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# The Concurrent Trajectories of Utility Value, Metacognitive Strategy Use, and Achievement

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**ABSTRACT**

Studies on utility value, metacognitive strategies, and achievement have usually examined these variables in a static manner. However, each of these variables changes across time and the relationships among them are dynamic. Hence, studies that examine changes in individual trajectories (change in each variable over time) and concurrent trajectories (how relationships among the variables change over time) are needed. The current study examined both the individual and concurrent trajectories of utility value, metacognitive strategies, and achievement using a three-wave longitudinal sample of 6,776 Hong Kong secondary students (Mean age at Time 1 = 13.23, SD = 1.06). Results of the latent growth models indicated that intrinsic utility value declined while achievement increased across three years. Multivariate latent growth modeling showed that students who started with higher levels of metacognitive strategy use experienced a slower decline in intrinsic utility value. Moreover, the faster metacognitive strategy use increased over the years, the slower intrinsic utility value declined and the faster achievement increased. This study suggests the importance of examining the dynamic relationships among motivation, strategy use, and achievement.

**KEYWORDS**

Academic achievement; metacognitive strategy use; multivariate growth curve modeling; utility value

## Introduction

STUDENTS WHO HAVE higher levels of utility value (UV) (the perception that schooling is important for achieving personal goals) are more likely to engage in self-regulated learning (SRL) (students' self-generated thoughts, feelings, and actions oriented toward the attainment of one's goals) (Neuville et al., 2007; Wolters & Pintrich, 1998) and get better grades (Cole et al., 2008; Hulleman et al., 2010). Likewise, students who have higher levels of achievement are also more likely to value school (Arens et al., 2019) and more able to deploy SRL strategies (Zimmerman, 2013). However, individual constructs change over time. For example, UV may decline across time or students may experience a growth in their use of SRL. For shorthand, we refer to this as a change in the *individual trajectory* (i.e., change in a single variable across time). Given that utility value (UV), metacognitive strategies (MS) and achievement are correlated, the relations between each other's change or trajectory should also be correlated. For example, a decline in utility value might precipitate a decline in achievement or an upward growth in student achievement might facilitate an increase in the use of SRL strategies. We refer to this as changes in *concurrent trajectories* (i.e., correlated changes across two variables).

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Although researchers theoretically acknowledge the existence of change in both individual and concurrent trajectories (Ben-Eliyahu, 2019; Ben-Eliyahu & Bernacki, 2015; Pintrich, 2004), they have seldom been examined simultaneously due to the complexity of computational demands (see O'Keefe et al., 2013 for an exception). To date, the field of motivation and SRL has been limited by a preponderance of cross-sectional studies which are unable to capture the developmental nature of key processes. The smaller number of longitudinal studies usually focus on modeling individual trajectories using repeated measures analyses (Caprara et al., 2008; Jacobs et al., 2002). However, concurrent trajectories, which more accurately capture the dynamic relationships among the constructs, have been neglected. This neglect is unfortunate given that psychological constructs do not change in isolation from each other. Change in one construct could precipitate changes in another closely related factor (e.g., Corker et al., 2013).

The goal of this study was to examine how UV, MS, and achievement change individually across time (*individual trajectory*); and how the changes in these constructs are associated with each other (*concurrent trajectories*). To achieve this goal, we tracked 6,776 students from sixteen middle schools in Hong Kong across three years. We focused on the relations among the changes in UV, MS, and academic achievement. In doing so, we jointly examined the trajectories of these core variables using multivariate latent growth modeling (Grimm et al., 2017), an approach that can simultaneously model the change in direction and speed of individual construct, and more importantly, the relationships among the changes of different constructs.

This investigation advances both theory and practice. In terms of theory, there is an increasing recognition that motivation, SRL, and achievement are not static but dynamic (Kaplan & Garner, 2017; Wigfield et al., 2015). However, given methodological constraints, much of the existing research has failed to capture the dynamic relations among these crucial variables. Our study examined this unexplored terrain. Practically, evidence revealing the dynamic relationships among UV, MS, and academic achievement should be informative for educational efforts and intervention programs intended to improve these crucial outcomes.

### *Utility Value*

Expectancy-value theory provides a useful framework for examining students' UV. Expectancy-value theory posits the central importance of expectancy and value in understanding students' motivation and learning (Wigfield & Eccles, 2020). Expectancy refers to students' expectations that they can succeed in key tasks (Wigfield & Eccles, 2000); value comprises attainment value (importance tied to personal identity), intrinsic value ("enjoyment one gains from doing the task"(Wigfield, 1994, p. 52), cost (time or effort investment), and *utility value* (usefulness) of education (Wigfield & Eccles, 2000). A major argument of expectancy-value theory is that both expectancy and value are essential for enhancing learning engagement and outcome (Wigfield et al., 2009).

As an essential subcomponent of value, UV refers to students' perceptions of the value of school tasks to help them achieve their current and long-term future goals (Wigfield et al., 2015). Past studies on UV have been mostly conducted with primary school students. Perhaps due to this reason, the construct of UV has been conceptualized in a general way as 'usefulness' to individuals' future life and measured with a small number of items, which are appropriate when participants are younger pupils. However, secondary students , such a global measure may be too general (Wigfield et al., 2015). For example, for some students, schooling may be useful for attaining wealth, but for others, it may be seen as instrumental to making contributions to society (Lee et al., 2010). These individual differences in UV have largely been ignored in existing UV research. Hence, UV researchers are calling for a nuanced approach to the construct (Wigfield et al., 2015).

To further refine the construct of UV, Lee et al. (2010) linked UV to intrinsic and extrinsic goals. Intrinsic goals refer to goals that can satisfy basic psychological needs for autonomy, relatedness, and competence. Examples of intrinsic goals include family (supporting one's future family), career (having a good job), and societal goals (contributing to society). On the other hand, extrinsic goals are those that do not lead to the fulfilment of basic psychological needs per se, but rather are driven by a need for external validation. Examples include fame (becoming a famous person), and wealth (becoming a rich person) goals. This intrinsic-extrinsic distinction is central to current extensions of self-determination theory which focuses on the content of one's goals or aspirations (Kasser, 2016; Kasser & Ryan, 1996; Vansteenkiste et al., 2004).

We use Lee and colleagues' (2010) intrinsic-extrinsic distinction by distinguishing between UV-extrinsic (UV for extrinsic goals) and UV-intrinsic (UV for intrinsic goals). UV-extrinsic pertains to students' perception of the importance/usefulness of education to achieve fame and wealth goals; and UV-intrinsic pertains to students' perception of the importance/usefulness of education to achieve career, family, and societal goals (Lee et al., 2010). We use this classification in our study in order to examine whether UV-extrinsic and UV-intrinsic would have differential relationships with MS and achievement and whether the salience of these different faces of UV change over time and in some form of synchrony with MS and achievement.

