0.13	0.07	> 0.05	
IV t1 → IV t2	0.21	0.08	< 0.01	0.21	0.08	< 0.01	0.20	0.08	< 0.01	
IV t2 → IV t3	0.32	0.09	< 0.001	0.31	0.08	< 0.001	0.30	0.08	< 0.001	
UV t1 → UV t2	0.16	0.06	< 0.05	0.18	0.07	< 0.01	0.17	0.07	< 0.01	
UV t2 → UV t3* GU	0.17	0.08	< 0.05	0.16	0.08	< 0.05	–	–	–	
UV t2 → UV t3* VO	0.13	0.04	> 0.05	–	–	–	0.13	0.11	> 0.05	0.62
SC t1 → AV t2	0.01	0.08	> 0.05	0.01	0.07	> 0.05	0.01	0.06	> 0.05	
SC t1 → IV t2	0.16	0.09	> 0.05	0.12	0.07	> 0.05	0.11	0.07	> 0.05	
SC t1 → UV t2	0.06	0.08	> 0.05	0.05	0.07	> 0.05	0.05	0.06	> 0.05	
SC t2 → AV t3	0.07	0.08	> 0.05	0.05	0.06	> 0.05	0.05	0.06	> 0.05	
SC t2 → IV t3	0.22	0.09	< 0.05	0.14	0.06	< 0.05	0.15	0.06	< 0.05	
SC t2 → UV t3	0.16	0.09	> 0.05	0.11	0.07	> 0.05	0.12	0.07	> 0.05	
AV t1 → SC t2	−0.07	0.07	> 0.05	−0.08	0.08	> 0.05	−0.06	0.06	> 0.05	
AV t1 → IV t2	0.04	0.06	> 0.05	0.00	0.07	> 0.05	0.00	0.06	> 0.05	
AV t1 → UV t2	0.06	0.08	> 0.05	0.05	0.07	> 0.05	0.04	0.06	> 0.05	
AV t2 → SC t3	−0.03	0.06	> 0.05	−0.03	0.06	> 0.05	−0.03	0.07	> 0.05	
AV t2 → IV t3	0.00	0.09	> 0.05	−0.00	0.07	> 0.05	−0.00	0.07	> 0.05	
AV t2 → UV t3	0.13	0.09	> 0.05	0.11	0.08	> 0.05	0.11	0.08	> 0.05	
IV t1 → SC t2	0.08	0.05	> 0.05	0.13	0.08	> 0.05	0.11	0.07	> 0.05	
IV t1 → AV t2	0.04	0.06	> 0.05	0.04	0.07	> 0.05	0.04	0.07	> 0.05	
IV t1 → UV t2 * GU	0.02	0.06	> 0.05	0.02	0.07	> 0.05	–	–	> 0.05	0.31
IV t1 → UV t2 * VO	0.00	0.07	> 0.05	–	–	–	0.00	0.08	> 0.05	
IV t2 → SC t3	0.12	0.06	< 0.05	0.15	0.07	< 0.05	0.16	0.07	< 0.05	
IV t2 → AV t3	0.14	0.07	< 0.05	0.15	0.07	< 0.05	0.14	0.07	< 0.05	
IV t2 → UV t3	0.03	0.08	> 0.05	0.04	0.08	> 0.05	0.03	0.08	> 0.05	
UV t1 → SC t2	0.03	0.05	> 0.05	0.05	0.07	> 0.05	0.05	0.06	> 0.05	
UV t1 → AV t2	0.16	0.05	< 0.01	0.18	0.06	< 0.01	0.17	0.06	< 0.01	
UV t1 → IV t2	0.14	0.06	< 0.05	0.13	0.06	< 0.05	0.13	0.06	< 0.05	
UV t2 → SC t3	0.02	0.05	> 0.05	0.02	0.06	> 0.05	0.02	0.06	> 0.05	
UV t2 → AV t3	0.19	0.06	< 0.01	0.18	0.06	< 0.01	0.18	0.06	< 0.01	
UV t2 → IV t3	0.12	0.07	> 0.05	0.10	0.06	> 0.05	0.11	0.06	> 0.05	

Note. SC = self-concept; AV = attainment value; IV = intrinsic value; UV = utility value; t1 = Time1; t2 = Time2; t3 = Time3; GU = general upper secondary schools; VO = vocational schools; numbers in bold = significant $p < .05$; B = unstandardized values; ß = standardized values.
* Path hold free between both groups based on results of the Wald test.

($d = -0.04$) between T1 and T2 and moderate between T2 and T3 ($d = -0.50$). While for students from general upper secondary schools, all autoregressive paths of academic self-concept were significant, for students from vocational schools, only the autoregressive path between T2 and T3 was statistically significant. This suggests carryover effects and that individual changes in academic self-concept have a cumulative effect on students' academic self-concept development. In other words, students from general upper secondary schools who scored above (or below) their average scores also tended to have scores above (or below) their average at the next time point. For students from vocational schools, this effect was only found from T2 to T3, when they changed to vocational schools. The non-significant autoregressive paths from academic self-concept between T1 and T2 and from utility value between T2 and T3 indicated higher randomness, as a change at the latter time point cannot be predicted by a change at the previous time point. All autoregressive paths of attainment value development were non-significant (contrary to H3), while all autoregressive paths of intrinsic value development were significant (confirming H3). That is, there seemed to be more flexibility in the development of attainment value, while changes in intrinsic value continuously affected changes in its development. This may also be explained by the fact that the practical orientation of teaching at vocational schools is more different from teaching at lower secondary schools (than at upper secondary schools), and this is more likely to lead to a 'break' in the development of attainment value. As intrinsic value is anchored in the students themselves, it may not be as susceptible to external changes (e.g. change of school).