### *The Development of Utility Value*

Jacobs et al. (2002) documented the growth trajectories of perceived task values (i.e., perceived values of specific domains, such as math, language and sports) of first graders through twelfth graders. Their task value questionnaire measured UV (asking students 'how useful they thought each activity was'), together with intrinsic value (asking students 'how interesting each activity was'), and attainment (asking students 'how important they thought being good at the activity was'). Results of the hierarchical linear modeling showed a decline of task value as children grew older. By further comparing findings across gender, the researchers found that while both boys' and girls' values showed similar declining patterns through the elementary grades, girls' values tended to level off (at Grade 7) and then recover during the following grades. The study provided a picture of the change pattern of task value over a relatively long duration. However, as Watt (2004) commented, it is unclear to what extent the effect was related to utility value, given that the researchers used an omnibus measure of value without distinguishing the measure of utility value from other overlapping constructs such as intrinsic value and attainment value. Moreover, this study did not examine whether the decline in UV is related to a change in achievement.

Watt (2004) focused on the value (intrinsic value and UV) of math and English perceived by adolescents through Grade 7 to Grade 11 (ages spanning from 13 to 17). Results of the multilevel modeling showed students' UV declined over Grade 7 and between Grades 10 and 11. Girls and boys followed similar developmental trajectories, with girls maintaining consistently higher ratings than boys did. Similar to Jacobs et al. (2002), Watt identified Grade 7 as a critical point when UV shifted downward. The decline in UV was interpreted as the outcome of the physiological and psychological pubertal changes (Hill & Lynch, 1983) and the abrupt structural changes that students undergo during their first year in secondary school. Watt (2004) argued that when students move from primary to secondary school, they experience disruptions to their social networks and undergo a more rigorous academic curriculum that can lead to declines in their motivation. Watt measured UV, but she did not link change in UV with achievement change.

In a ten-year project examining the motivation of children (from 6 to 16 years old) learning English as a foreign language in Spain, Muñoz (2017) identified two types of motivation factors: perceived importance of studying English for studying abroad and for getting a better job. Both can be conceptually related to UV. The two motivation factors fluctuated during the study, but

both showed a declining trend. The association between these two motivation factors and their English scores in two grades, namely, Grades 6 and 10, was only strong in Grade 10.

The literature reviewed above broadly shows that the decline in UV starts from elementary school years and continues till the end of secondary school years (or even longer). Meanwhile, this decline in UV appears to have deleterious consequences for student learning and achievement (Muñoz, 2017). This decline seems to be universal and inevitable (Watt, 2004). However, existing studies have mostly focused on the change in UV itself and neglected the potential of other key constructs (e.g., MS) whose change might be associated with the change of UV. A benefit of studying the dynamic relations between the change in UV and the change in another key construct is that, if the other construct changes in a positive way (i.e., increases) and this change is positively related to the decline of UV, then this construct might be considered as having the potential to mitigate the decline in UV (Grimm et al., 2017). The next section discusses the potential of MS for mitigating the decline of UV, given that MS has been frequently linked to motivation (Bandura, 1986; Pintrich, 2004; Zimmerman & Schunk, 2011).

## Metacognitive Strategies

We define metacognitive strategies (MS) under the general rubric of self-regulated learning strategies (Pintrich, 2004). These strategies involve students' control of their own cognition. In the current study, MS included: evaluating, planning, and monitoring. We were primarily interested in how students' use of metacognitive strategies changes during secondary school when students are in their adolescence. Insights from neurocognitive psychology show that the pre-frontal cortex matures during adolescence, and this maturity provides a mechanism for increased brain processing (Brynes, 2003) that enables a greater degree of metacognition, or the ability to reflect upon one's own thought (Metcalfe, 1996). Consequently, MS use should also increase with age (Ryan & Pintrich, 1997). However, high metacognitive capacity alone does not automatically lead to more effective use of metacognitive strategies (Schneider et al., 2017). To fulfil their learning goals, students must also master relevant strategy knowledge. Thus, one would also expect that the actual use of metacognitive strategies would develop and mature gradually during the learning progression (Paris & Paris, 2001). However, longitudinal studies on the development of these metacognitive in adolescence is quite limited (Pintrich, 2003) though there are a few exceptions (Caprara et al., 2008; Heater, 2005; Helle et al., 2013; Schneider et al., 2017).

## The Development of Metacognitive Strategies

The few studies examining the development of MS from primary schools to among middle school students have produced mixed findings. Studies including different types of self-regulated learning strategies, which includes MS, seemed to show that MS declined as students moved toward higher grades. For example, Heater (2005) studied the development of MS among middle school students from Grades 6 to 8 ($N = 127$) and measured their MS together with cognitive strategies (Pintrich & De Groot, 1990). Results indicated a decline in MS as well as well as in cognitive strategies. Helle and colleagues (2013) evaluated the changes in self-regulated learning and the developmental relations between perceived self-regulated learning strategies including cognitive strategies, MS, conceptions of learning, and achievement. Their results showed that the level of perceived self-regulation declined between the two-time points.

A six-wave study conducted by Caprara et al. (2008) investigated the longitudinal relations between perceived efficacy for self-regulated learning (e.g., 'How well can you organize your school work?') and achievement. Results showed that self-regulated learning efficacy gradually declined from junior to high school, with boys experiencing faster decrease. A faster decline was associated with lower school grades at junior high (Time 1 to 4).

Although some studies showed a decline in MS, other studies documented an increase. For example, Schneider et al. (2017) examined the development of metacognitive knowledge and the relation of this development to changes in achievement. A major conclusion of their study is that metacognition showed a substantial growth over the observed period. The study also found a significant gender effect on the growth of metacognitive knowledge in favor of girls and a significant effect of school track in favor of higher ability schools.

A number of limitations in these studies limit their contribution to our understanding of the processes involved in the dynamic relations among UV, MS and achievement. For example, Heater (2005) as well as Helle and colleagues (2013) collected data across two waves. The question of whether the same pattern would remain if the observation had been extended to a longer term remains an open question. Although Caprara and colleagues were able to observe the developmen of SRL over a much longer time period than Heater (2005) and Helle et al. (2013), what they measured was more related to self-efficacy to engage in self-regulated learning rather than MS itself which is the focus of the current study. These studies suggest that MS might appear to decline if observed in a short-term duration (e.g., Caprara et al., 2008; Heater, 2005). However, if MS were observed over a longer time duration, a different picture may emerge (i.e., increase, as shown in Schneider et al., 2017).

### *Relations Among Utility Value, Metacognitive Strategies, and Achievement*

Theoretical models of self-regulated learning posit that key constructs such as UV, MS, and achievement are intricately and dynamically related to each other (Pintrich, 2004). For example, Ben-Eliyahu and Bernacki (2015) work posits that motivation drives self-regulated learning processes which then drives learning outcomes such as achievement. Without motivation, students will not regulate themselves toward the attainment of learning goals. Early research posited motivation as a stimulant that evokes action and maintains action through volitional processes (Kuhl, 1984, 1994). However, aside from these unidirectional effects from motivation to self-regulation to achievement, Ben-Eliyahu and Bernacki (2015) as well as other key authors also explicitly argued that these variables are dynamically and reciprocally related to each other across time (Winne & Hadwin, 2008; Zimmerman & Schunk, 2011).

Empirical studies have supported the contention that motivation, SRL, and achievement are closely related. Wolters and Pintrich (1998) examined the relation between Grade 7 and Grade 8 students' motivational beliefs (including task value), self-regulated learning (which includes both MS and cognitive strategies), and academic achievement in various domains. A key finding of their study is that utility value (the usefulness and interest for the materials studied within mathematics, English or social studies) was the single best predictor of SRL across all subjects. The effect of task value on performance in all subjects was not significant. The researchers argued the function of task value was to jumpstart learning and after this initial stage, self-regulated learning will take over in leading to actual learning and performance gains. Other studies with elementary and secondary students focusing on the relationship between a more limited set of constructs consistently revealed that UV is related to academic achievement (Hulleman et al., 2008; Wigfield & Eccles, 1994).

Cole et al. (2008) identified a significant direct effect of task variables (i.e., usefulness, interest and importance) on test scores among students at the college level. In another study, with a mixed sample of college students and middle school students, Hulleman et al. (2008) found that UV directly predicted college students' final classroom grade (psychology course) and middle school students' performance based on the coach's ratings. This variation suggests the relation between UV and academic achievement gradually becomes stronger with age.

The studies reviewed above indicate that UV, MS, and achievement are closely related to each other. Existing studies also showed that UV, MS and achievement all change as students grow older and move toward upper grades. However, existing studies rarely explored the concurrent changes of the variables and hence, the modeling of potential dynamic relationship among UV, SRL and achievement is highly necessary.

## Hong Kong Chinese Context

The current study was conducted in the Hong Kong Chinese context. Hong Kong is a special autonomous region (SAR) of China and was formerly a British colony until 1997. Hong Kong's population is 95 percent Chinese and five percent from other ethnic groups (e.g., Indian, Pakistani, Filipinos, British). It is considered a collectivist society which prioritizes in-group relationships (Hofstede, 2001).

The educational system is broadly based on the British educational system and is typically focused on high achievement for both boys and girls. Although Hong Kong is a collectivist society, influences of the British highly individualistic society can be found in today's education. For instance, competition among students is fierce, particularly when entering higher education. There are three main groups of schools; government schools, subsidized schools (e.g., run by charitable bodies), and private schools. In the majority of the schools, Chinese is currently the medium of instruction. There are both co-educational as well as single-sex schools in Hong Kong, although the former is more common. Education is highly valued in Hong Kong society and Hong Kong students have consistently placed at the top of educational rankings such as the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) (OECD, 2014, 2016). Doing well in school is a primary cultural mandate and students have been found to endorse a more social orientation towards achievement (King et al., 2013, 2014, 2017).

## The Current Study

The aim of the current study was to examine how UV, MS, and achievement changed individually (*individual trajectory*) and how the changes of these constructs are related to each other across time (*concurrent trajectories*). The literature provides consistent evidence showing that UV declines, whereas use of MS might increase (e.g., Schneider et al., 2017). In terms of achievement, studies have shown that as students learn more across the years, their achievement also increases (Grant et al., 2015; Ortega & Iberri-Shea, 2005). These studies led us to the following hypotheses about individual trajectories:

*Hypothesis 1. Utility value of education for extrinsic goals (UV-extrinsic) declines over time.*

*Hypothesis 2. Utility value of education for intrinsic goals (UV-intrinsic) declines over time.*

*Hypothesis 3. Metacognitive strategies (MS) increases over time.*

*Hypothesis 4. Academic achievement increases over time.*

Given the scarcity of research on how change in one variable would be associated with change in another variable, we did not posit any specific hypothesis about concurrent trajectories. Moreover, to ensure that the findings obtained are not due to the presence of unmeasured confounding variables, we included school ability (Schneider et al., 2017), gender (Schneider et al., 2017) and grade levels as covariates as previous studies have found that these factors might affect the developmental trajectories of MS, utility value and achievement.

Table 1. Demographic information.

| | Cohort 1 | | Cohort 2 | | Cohort 3 | | |
|---|---|---|---|---|---|---|---|
| School ability (No. of Schools) | Boys | Girls | Boys | Girls | Boys | Girls | Subtotal |
| High (3) | 256 (3.78%) | 406 (5.99%) | 277 (4.09%) | 431 (6.36%) | 265 (3.91%) | 434 (6.40%) | 2,069 (30.53%) |
| Medium (9) | 628 (9.27%) | 546 (8.06%) | 699 (10.32%) | 555 (8.19%) | 648 (9.56%) | 598 (8.83%) | 3,674 (54.22%) |
| Low (4) | 281 (4.15%) | 77 (1.14%) | 262 (3.87%) | 61 (.90%) | 264 (.90%) | 88 (1.30%) | 1,033 (15.24%) |
| Subtotal | 1,165 (17.19%) | 1,029 (15.19%) | 1,238 (18.27%) | 1,047 (15.45%) | 1,117 (17.37%) | 1,120 (16.53%) | 6,776 (100.00%) |
| | 2,194 (32.38%) | | 2,285 (33.72%) | | 2,297 (33.90%) | | |
| Mean Age | 12.21 (S.D. = .629) | | 13.23 (S.D. = .675) | | 14.22 (S.D. = .693) | | 13.23 (S.D. = 1.059) |

## Method

### Participants and Data

Table 1 presents the demographic information. The sample involved 6,776 students from sixteen Hong Kong secondary schools, covering three levels of school ability. In Hong Kong, primary students are classified into three bands at the end of their primary school study according to their internal examination scores and the Pre-Secondary One Hong Kong Attainment Test (Education Bureau, 2018). These three groups include: Band 1 (high-ability), Band 2 (medium-ability), and Band 3 (low-ability). Lower ability schools are usually overrepresented by students from minority groups or with low socio-economic status (see Lee & Chiu, 2017 for more information).