3.2.2. *Mathematics RI-CLPM*

To test whether the reciprocal effects between academic self-concept and task values in mathematics were the same for students in general upper secondary schools versus students in vocational schools, a multiple-group analysis was performed. First, a multiple-group RI-CLPM for mathematics without constraints across the groups was computed ($\chi^2(12) = 22.38$, $p < .05$; CFI = 1.00, RMSEA = 0.02 (0.01–0.04); SRMR = 0.02). Subsequently, a model in which lagged parameters are invariant across groups was run ($\chi^2(44) = 78.09$, $p < .05$; CFI = 1.00, RMSEA = 0.02 (0.01–0.03); SRMR = 0.03). The chi-square difference test of these two nested models yielded $\Delta\chi2(32) = 55.71$ ($p < .05$), which implied that the lagged effects of academic self-concept and task values in mathematics for students from general upper secondary schools versus students in vocational schools appeared not to be the same (Mulder & Hamaker, 2021). However, using the Wald test comparing each path in the model between the two groups subsequently, we could identify only three paths in the model, in which both groups significantly differed (calculating the effect size with Cohen's *d*): the autoregressive path from self-concept at T1 to self-concept at T2 ($\chi^2(1) = 18.65$, $p < .001$; $d = 0.83$), the autoregressive path from self-concept at T2 to self-concept at T3 ($\chi^2(1) = 5.37$, $p = .021$; $d = 1.37$) and the cross-lagged path from attainment value at T1 to self-concept at T2 ($\chi^2(1) = 6.12$, $p = .013$; $d = 2.33$). Accordingly, we allowed these three paths to be freely estimated in the final constrained model, which

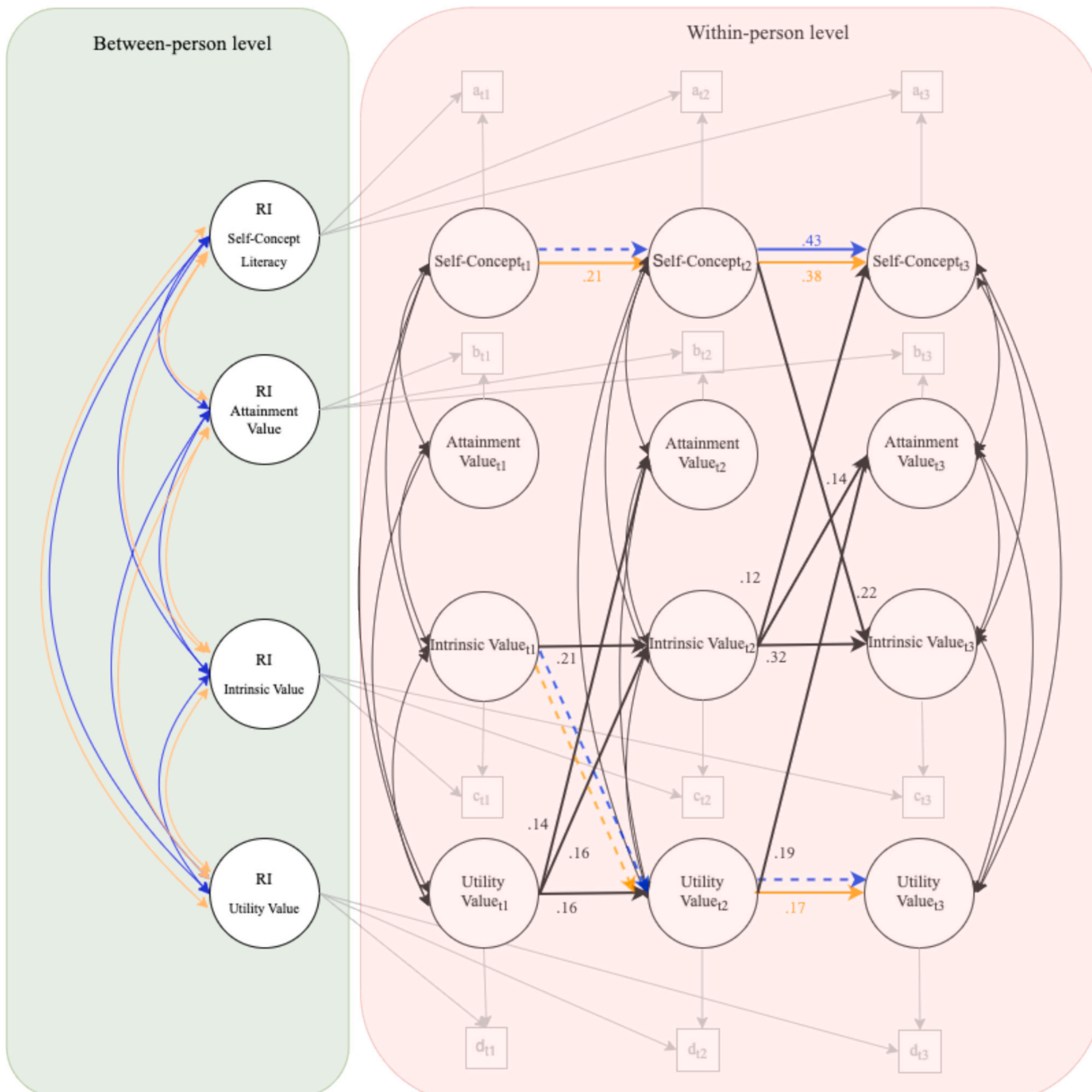

Fig. 2. Three-wave constrained Multigroup Random Intercept Cross-Lagged Panel Model (RI-CLPM) for Literacy with four lagged paths hold free between both groups.
Note. Significant unstandardized associations ($p < .05$) for the lagged paths from the constrained RI-CLPM for literacy among students from upper secondary schools and vocational schools. The standardized results are reported in Table 1 and Table 2. The figure displays only the significant auto-regressive and (cross-)lagged associations between the within-person values of the measures over time and the between-person associations between the random intercept factors of the measures as well as the within-person associations within time; non-significant associations were excluded for figure clarity except paths, in which both groups significantly differ; RI = Random Intercept (RIs were freely estimated between groups); colored lines: paths hold free between both groups (blue lines: students from general upper secondary schools; orange lines: students from vocational schools); dotted paths = not-significant. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

showed a good model fit ($\chi^2(41) = 69.63$, $p < .05$; CFI = 1.00, RMSEA = 0.02 (0.01–0.03); SRMR = 0.03).