The three high-ability schools (Band 1) had 2,069 students (30.53% of the total sample); the nine medium-ability schools (Band 2) had 3,674 students (54.22% of the total sample); and the four low-ability schools (Band 3) had 1,033 students (15.24% of the total sample). At the start of the study, students were recruited from Secondary 1 (2,194 students; mean age = 12.21; SD = .629); Secondary 2 (2,285 students; mean age = 13.23; SD = .675); and Secondary 3 (2,297 students; mean age = 14.22; SD = .693). Data were collected in three waves. All students answered a survey measuring various motivational constructs (i.e., UV and MS). To cater to students' language preference, each questionnaire had a Chinese version (original) and an English version . Students were given the choice to use the English or the Chinese version. In the end, all students chose the Chinese version. Students also answered a standardized English achievement test. English achievement was preferred over other subjects (e.g., science, mathematics) because English proficiency is considered extremely important by the government and the business sector for maintaining the economic advantage of Hong Kong (Nunan, 2003). Importantly, English is the medium of instruction in tertiary education in Hong Kong and therefore, a good mastery of English opens up new opportunities for students to pursue their education attainment (Curriculum Development Council, 2000).

Each measure was administered three times with an interval of one year. Data were collected at the end of each academic year (usually late June or early July). This was to ensure that students had covered the whole range of course content for the academic year before the achievement test.

### Measures

#### UV (Utility Value of Education)

UV was measured in relation to UV-extrinsic and UV-intrinsic (J. Q. Lee et al., 2010). Items were rated on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree) to measure

perceived UV-extrinsic and UV-intrinsic. UV-extrinsic goals pertained to goals related to fame and wealth (e.g., "I need to continue my education beyond secondary level to make a lot of money"). UV-intrinsic included goals related to family, career, and society (e.g., I need to continue my education beyond secondary level to develop my society."). The reliability estimates of the UV-extrinsic across time were 0.88 at each of the three-time points, and those of the UV-intrinsic were 0.92, 0.92, and 0.90, at T1, T2, and T3 respectively.

### MS (Metacognitive Strategies)

To measure MS, we used the Self-Directed Learning Scale (SLS) developed by Mok et al. (2006). The SLS was a 5-point Likert scale containing three subscales, each measured with five items. The three subscales were planning, monitoring, and changing. Planning refers to preparatory activities that students take for future work (e.g., 'I like to get a list of the things I need to do, and then tackle them one by one'). Monitoring measures students' online self-check of understanding and learning (e.g., 'I check if I have corrected the mistakes in learning that I have made previously'). *Changing* contains various measures that students take for more effective learning (e.g., 'I modify my learning methods to meet the needs of a school subject'). The reliability estimates of the MS across time were 0.94, 0.94, and 0.93, respectively.

### Psychometric Properties of the Scales

Note that UV-extrinsic, UV-intrinsic, and MS used multiple indicators and we used composite scores for these three constructs. Before computing composite scores for these variables, we evaluated the data-model fit using confirmatory factor analysis (CFA) with each round of data based on multiple criteria recommended in the literature: CFI and TLI values larger than .90 and .95 (Byrne, 2010), RMSEA values smaller than .08 (Browne & Cudeck, 1992), and SRMR values smaller or closer to .09 (Hu & Bentler, 1999). We then conducted a series of CFA with the item-level scores to check the longitudinal measurement invariance of the subscales across the contextual variables of school ability, gender, and year level. For measurement invariance evaluation, we took a decrease in the CFI of or less than .01 as evidence of invariance (Cheung & Rensvold, 2002). Although there are different methods for examining invariance, the criterion espoused by Cheung & Rensvold appears to be the criterion with the greatest currency and so this method was adopted. Given the limited space, this detailed information was not presented in the current paper but is available from the authors.

### Academic Achievement

Students' academic achievement was represented and measured using the English Language Ability Calibrated (ELAC) Scale, a standardized English language test developed by A. Y. P. Lee (2009, October). The ELAC was an item bank consisting of over 2,500 items. The bank had been calibrated using Rasch (Bond & Fox, 2015) on a large sample size of students (N = 15,000 students) between Primary 1 and Secondary 3 in Hong Kong. The ELAC is commonly used in Hong Kong schools to assess English competency in listening, grammar, reading and writing. Further information on the ELAC may be found in A. Y. P. Lee (2009, October).

### Control Variables

There are also a number of other socio-demographic factors that have been found to be associated with UV-extrinsic, UV-intrinsic, MS, and academic achievement such as gender (Caprara et al., 2008), cohort (Caprara et al., 2008), and school ability (Schneider et al., 2017). Therefore, we included these covariates during the exploration of the concurrent changes. At the start of the

study, students were recruited from different year levels: Secondary Year 1, Secondary Year 2, and Secondary Year 3 students.

### Data Analyses

For missing data, we first excluded students with missing rates larger than 20% (Enders, 2010). Then we used multiple imputation (Rubin, 1987; Schafer, 1997) and computed five sets of data using MPLUS 7.4 (Muthén & Muthén, 1998-2018). All growth modeling results (i.e., parameters, standard errors and model fit indices) reported in the current study were the averaged estimates out of five sets of imputed data.

The primary data analysis involved two major steps: 1) LGM (latent growth modeling), and 2) MLGM (multivariate LGM) (Grimm et al., 2017). All LGM and MLGM analyses were conducted using Mplus 7.4 (Muthén & Muthén, 1998-2018), with the Maximum Likelihood Robust (MLR) estimator (Satorra & Bentler, 1994).

#### 1) LGM

LGM was conducted to test the four hypotheses (i.e., the hypothesized trajectory of each of the four key constructs: UV-extrinsic, UV-intrinsic, MS, and academic achievement). An LGM trajectory is usually determined by two latent factors: an intercept factor representing stability (the average or mean) and a slope factor representing change. To test each LGM, all repeated measures had fixed loadings of 1 on the intercept factor and had fixed loadings of 0, 1 and 2 at Time1, Time 2, and Time 3 measure, respectively.

#### 2) MLGM

MLGM was conducted to examine the concurrent trajectories of the variables after controlling for covariate effects. This was achieved by allowing the intercept and slope of each of the four variables (UV-intrinsic, UV-extrinsic, MS, and achievement) to be freely correlated with each other. Doing so allowed us to test all the possible concurrent relationships among the variables without positing directional effects.

When interpreting effect sizes, we followed Duncan et al. (2011) and took values of .10, .30, and .50 as criteria of small, medium, and large effect, respectively. Note that effect sizes in our study refer to the relations of changes (e.g., correlations between slope factors), which is the focus of the current study, rather than the speed of a change (i.e., the mean of the slope factor) of a single construct. To our best knowledge, we are not aware of such criteria for interpreting the effect size of the mean of a single change factor, nor of empirical studies using growth modeling that interpret the effect size of the mean of a single change factor.

## Results

### Descriptive Statistics and Bivariate Correlations

Table 2 shows the descriptive statistics of all key measures over time. The T1-T3 means of UV-extrinsic were 3.02, 3.02, and 3.01. Low-ability school students produced UV- extrinsic means slightly lower than the median of 3 (M = 2.94, 2.98, 2.90), whereas the means by students from the medium and high-ability schools had values slightly higher than the median. The over-time UV- extrinsic means appeared to be stable across all cohorts and across genders.

The T1-T3 UV-intrinsic means were 3.35, 3.34, and 3.31. The over-time UV- intrinsic means tended to vary across three types of schools. The highest means were with high-ability schools (Ms = 3.43, 3.41, 3.38), followed by medium-ability schools (Ms = 3.32, 3.31, 3.29), and low-

**Table 2.** Descriptive statistics.

| | | Utility value for extrinsic goals | | | Utility value for intrinsic goals | | | Metacognitive strategies | | | Achievement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T1 | T2 | T3 | T1 | T2 | T3 | T1 | T2 | T3 |
| Overall | Mean | 3.02 | 3.02 | 3.01 | 3.35 | 3.34 | 3.31 | 2.84 | 2.81 | 2.83 | 46.35 | 48.78 | 49.53 |
| | S. D. | 0.64 | 0.62 | 0.61 | 0.53 | 0.52 | 0.52 | 0.52 | 0.51 | 0.49 | 11.15 | 9.75 | 9.05 |
| High-ability school | Mean | 3.04 | 3.02 | 3.06 | 3.43 | 3.41 | 3.38 | 2.90 | 2.87 | 2.91 | 54.02 | 56.76 | 56.04 |
| | S. D. | 0.63 | 0.62 | 0.58 | 0.48 | 0.49 | 0.47 | 0.49 | 0.48 | 0.44 | 9.82 | 7.50 | 7.28 |
| Medium-ability school | Mean | 3.04 | 3.03 | 3.02 | 3.32 | 3.31 | 3.29 | 2.82 | 2.79 | 2.83 | 44.17 | 46.17 | 47.52 |
| | S. D. | 0.64 | 0.61 | 0.60 | 0.54 | 0.53 | 0.53 | 0.53 | 0.52 | 0.50 | 9.73 | 8.26 | 7.95 |
| Low-ability school | Mean | 2.94 | 2.98 | 2.90 | 3.27 | 3.30 | 3.24 | 2.76 | 2.73 | 2.72 | 38.72 | 41.77 | 42.95 |
| | S. D. | 0.66 | 0.63 | 0.65 | 0.56 | 0.54 | 0.58 | 0.54 | 0.54 | 0.55 | 9.63 | 8.17 | 8.06 |
| Secondary 1 | Mean | 3.01 | 3.01 | 3.00 | 3.39 | 3.34 | 3.31 | 2.89 | 2.82 | 2.82 | 44.07 | 47.61 | 47.39 |
| | S. D. | 0.66 | 0.61 | 0.60 | 0.52 | 0.53 | 0.52 | 0.56 | 0.52 | 0.49 | 10.38 | 11.70 | 8.17 |
| Secondary 2 | Mean | 3.02 | 3.02 | 3.02 | 3.31 | 3.33 | 3.31 | 2.83 | 2.81 | 2.84 | 46.91 | 48.40 | 49.34 |
| | S. D. | 0.65 | 0.63 | 0.60 | 0.56 | 0.53 | 0.53 | 0.52 | 0.52 | 0.50 | 13.02 | 8.18 | 8.66 |
| Secondary 3 | Mean | 3.03 | 3.03 | 3.02 | 3.34 | 3.35 | 3.31 | 2.80 | 2.79 | 2.84 | 47.97 | 50.27 | 51.79 |
| | S. D. | 0.60 | 0.61 | 0.61 | 0.50 | 0.51 | 0.51 | 0.49 | 0.50 | 0.49 | 9.36 | 8.89 | 9.71 |
| Boys | Mean | 3.03 | 3.02 | 3.01 | 3.32 | 3.30 | 3.27 | 2.82 | 2.80 | 2.83 | 44.25 | 46.80 | 47.96 |
| | S. D. | 0.66 | 0.64 | 0.64 | 0.55 | 0.55 | 0.56 | 0.56 | 0.55 | 0.54 | 11.11 | 9.72 | 9.28 |
| Girls | Mean | 3.01 | 3.02 | 3.02 | 3.38 | 3.38 | 3.35 | 2.86 | 2.81 | 2.84 | 48.70 | 50.96 | 51.26 |
| | S. D. | 0.62 | 0.59 | 0.56 | 0.50 | 0.48 | 0.47 | 0.48 | 0.46 | 0.44 | 10.72 | 9.30 | 8.47 |

*Abbreviations.* T1 – T3 = Time 1 to Time 3.

ability schools (Ms = 3.27, 3.30, 3.24). The over-time UV- intrinsic means tended to be stable across cohorts and tended to have higher values in girls.

The T1-T3 means of MS were 2.82, 2.80, and 2.83. Students from high-ability schools seemed to have highest over-time means (all about 2.90), followed by medium-ability schools (all about 2.80), and low-ability schools (about 2.73). The over-time MS means appeared to be even across cohorts and genders.

For academic achievement tests, the T1-T3 means were 46.35, 48.78, and 49.53, respectively. High-ability schools had highest means (all above 55), followed by medium-ability schools (around 46) and low-ability schools (around 41). Higher cohorts seemed to have higher English achievement and girls had higher achievement means than boys.

Table 3 shows the bivariate correlations among the key variables. All correlations were significant except for those between UV-extrinsic and academic achievement.

## *Latent Growth Models (LGM)*

H1 to H4 which examined individual trajectories were tested by constructing individual latent growth models (LGM) for each of the variables. Results of the LGM are shown in Table 4. All tested models produced good fit indices, with all RMSEA values smaller than .05 (except for Model 3, or the LGM for MS), all SRMR smaller than .05, and all CFI and TLI larger than .95.

Table 5 presents the estimates of LGM trajectory parameters. The interpretation of the trajectory is an integrated consideration of the estimates of intercept and slope (Newsom, 2015). The intercept mean represents the initial value, while the slope mean represents the rate of change. A positive slope mean indicates growth and a negative value indicates decline. The correlation between intercept and slope means represents the change rate relative to the initial level. When the slope is positive, a positive intercept-slope correlation indicates that the higher a student endorsed a variable at the beginning of the study, the faster he/she will increase on that variable over time; a negative intercept and slope correlation suggests the opposite. With a negative slope, a positive intercept-slope correlation means, the higher a student endorsed a variable at the beginning of the study, the faster he/she will decline on that variable over time; a negative intercept-slope correlation suggests the otherwise (Newsom, 2015).