3.2.2.1. Between-person associations (testing Hypotheses H1a and H1b). For students from general upper secondary schools, all between-person associations between all four random intercept variables were positively significant, representing stable between-person levels of academic self-concept and all three task values. This means that, on average, students from general upper secondary schools who had a higher academic self-concept overall in maths also experienced higher levels of all three task values (and vice versa) than students who had a lower academic self-concept (confirming H1a). Further, on average, students who had one task value higher in maths also had the other two values (and academic self-concept) higher compared to students who had lower task values (see Table 3) (confirming H1b).

For students from vocational schools, only three associations were positively significant (partially confirming H1a and H1b): those between academic self-concept and attainment value (H1a), academic self-

Table 3
Between-person associations and within-person within-time associations of the constrained multigroup RI-CLPMs in math with 3 paths free.

	Students from general upper secondary schools		Students from vocational schools	
	$r_{ust.}$	$r_{std.}$	$r_{ust.}$	$r_{std.}$
Between-person associations (covariances/correlations between the RI factors)				
RI-SC ⇔ RI-AV	0.26***	0.75***	0.20**	0.53***
RI-SC ⇔ RI-IV	0.37***	0.78***	0.34***	0.77***
RI-SC ⇔ RI-UV	0.15**	0.58***	0.10	0.42*
RI-AV ⇔ RI-IV	0.30***	0.79***	0.30***	0.87***
RI-AV ⇔RI-UV	0.13*	0.60***	0.11	0.58***
RI-IV ⇔ RI-UV	0.19**	0.69***	0.16	0.73***
Within-person within-time associations				
SC t1 ⇔ AV t1	0.19***	0.44***	0.21**	0.49***
SC t1 ⇔ IV t1	0.32***	0.53***	0.31***	0.61***
SC t1 ⇔ UV t1	0.25***	0.43***	0.25**	0.47*
AV t1⇔ IV t1	0.24***	0.50***	0.30**	0.52***
AV t1 ⇔ UV t1	0.29***	0.62***	0.39***	0.65***
IV t1 ⇔ UV t1	0.41***	0.62***	0.39***	0.54***
SC t2 ⇔ AV t2	0.18***	0.45***	0.17***	0.37***
SC t2 ⇔ IV t2	0.22***	0.53***	0.20***	0.42***
SC t2 ⇔ UV t2	0.18***	0.44***	0.17***	0.36***
AV t2⇔ IV t2	0.29***	0.56***	0.35***	0.61***
AV t2 ⇔ UV t2	0.31***	0.61***	0.39***	0.68***
IV t2 ⇔ UV t2	0.29***	0.54***	0.35***	0.60***
SC t3 ⇔AV t3	0.27***	0.53***	0.20***	0.43***
SC t3 ⇔ IV t3	0.30***	0.62***	0.25***	0.53***
SC t3 ⇔ UV t3	0.15***	0.33***	0.17***	0.33***
AV t3⇔ IV t3	0.39***	0.61***	0.37***	0.61***
AV t3 ⇔ UV t3	0.29***	0.48***	0.41***	0.64***
IV t3 ⇔ UV t3	0.25***	0.44***	0.34***	0.52***

Note. RI = Random Intercept factor; SC = self-concept; AV = attainment value; IV = intrinsic value; UV = utility value; t1 = Time1; t2 = Time2; t3 = Time3.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

concept and intrinsic value (H1a) and attainment value and intrinsic value (H1b). However, utility value was not significantly associated with academic self-concept or with the other two task values (contrary to H1a and H1b). This means that there were no significant between-person associations in terms of students' utility value in maths.

3.2.2.2. Within-person associations (testing Hypotheses H2 and H3). Table 3 reports the 'state-like' within-person associations (correlations) at a given time point between academic self-concept and task values in mathematics for students from both general upper secondary schools and vocational schools.

Table 4 reports the within-person auto-regressive (H3) and cross-lagged associations (H2) between academic self-concept and task values in mathematics for students from both general upper secondary schools and vocational schools over time.

Based on testing H2, there were significant positive cross-lagged effects of academic self-concept on both attainment and intrinsic values, which indicated that individuals who perceived higher (lower) levels of academic self-concept in relation to their own expected scores were likely to experience a subsequent increase (decrease) in both attainment and intrinsic value in relation to their expected scores after controlling for autoregressive effects. The cross-lagged effects in the other direction were only statistically significant from attainment value at T1 (grade 9) to academic self-concept for students in general upper secondary schools. This path was negative, indicating that individuals from general upper secondary schools who experienced higher (lower) levels of attainment value in relation to their own expected scores were likely to subsequently report lower (higher) academic self-concept. However, a model in which only academic self-concept and attainment value were included showed no significant effect on this path, suggesting a multicollinearity issue.