**Table 3.** Bivariate correlations and reliability (N = 6776).

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. T1 UV-extrinsic | | | | | | | | | | | | |
| 2. T2 UV-extrinsic | .453** | | | | | | | | | | | |
| 3. T3 UV-extrinsic | .414** | .499** | | | | | | | | | | |
| 4. T1 UV-intrinsic | .626** | .260** | .252** | | | | | | | | | |
| 5. T2 UV-intrinsic | .248** | .641** | .300** | .363** | | | | | | | | |
| 6. T3 UV-intrinsic | .263** | .314** | .661** | .336** | .421** | | | | | | | |
| 7. T1 MS | .268** | .162** | .165** | .390** | .240** | .202** | | | | | | |
| 8. T2 MS | .153** | .252** | .169** | .219** | .371** | .228** | .524** | | | | | |
| 9. T3 MS | .169** | .175** | .287** | .205** | .238** | .340** | .434** | .542** | | | | |
| 10. T1 Achievement | .041* | .008 | .013 | .084** | .069** | .047** | .076** | .090** | .058** | | | |
| 11. T2 Achievement | .034 | .018 | .038* | .101** | .102** | .078** | .128** | .107** | .096** | .459** | | |
| 12. T3 Achievement | .028 | .005 | .027 | .095** | .081** | .087** | .056** | .069** | .091** | .426** | .474** | |
| Cronbach's alpha | .88 | .88 | .88 | .92 | .92 | .90 | .94 | .93 | .93 | – | – | – |

***Note.***
*$p < .05$,
**$p < .01$.
*T1 – T3 = Time 1 to Time 3; UVEG = utility value for extrinsic goals; UVIG = utility value for intrinsic goals; MS = metacognitive strategies; ACH = academic achievement.*

**Table 4.** Model fit indices of LGM.

| Models | $X^2$ | *df* | $X^2/df$ | p = | RMSEA | CFI | TLI | SRMR |
|---|---|---|---|---|---|---|---|---|
| Model 1. Utility value-extrinsic | .729 | 1 | .729 | .393 | .000 | 1.000 | 1.000 | .003 |
| Model 2. Utility value-intrinsic | 3.269 | 1 | 3.269 | .071 | .018 | .999 | .996 | .006 |
| Model 3. Metacognitive strategies | 37.055 | 1 | 37.055 | .000 | .073 | .983 | .950 | .016 |
| Model 4. Achievement | .375 | 1 | .375 | .540 | .000 | 1.000 | 1.000 | .002 |
| Model 5. MLGM | 158.259 | 28 | 5.652 | .001 | .026 | .996 | .984 | .012 |

**Abbreviations:** *MLGM = multivariate latent growth model.*

The intercept variances represent inter-individual variations in the starting value of the key variables. The slope variances represent inter-individual variations in the rate of change. When the intercept or slope variances are statistically significant, then it justifies the testing of conditional LGMs wherein the researcher can explore the effects of other covariates on the initial levels (intercept) or change (slope) in the variables. The remaining part of this section explains the results of these unconditional and conditional LGMs results presented above.

As Table 5 shows, the LGM for UV-extrinsic had a significant intercept mean of 3.02 ($p < .05$), falling somewhere in the middle between 1 representing *strongly disagree* to 5 representing *strongly agree*. The mean of slope had a non-significant value of − .004 ($p < .351$). This meant that there was no change in UV-extrinsic across time.

The LGM for UV-intrinsic had an intercept of 3.35 ($p < .001$) and a slope mean of −.019 ($p < .001$). This meant that UV-intrinsic decreased across three years. The intercept and slope factors negatively correlated with each other (b = −.014, p < .001), which meant that those who had higher starting values in UV-intrinsic experienced a slower rate of decline in their UV-intrinsic over time.

The MS trajectory had an intercept mean of 2.89 ($p < .001$) and negative but non-significant slope mean of −.001 ($p > .05$). This meant that there was no change in MS across time in the overall sample. The correlation between the two factors was negative but not significant ($b = -.025$, $p > .05$).

The trajectory of English achievement had an intercept of 46.36 ($p < .001$) out of a total score of 100 and a slope mean of 1.55 ($p < .001$) which meant that English achievement increased across time. The intercept and slope were negatively correlated with each other ($b = -12.99$, $p < .001$). This meant that students who had higher levels of English at the start had a slower rate of improvement, perhaps reflecting ceiling effects.

**Table 5.** Means and variances of intercepts and slopes.

| *Unconditional (unstandardized)* | | | | | |
|---|---|---|---|---|---|
| Parameters | | UV-extrinsic | UV-intrinsic | MS | Achievement |
| Intercept with slope | | -.025*** | -.014*** | -.025*** | −12.992*** |
| Intercept mean | | 3.024* | 3.352*** | 2.828*** | 46.363*** |
| Slope mean | | -.004 | -.019*** | -.001 | 1.551*** |
| Intercept variance | | .197* | .119*** | .159*** | 69.975*** |
| Slope variance | | .025* | .018*** | .022*** | 6.773*** |
| *Conditional (standardized)* | | | | | |
| Intercept (on) | School ability | .049** | .136*** | .114*** | .662*** |
| | Secondary level | .020 | -.040** | -.086*** | .177*** |
| | Gender | -.034* | .050** | .008 | .122*** |
| Slope (on) | School ability | .060* | .040 | .049* | .160*** |
| | Secondary level | -.004 | .076** | .134*** | .016 |
| | Gender | .029 | .054 | -.036 | -.095* |

***Note.***
*$p < .05$;
**$p < .01$;
***$p < .001$.
School banding was recoded as 1 = low, 2 = medium and 3 = high. For gender, 1= boys and 2= girls.

### *Multivariate Latent Growth Models (MLGM)*

To test the relationships among concurrent trajectories, we constructed a multivariate latent growth model (MLGM) by modeling simultaneously the trajectories of all key variables (i.e., UV-extrinsic, UV-intrinsic, MS, and academic achievement). To control for possible confounding effects on the individual and concurrent trajectories, we also regressed the trajectories factors of all key variables on the three covariates (i.e., school ability, cohort and gender). The fit indices show almost perfect model-data fit: $x^2/df = 158.26/28 = 2.02$, $p < .001$, CFI = .97, TLI = .98, RMSEA = .03, and SRMR = .01. Figure 1 shows the diagram of the MLGM with standardized estimates.