In addition, there was a significant positive cross-lagged effect from intrinsic value at T2 (grade 10) to academic self-concept at T3 (grade 12) for both student groups, indicating that students who perceived higher (lower) intrinsic value in relation to their expected scores were likely to perceive a subsequent increase (decrease) in their academic self-concept in relation to their expected scores, after controlling for autoregressive effects. There was also a positive reciprocal relationship, at least in part, between the development of academic self-concept and utility value. Students who perceived higher (lower) levels of utility value in relation to their own expected scores were likely to experience a subsequent increase (decrease) in their academic self-concept in relation to their expected scores after controlling for autoregressive effects. The reciprocal effect from academic self-concept to utility value was only found to be statistically significant between T1 (grade 9) and T2 (grade 10). Furthermore, students who perceived higher (lower) levels of utility value in relation to their own expected scores were likely to experience a subsequent increase (decrease) in their attainment (at T2 and T3) and intrinsic value (at T2) in relation to their expected scores after controlling for autoregressive effects. The significant auto-regressive and (cross-)lagged associations between within-person values of the measures from the RI-CLPM for mathematics and students from general upper secondary schools are shown in Fig. 3. The results partially confirmed H2.

Based on testing H3, both student groups differed significantly in the autoregressive paths of academic self-concept from T1 to T2 ($d = 0.83$) and from T2 to T3 ($d = 1.37$) that reflect the amount of within-person carryover effect. Again, while for students from general upper secondary schools, all autoregressive paths of academic self-concept were significant (confirming H3), for students from vocational schools, only the autoregressive path between T2 and T3 was statistically significant (partially confirming H3). This suggests carryover effects and that individual changes in academic self-concept have a cumulative effect on students' academic self-concept development. In other words, students from general upper secondary schools who scored above (or below) their average scores tended also to score above (or below) their average scores at the next time point. For students from vocational schools, this effect was found only from T2 to T3, when they changed to vocational schools. The non-significant autoregressive paths from academic self-concept between T1 and T2 for students in vocational schools indicated that higher randomness as a change at the latter time point cannot be predicted by a change at the previous time point, which is possibly also a result of the school transition, since the changes between lower secondary schools and vocational schools are more fundamental (than between lower and upper secondary schools). In line with this, all autoregressive paths of attainment value development were non-significant. However, all autoregressive paths of utility value development were significant, meaning that the utility of mathematics tended to develop continuously among students across the school transition. The autoregressive paths of the intrinsic value were non-significant between T1 and T2, indicating that individual students' deviations from their expected scores in intrinsic value were not likely to carry over from the first measurement wave to the next (i.e. through the school transition). However, this autoregressive path was found to be statistically significant between T2 and T3. This indicates that the fluctuation from the overall level in intrinsic value at T3 is predicted by a similar difference from the overall level at T2, when students are in separate school types.

4. Discussion

Based on SEVT, which highlights the situated nature in the development of academic self-concept and task values, this study aimed to explore both the within-person fluctuations (temporal deviations) and stable between-person differences (stable trait factors) in the development of academic self-concept and task values over time in mathematics and literacy during middle to late adolescence in grades 9, 10 and 12.

Table 4
Estimates for the constrained RI-CLPM in math with three paths hold free between groups.

	Unstandardized estimates			Standardized estimates for students in general upper secondary schools			Standardized estimates for students in vocational schools			
	B	*SE B*	*p*	ß	*SE* ß	*p*	ß	*SE* ß	*p*	*Cohen's d*
SC t1 → SC t2[*] GU	0.28	0.07	< 0.001	0.33	0.07	< 0.001	–	–	–	0.83
SC t1 → SC t2[*] VO	0.17	0.18	> 0.05	–	–	–	0.15	0.16	> 0.05	
SC t2 → SC t3[*] GU	0.21	0.09	< 0.05	0.19	0.08	< 0.05	–	–	–	1.37
SC t2 → SC t3[*] VO	0.34	0.10	< 0.01				0.33	0.10	< 0.01	
AV t1 → AV t2	−0.10	0.15	> 0.05	−0.08	0.11	> 0.05	−0.08	0.12	> 0.05	
AV t2 → AV t3	0.11	0.07	> 0.05	0.09	0.06	> 0.05	0.10	0.07	> 0.05	
IV t1 → IV t2	0.10	0.09	> 0.05	0.10	0.08	> 0.05	0.10	0.09	> 0.05	
IV t2 → IV t3	0.36	0.07	< 0.001	0.33	0.07	< 0.001	0.33	0.07	< 0.001	
UV t1 → UV t2	0.42	0.07	< 0.001	0.40	0.07	< 0.001	0.41	0.07	< 0.001	
UV t2 → UV t3	0.31	0.08	< 0.001	0.31	0.08	< 0.001	0.29	0.08	< 0.001	
SC t1 → AV t2	0.25	0.07	< 0.001	0.23	0.06	< 0.001	0.18	0.05	< 0.01	
SC t1 → IV t2	0.26	0.07	< 0.001	0.23	0.07	< 0.001	0.19	0.06	< 0.01	
SC t1 → UV t2	0.13	0.06	< 0.05	0.11	0.05	< 0.05	0.09	0.04	< 0.05	
SC t2 → AV t3	0.20	0.07	< 0.01	0.13	0.05	< 0.01	0.15	0.05	< 0.01	
SC t2 → IV t3	0.20	0.08	< 0.01	0.14	0.05	< 0.01	0.15	0.06	< 0.05	
SC t2 → UV t3	0.09	0.08	> 0.05	0.06	0.06	> 0.05	0.06	0.06	> 0.05	
AV t1 → SC t2[*] GU	−0.32	0.12	< 0.01	−0.31	0.10	< 0.01	–	–	–	
AV t1 → SC t2[*] VO	-. 04	0.12	> 0.05	–	–	–	−0.04	0.13	> 0.05	2.33
AV t1 → IV t2	−0.22	0.13	> 0.05	−0.15	0.09	> 0.05	−0.18	0.10	> 0.05	
AV t1 → UV t2	0.02	0.09	> 0.05	0.01	0.07	> 0.05	0.01	0.07	> 0.05	
AV t2 → SC t3	−0.05	0.06	> 0.05	−0.06	0.07	> 0.05	–	–	> 0.05	
AV t2 → IV t3	0.01	0.07	> 0.05	0.01	0.06	> 0.05	0.01	0.06	> 0.05	
AV t2 → UV t3	0.07	0.07	> 0.05	0.06	0.07	> 0.05	0.06	0.06	> 0.05	
IV t1 → SC t2	−0.01	0.06	> 0.05	−0.01	0.08	> 0.05	−0.01	0.08	> 0.05	
IV t1 → AV t2	-. 07	0.07	> 0.05	−0.07	0.07	> 0.05	−0.07	0.07	> 0.05	
IV t1 → UV t2	0.04	0.06	> 0.05	0.01	0.07	> 0.05	0.04	0.06	> 0.05	
IV t2 → SC t3	0.13	0.06	< 0.05	0.16	0.07	< 0.05	0.15	0.07	< 0.05	
IV t2 → AV t3	0.19	0.06	< 0.01	0.17	0.06	< 0.01	0.18	0.06	< 0.01	
IV t2 → UV t3	0.13	0.07	> 0.05	0.12	0.07	> 0.05	0.11	0.06	> 0.05	
UV t1 → SC t2	0.24	0.07	< 0.001	0.31	0.09	0.001	0.31	0.09	0.001	
UV t1 → AV t2	0.41	0.07	< 0.001	0.42	0.09	< 0.001	0.42	0.09	< 0.001	
UV t1 → IV t2	0.32	0.08	< 0.001	0.31	0.09	< 0.001	0.33	0.09	< 0.001	
UV t2 → SC t3	0.11	0.06	> 0.05	0.14	0.07	> 0.05	0.14	0.08	> 0.05	
UV t2 → AV t3	0.23	0.06	< 0.001	0.21	0.06	< 0.001	0.22	0.06	< 0.001	
UV t2 → IV t3	0.10	0.07	> 0.05	0.09	0.06	> 0.05	0.10	0.07	> 0.05	

Note. SC = self-concept; AV = attainment value; IV = intrinsic value; UV = utility value; t1 = Time1; t2 = Time2; t3 = Time3; GU = general upper secondary schools; VO = vocational schools; numbers in bold = significant $p < .05$; B = unstandardized values; ß = standardized values.
[*] Path hold free between both groups based on results of the Wald test.

This temporal period included the school transition from lower secondary school to either general upper secondary school or vocational school, which has rarely been the focus of existing research. In addition, even though previous studies have shown evidence of both concurrent and longitudinal relations between self-concept and task values (e.g. Arens et al., 2019; Chung & Kim, 2022; Marsh et al., 2005; Perez et al., 2019; Viljaranta et al., 2014; Wigfield et al., 2016), they used a traditional cross-lagged approach. This statistical tool does not differentiate between within-person effects and trait-like differences between individuals. In the current study, RI-CLPM treats within-person variability and between-person variability separately and explores both the autoregressive paths and the cross-lagged effects.

Hypotheses 1a and 1b were only partly confirmed. The four random intercept associations were positively significant for both student groups in literacy, but they were solely positively significant for students from general upper secondary schools in maths. Contrary to Hypothesis 1a, the random intercept variable of utility value for students from vocational schools was not significantly related to their academic self-concept in maths. Contrary to Hypothesis 1b, the random intercept variable of utility value for students from vocational schools was not significantly related to the other two task values in maths. This may possibly be due to the fact that there were larger differences between the students of vocational schools than those of general upper secondary schools: Vocational school students who require maths for their future professions may possibly show significant correlations between utility value, their academic self-concept and the other two task values in maths, but students who want to work, for example, in the social field may see the utility value in maths detached from the other two task values and also detached from their academic self-concept in this subject. The utility of literacy skills is more likely to be associated with most occupational activities, and the utility of mathematics may be more likely to be associated with appropriately specific occupational fields. The results are in line with the findings of Trautwein et al. (2012), who showed that attainment and intrinsic values have more in common, as they can be described more as intrinsic values, whereas utility (and cost) value represent more 'extrinsic' values and are therefore more sensitive to effects from the outside.

Overall, the results show that academic self-concept and task values go hand in hand. The correlations between the four random intercepts indicated the extent to which stable interindividual differences in each SEVT dimension were associated with stable interindividual differences in the other SEVT dimensions. In other words, in line with Hypothesis 1a, students who have higher self-concept of literacy set higher values of literacy and vice versa in comparison to students with lower academic self-concepts. This implies that particular students with a lower self-concept might need special attention to foster their motivation, which is in line with previous studies based on a German sample (Bakadorova & Raufelder, 2015, 2016). This finding is also consistent with previous research suggesting that academic success expectancies and task values are positively interwoven (see Arens et al., 2019; Guo et al., 2015; Trautwein et al., 2012). Our results add to the previous literature by showing that the associations are true for both students attending general upper secondary schools and vocational schools (except for vocational students' utility value in math). In other words, students who, on