After controlling for the covariate effects, the intercepts of achievement, MS and UV-intrinsic were significantly related to each other: achievement with MS ($b = .11$, $p < .001$), achievement with UV-intrinsic ($b = .18$, $p < .001$), and MS with UV-intrinsic ($b = .54$, $p < .001$). UV-extrinsic was significantly related to UV-intrinsic ($b = .68$, $p < .001$) and MS ($b = .36$, $p < .001$). In other words, students' starting values for all the crucial variables such as UV-extrinsic, UV-intrinsic, MS, and achievement were all positively correlated with each other.

The slope of achievement was only significantly related to the slope of MS ($b = .48$, $p < .001$). The slope of MS was significantly related to UV-intrinsic ($b = .35$, $p < .001$). Finally, the slope of UV-intrinsic was positively related to the slope of UV-extrinsic ($b = .60$, $p < .001$) which meant that greater stability in UV-extrinsic was associated with a slower rate of decline in UV-intrinsic. No other significant slope correlations were observed.

## Discussion

The current study aimed to examine the dynamic relationships among UV, MS, and achievement. Our study showed that these constructs not only changed across time (individual trajectories) but that they also dynamically influenced each other across time such that changes in one variable were associated with changes in other variables (concurrent trajectories). Hence, our study provides strong empirical evidence for theoretical arguments that motivation, SRL, and achievement are dynamically related to each other across time (Ben-Eliyahu, 2019; Conley & French, 2014; Winne & Hadwin, 2008; Zimmerman & Schunk, 2011). Though the theoretical insight that key variables are dynamic is not new (e.g., Paris & Newman, 1990; Winne, 2005), empirical research

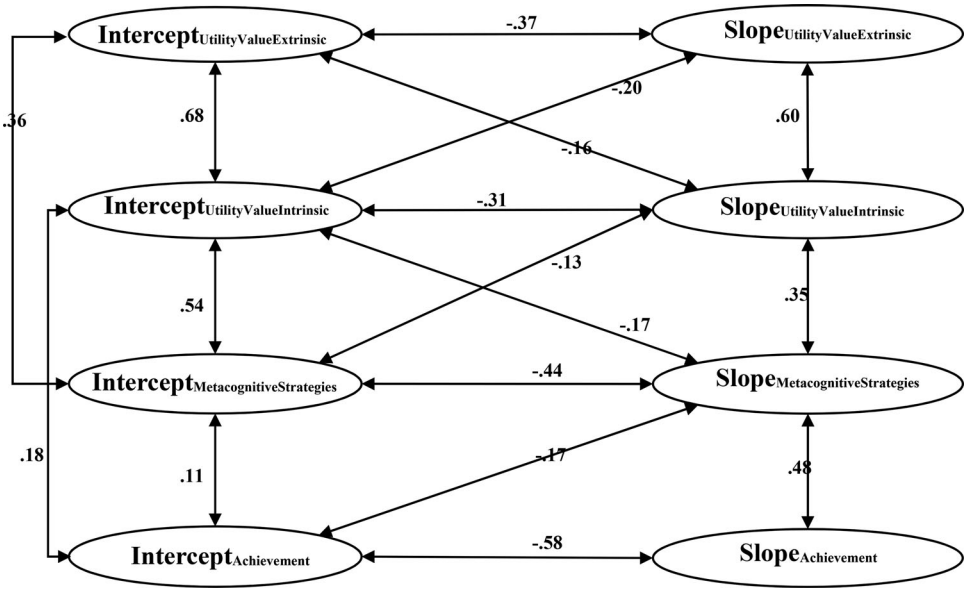


**Figure 1.** Results of multivariate growth curve modeling (Standardized).
*Note.* For brevity, covariates and relevant estimates are omitted.

has lagged behind most studies using cross-sectional approaches which fail to show the dynamic reciprocal relations among the constructs of interest.

## *Individual Trajectories*

*UV-extrinsic was stable across time.* The nonsignificant mean of slope ($M = -.004$, $p > .05$) for UV-extrinsic indicated that on average UV-extrinsic remained stable among Hong Kong secondary students across the observed years. Therefore, our hypothesis that UV-extrinsic declines was not confirmed. The stability of UV-extrinsic seems to go against past studies which have observed declines in UV (e.g., Jacobs et al., 2002; Watt, 2004). A possible reason for this disagreement is related to the measurement of UV.

A key contribution of our study was that we distinguished between UV-extrinsic and UV-intrinsic in line with prior research conducted by Lee and colleagues (2010). Expectancy-value researchers usually do not distinguish among different types of utility value as past studies have generally focused on UV in general or the overall perceived usefulness of schooling without delving into the specifics (for example whether schooling is useful for intrinsic or extrinsic reasons (Wigfield, 1994; Wigfield & Eccles, 2000).

Empirically, we demonstrated that students' trajectories in these two types of UV were distinct with no change in UV-extrinsic but an overall decline in UV-intrinsic. This is a cause for concern because UV-intrinsic is considered more adaptive than UV-extrinsic. It also mirrors past studies showing declines in adaptive motivational factors across time (Gillet et al., 2012; Gottfried et al., 2007; Lepper et al., 2005; Scherrer & Preckel, 2019; Watt, 2004). The different trajectories of UV-extrinsic and -intrinsic also corroborate past studies showing the multifaceted nature of task value (Eccles & Wigfield, 2002) and more specifically the benefits associated with further distinguishing between different types of utility value (Lee et al., 2010).

Note that in the Hong Kong Chinese context, learning English is mandatory. Mastery of the language is also key to gaining upward mobility and it is one of the critical subjects tested in the university entrance exams. Hong Kong society also places a very high importance on English.

This might be the reason why there was no change at all in UV-extrinsic as most students might recognize the extrinsic value of education in general and the English language in particular.

*UV-intrinsic declined over time.* The negative value of UV-intrinsic slope mean ($M = -.019$, $p < .001$) suggested that UV-intrinsic declined therefore confirming our second hypothesis. Compared with the trajectory of UV-extrinsic, the LGM results of UV-intrinsic suggests that, although UV-intrinsic starts at a relatively higher level than that for UV-extrinsic, UV-intrinsic declines during the secondary years. This is not surprising, given the delclines in UV reported across various academic domains (Fredricks & Eccles, 2002; Jacobs et al., 2002; Nagy et al., 2010). It also corroborates one of the most comprehensive meta-analyses of longitudinal studies in motivation which showed that adaptive types of motivation such as intrinsic motivation showed the steepest decline across the years (Scherrer & Preckel, 2019).