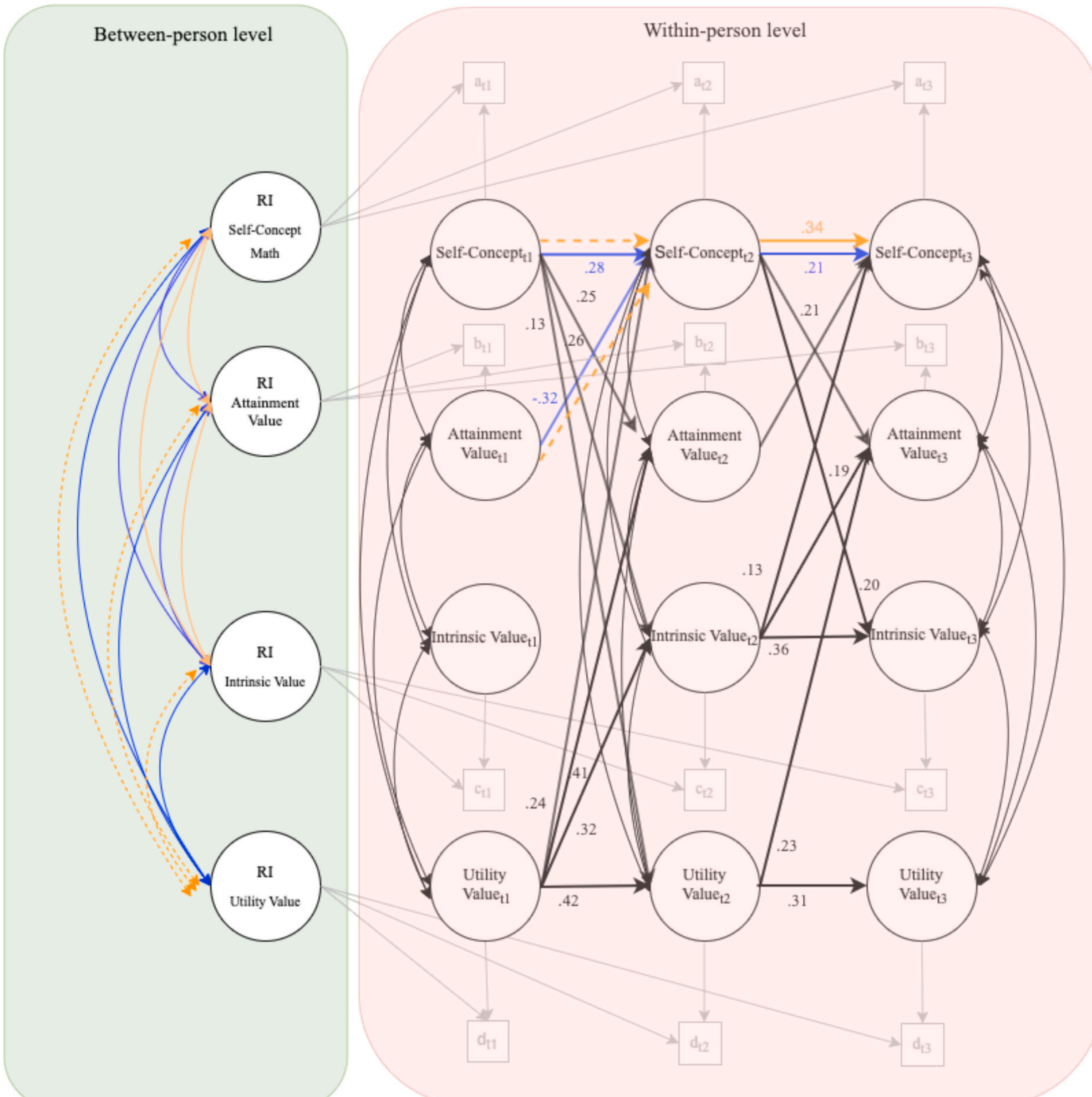

Fig. 3. Three-wave constrained Multigroup Random Intercept Cross-Lagged Panel Model (RI-CLPM) for Math with three lagged paths hold free between both groups. Note. Significant unstandardized associations ($p < .05$) for the lagged paths from the constrained RI-CLPM for math among students from upper secondary schools and vocational schools. The standardized results are reported in Table 3 and Table 4. The figure displays only the significant auto-regressive and (cross-)lagged associations between the within-person values of the measures over time and the between-person associations between the random intercept factors of the measures as well as the within-person associations within time; non-significant associations were excluded for figure clarity except paths, in which both groups significantly differ; RI = Random Intercept (RIs were freely estimated between groups); colored lines: paths hold free between both groups (blue lines: students from general upper secondary schools; orange lines: students from vocational schools); dotted paths = not-significant. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

average, have a higher academic self-concept than their peers also have higher task values and vice versa, independent of the school type (except for vocational students' utility value in math).

The present study was particularly focused on the within-level cross-lagged (RQ2) and autoregressive (RQ3) associations, which allowed us to conclude whether higher-than-usual levels of academic self-concept at one time point are linked to higher-than-usual levels of academic self-concept (i.e. carryover) or task values (i.e. spillover) at the next time point for the same individual. Hypothesis 2 was partly confirmed, as some significant within-person associations between the different components of academic self-concept and task values could be identified. In general, when cross-lagged associations between academic self-concept and task values were found, they were mostly found in mathematics but not in literacy (except for one path from academic self-concept on the intrinsic value from grade 10 to grade 12 in literacy).

The natures of maths and literacy differ significantly, which might impact the relationship between self-concept and task values. Maths classes typically involve more rigid cognitive formats, emphasising problem-solving and precise calculations and leading to a higher prevalence of clear right and wrong answers (Cvencek et al., 2011). Mathematics is often perceived as challenging, requiring continuous adoption of new concepts throughout one's academic journey, making it laborious (Cvencek et al., 2011; Sainio et al., 2019), but also more stable. Research has suggested that academic self-concept in maths tends to exhibit greater stability over time compared to literacy, particularly during adolescence (Cvencek et al., 2011; Jansen et al., 2020). As students progress through school, they build upon foundational maths concepts and skills, leading to a more consistent and predictable trajectory of maths self-concept development (Cvencek et al., 2011; Jansen et al., 2020). Additionally, the objective nature of maths assessments, which often rely on standardized tests and clear criteria for correctness, may provide students with more concrete feedback about their maths abilities, thereby contributing to the stability of their maths self-concept (Cvencek et al., 2011; Jansen et al., 2020), which might positively influence task values. Due to the nature of the subject, classes in maths in lower secondary school might not differ so much from maths classes in upper secondary schools (independent of different school forms).

More precisely, self-concept in maths was found to predict all task values (except for utility value at T3) both before and after the school transition. Higher-than-usual levels of academic self-concept before (T1) and after school transition (T2) were linked to higher-than-usual levels of task values at the next time point for the same individual. Between T2 and T3, these relationships were reciprocal in nature for attainment and intrinsic values. This finding is in line with SEVT and previous empirical findings based on traditional CLPM approaches and relatively general motivational assessments (e.g. Arens et al., 2019; Sewasew et al., 2018; Viljaranta et al., 2014).

In contrast, in the literacy RI-CLPM, there was only one spillover effect from academic self-concept to intrinsic values from T2 to T3; however, this relationship was reciprocal. In general, literacy classes often offer more flexibility and encourage interpretation, creativity and subjective responses (Schmitt et al., 2017). Literacy skills encompass a broader range of abilities, including reading, writing, speaking and listening, which may develop at different rates and can result in more variability in individuals' perceptions of their literacy abilities over time, leading to a potentially less stable literacy self-concept during adolescence (Jansen et al., 2020). Accordingly, the less stable academic self-concept might not be able to influence the task values over time.

However, in our study, it was also found that utility value predicted students' other task values and self-concepts, especially in mathematics. In other words, there is a bidirectional spillover effect between academic self-concept and utility value in mathematics from the last year of common comprehensive school to the first class in upper secondary school. This also means that interventions based on utility value (Alberts et al., 2022; Gaspard et al., 2015; Rosenzweig et al., 2022) for secondary school students (compared to university students of mathematics) are quite a reasonable approach. This is especially true, since the utility value was also significantly related to the other two task values (or from T2 to T3 only with respect to the intrinsic value) in both literacy and mathematics. This could indicate that if a student found maths useful, this could support the development of their self-concept (in mathematics) as well as the development of feelings of interest in and importance of mathematics and literacy in further years. This finding corresponds to the idea that supporting students' understanding of the utility of a certain area could support not only their interest in the subject or performance (Alberts et al., 2022; Hulleman & Harackiewicz, 2021) but also their self-concept and motivation in a broader sense.

In addition, individual students from general upper secondary schools who experienced higher (lower) levels of attainment value in relation to their own expected scores in comprehensive school were likely to subsequently report lower (higher) academic self-concepts in mathematics in the first year of general upper secondary school. Arens et al. (2019) also found a negative longitudinal relationship between attainment value and self-concept, which they explained by reasons of multicollinearity. Since the correlations between task values and academic self-concept were consistently positive in the present study (see Table A2/Appendix), this result may also have a multicollinearity problem. To check this, the model was first run with only academic self-concept and attainment value (the path was not significant), then the intrinsic value was added (the path was also not significant), and only in the model with all three task values did the path become significant, which highlights possible multicollinearity. Alternatively, multicollinearity problems arising from the task value facet can be addressed by restricting the path from attainment value to self-concept to the same value (see Arens et al., 2019; Marsh et al., 2004). The model with our data, following this alternative approach, can be found in the Appendix (see Fig. A1).

Students from vocational schools and those from general upper secondary schools did not differ in the cross-lagged paths from academic self-concept to task values. This finding suggests, on one hand, that both educational contexts we examined in the current study might not be that different, as they serve a similar purpose: to provide students with secondary education, irrespective of the vocational or academic path. On the other hand, it contradicts the SEVT idea that the specific context is highly relevant to the development of success expectations and task values. However, it may also be due to the fact that in the present study, we had large time intervals between the surveys, while the situational and contextual influences might rather operate at a smaller grain size (e.g. using situation-specific measures of expectancies and subjective task values across days or weeks), as argued by recent SEVT studies (Benden & Lauermann, 2023; Beymer et al., 2022; Dietrich et al., 2017, 2019; Moeller et al., 2022; Parrisius et al., 2022).

With regard to the third research question, the results concerning the auto-regressive paths showed some interesting differences between students in different school types, domain-related self-concepts and task values. First, and in line with Hypothesis 3, the findings concerning self-concepts indicated that among students entering general upper secondary school, a higher-than-usual academic self-concept in mathematics and literacy before the transition (T1) and after the transition (T2) is linked to higher-than-usual levels of academic self-concept at the next time point for the same individual students. For students in vocational schools, Hypothesis 3 was only partly confirmed, as the autoregressive path was found to be significant only within the vocational school period (T2 to T3). The non-significant autoregressive paths from academic self-concept between T1 and T2 for students in vocational schools indicated higher randomness, as a change at the latter time point cannot be predicted by a change at the previous time point. The reason for these findings may reflect the different natures of different educational pathways in the Finnish educational context. General upper secondary schools provide students with general academic studies needed in further tertiary education, while vocational schools prepare students for their future occupations by providing practical skills needed in their work life as car mechanics, hairdressers or other professionals. It could be that the nature of a school subject changes more during the transition to vocational school because its focus changes from very theoretical to practical skills, which could explain the instability among vocational school students.

In addition, all autoregressive paths of attainment value development were non-significant, while all autoregressive paths of utility value development were significant. That is, there seemed to be more flexibility in the development of attainment value (or the attainment value was more affected by situational and environmental influences, such as specific class content or school transition), while changes in utility value continuously affected changes in development. This result is not surprising, since attainment value focuses more on the momentary personal importance of a task, while utility value focuses on the future, so more flexibility is experienced in the change in the development of attainment value over time. This finding further supports the idea of Trautwein et al. (2012) that attainment value is more 'intrinsic' in nature, while utility value is more extrinsic in nature. The analysis further revealed significant autoregressive (i.e. carryover) effects for students' intrinsic value in mathematics over time; that is, the autoregressive effect in literacy was significant only from the beginning to the end of vocational school. The non-significant autoregressive paths from intrinsic value between T1 and T2 for students in vocational schools indicated higher randomness, as a change at the latter time point cannot be predicted by a change at the previous time point. Here, there seemed to be a greater fluctuation in the development of intrinsic values within individual students of vocational schools, which may have been due to different emphases in the teaching of comprehensive and vocational schools in the subject of literacy. The study by Moeller et al. (2022) also found some (but not all) auto-regressions of attainment, intrinsic and utility value to be inconsistent across models and time lags. In contrast, in the study by Arens et al. (2019), all autoregressive paths in the classic CLPM of attainment and intrinsic values were significant from one measurement time point to the next in maths, German and English, but not across larger measurement time points (e.g. from T2 to T4).

Overall, the findings suggest that there may be fluctuations in the development of individual task values, depending on the temporal distance between the measurements and on the situation. However, because other studies have not distinguished between-level and within-level using RI-CLPM, it should also be noted here that when stable between-person differences are present in at least one variable, they affect the estimates of the autoregressive and cross-lagged paths and, as a consequence, might increase the probability of spurious findings (for empirical demonstrations, see Berry & Willoughby, 2017; Hamaker et al., 2015; Mund et al., 2021; Mund & Nestler, 2019). 'As a consequence of the shift toward within-person associations, the results of the RI-CLPM can differ markedly from results obtained with the CLPM (Hounkpatin et al., 2018; Mund & Nestler, 2019; Orth et al., 2021)' (Mund et al., 2021, p. X). To make reliable statements, further comparative studies with RI-CLPM are desirable.

4.1. Practical implications

As the carryover effect on the academic self-concept of students from general upper secondary schools in literacy only becomes apparent after school transition, schools could take measures to specifically support students during upper secondary education studies. Here, special attention could be paid to promoting academic self-concept to ensure positive development. The lack of a significant effect of utility value on academic self-concept from the beginning of upper secondary education studies to the end of literacy studies suggests that special efforts could be made to strengthen the perception of the usefulness of educational content in the primary and lower secondary school periods. The practical relevance of the teaching material and its clarified relevance for personal and professional development could play a role here. The identified cross-lagged paths from intrinsic value to academic self-concept and attainment value in both literacy and maths could indicate that the promotion of intrinsic values is particularly important in connection with learning success and personal growth. Schools could therefore focus more on creating learning environments that promote students' intrinsic motivation by providing interesting, challenging and meaningful tasks. Learning approaches could aim to clarify the intrinsic value of mathematical concepts and problem solving, such as through the phases of enquiry-based learning. The identified reciprocal effects between academic self-concept and utility value in mathematics in grades 9 and 10 indicate that the perception of the usefulness of mathematics has an influence on mathematical self-concept and vice versa before and after school transition. In the classroom, more attention could be paid to conveying the practical applicability and importance of mathematics to students to promote positive feedback effects. The significant between-level connections between the random intercepts point to interindividual differences. Teachers could adapt their pedagogical approaches to the different needs and prerequisites of students to support the positive development of motivation, such as through phases of self-directed learning.

Overall, these results could be used to develop targeted interventions in everyday school life aimed at promoting students' motivational processes. This could be done by integrating practice-relevant content, emphasising intrinsic values and providing targeted support during crucial transition phases.

4.2. Limitations and future directions

When interpreting the results, it is important to note that only three of the four task values described in SEVT were used. Future studies that include cost value would complement the results. Moreover, only the academic self-concept was considered in the present study to be a demonstration of success expectancies. While this study focused on examining the longitudinal relationships between self-concept and task values, it is essential to recognise that changes in these constructs can also be influenced by external factors, such as performance, quality of teaching or other unmeasured variables. To address this issue, future research could consider incorporating additional measures or controls for potential confounding variables, such as academic achievement or teaching quality, to better understand the unique contributions of self-concept and task values to students' outcomes, which can enhance the robustness and validity of its findings. Another limitation of this study is its focus on data from Finnish students. Follow-up studies with data from other countries should be conducted, as school types often differ across countries. Finally, all constructs investigated in this study were measured using two indicators.

5. Conclusions

Overall, the present study adds evidence to the SEVT and addresses several research gaps through its (a) longitudinal design (three waves, including a school transition), (b) focus on both middle and late adolescence, (c) consideration of task values in both literacy and mathematics, (d) differentiation between students in different school tracks, (e) detection of causal relationships between task values and academic self-concepts and (f) consideration of both within- and between-person effects. It further supports the assumption that the relationship between expectancy and values is bidirectional in nature (see Benden & Lauermann, 2023; Eccles, 2005, 2009; Wigfield et al., 1997).

In sum, the findings highlight the importance of distinguishing between-person and within-person motivational processes and suggest that different situational contexts may show different developmental patterns of academic self-concept and task values. The findings further underline the current discussions on the heterogeneity between situations and between individuals in situational expectancy-value experiences (Dietrich et al., 2019; Moeller et al., 2022). Overall, the utility value seems to be the most promising motivational construct in changing motivational beliefs and thus serves as a promising starting point for preventing motivational decline over school transition from lower to upper secondary schools. Furthermore, the academic self-concept in maths might be a promising starting point due to its spillover effects to task values, underscoring the importance of nurturing students' confidence and beliefs in their own mathematical abilities.

CRediT authorship contribution statement

Diana Raufelder: Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Olga Steinberg:** Writing – review & editing, Writing – original draft. **Jaana Viljaranta:** Project administration, Investigation, Funding acquisition, Data curation, Conceptualization. **Anna-Maija Poikkeus:** Investigation, Data curation, Conceptualization. **Kati Vasalampi:** Project administration, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

None.

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Appendix A. Supplementary data

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