A possible explanation of this decline could be provided by research on stage-environment fit (Gutman & Eccles, 2007; Wigfield & Eccles, 2000) which states that negative psychological changes during adolescent development are due to a mismatch between developing needs of students and the opportunities available in the social environment. The quality of the school environment typically decreases after transition to middle school and the changes in the school environment could cause disruptions in children's social networks which are also closely linked to a decrease in academic functioning.

*MS was stable across time.* The developmental trend of MS is a complex one. On the surface, the non-significant mean of the MS slope seemed to suggest that students' reported use of MS remained unchanged during the observed years. In part, this finding corroborates the belief that sufficient cognitive capacity developed during early adolescence does not ensure automatic use of this higher-order processing (Metcalfe, 1996). However, we were not able to disconfirm our hypothesis on the increase of MS at this stage, as we were surprised to find later during our MLGM that the slope of MS is significantly related to the slope of UV-intrinsic and the slope of achievement (please see our results of the MLGM). Note that the non-significant slope meant that the MS trajectories of the different students when averaged together was non-significant. However, this does not preclude the possibility that for some students there might have been a change in MS. For example, for some students, MS might have increased and for others, it might have decreased which when averaged together could have led to a non-significant slope.

There might actually be a reason to believe that different types of students had different trajectories which were masked by the overall pattern. We, therefore, ran conditional LGM with school ability and student cohort as predictors (i.e., students' starting grade when data collection initially began).

The positive albeit small effect of school ability on MS slope ($\beta = .05$, $p < .001$) indicated that students' MS tended to increase among high-ability schools. However, this was not the case among low-ability schools. The variation in slope means across year levels clearly showed that the MS trajectories varied from declining with Secondary 1 students ($M = -.21$, $p < .001$), to being stable with Cohort 2 students ($M = .07$, $p = .095$), and then to increasing with Secondary 3 ($M = .12$, $p = .005$). Hence, the overall non-significant slope of MS masks heterogeneity in the sample. Older students experienced an increase in their MS use over time and this finding is in line with the findings of Schneider and colleagues (2017) with secondary students (Grades 5 to 9).

Interestingly, this increase in the use of MS which was found among older students contradicted the findings by other studies (e.g., Caprara et al., 2008; Heater, 2005; Helle et al., 2013). We examined the design of these studies and identified the following features. First, the measures of MS either overlapped with other non-SRL constructs such as self-efficacy (e.g., Caprara et al., 2008), or with SRL factors such as cognitive strategies (e.g., Caprara et al., 2008; Heater, 2005). In addition, none of these studies considered covariates such as school ability and grade that might have a significant effect on the trajectory of MS as suggested by the findings of Schneider and

colleagues (2017). It seems that controlling for covariate effects from multiple sources (especially school ability) is essential for future research to obtain a clearer picture of change in MS.

*Students' academic achievement increased over time.* The positive slope mean ($M = 1.55$, $p < .001$) confirmed our hypothesis that English achievement improved across time. This increasing trend in English learning is consistent in general with findings regarding the trajectories of language learning with students learning more as they spend more time in school (Van de Gaer et al., 2009). The mean of the intercept ($M = 46.36$) indicated that students' academic achievement was at an intermediate level when the study began as the maximum score was 100. The negative relation between the intercept and slope factors ($b = -12.99$, $p < .001$) suggested that students starting at lower levels increased faster in English achievement perhaps demonstrating ceiling effects for the more advanced students.

## Concurrent Trajectories

The discussion above focused on change in individual trajectories. Next, we examined concurrent trajectories. More specifically, we examined whether changes in UV-extrinsic, UV-intrinsic, MS, and achievement were related to each other after controlling for the covariates of school ability, grade level, and gender.

Results of the slope correlations provide information regarding the dynamic relations among UV, MS, and academic achievement. The slopes of achievement and MS were positively correlated with each other ($r = .48$, $p < .001$), suggesting that a faster increase in achievement goes together with a faster increase in MS. This pattern might be especially true for older students (i.e., those who were in Secondary 3 at the start of the study) whose MS increased over time as in our supplementary analysis. This dynamic relationship is consistent with the findings by Schneider et al. (2017). The association between change in achievement and in MS provides evidence that they are mutually reinforcing (Pintrich, 2000; Winne, 2011; Zimmerman & Schunk, 2011). It is also consistent with prior studies showing dynamic interdependence which is gaining the attentions of systems thinking researchers (Cai & Cheung, 2021; Jacobson et al., 2016). According to this strand of research, the development of these two variables is intertwined. In much of extant literature, however, researchers typically posit MS as precursors to achievement. Though there is a small body of work showing that MS could drive subsequent achievement (King & Mcinerney, 2016), these types of studies remain relatively scarce. Our results demonstrate that these two variables are best viewed as dynamically intertwined.

The slopes of MS and UV-intrinsic had a medium-sized correlation ($r = .35$, $p < .001$). The interpretation of this relation between MS and UV is not straightforward, as UV-intrinsic showed a declining trend (see our earlier discussion for Hypothesis 2) and MS appeared to be stable (see our discussion for Hypothesis 3). Substantively, a positive correlation between a positive mean slope (representing an increasing trend) and a negative mean slope (representing a declining trend) should be interpreted as a faster increase in one construct goes together with a slower decline in the other (Grimm et al., 2017). In our case, the positive correlation between the positive mean slope of MS and the negative mean slope of UV-intrinsic suggests that a faster increase in MS goes together with a slower decline in UV-intrinsic. These results broadly converge with past studies showing that more intrinsic types of motivation are adaptive and have protective effects (Howard et al., 2017; Ryan & Deci, 2020). Students who perceive school as useful for achieving their intrinsic goals or aspirations are more likely to use more adaptive MS as they progress through their school journeys.

The dynamic relation between MS and UV-intrinsic provides a plausible interpretation for the stable stage of UV development at the transition to secondary school study found in the literature (Wigfield et al., 2015). At this stage, students' MS increases due to their maturation in metacognition (Ryan & Pintrich, 1997). Given that higher MS usually goes together with higher UV-

intrinsic (Wolters & Pintrich, 1998), an improvement in MS goes together with a slower decline in UV-intrinsic. This finding, together with that of the positive correlation between the slope of MS and the slope of academic achievement, is the first empirical evidence verifying a dynamic relation between UV, MS, and academic achievement hypothesized by self-regulated learning researchers (e.g., Pintrich, 2000; Zimmerman & Schunk, 2011) and expectancyvalue theorists (Wigfield et al., 2015). It also extends past theorizing on the important linkage between motivation and MS. It seems that MS is a crucial factor in optimal motivation and learning as a faster increase in MS was related to a greater increase in achievement and a slower decline in UV-intrinsic. These patterns are applicable to older students and students in higherability schools who experienced an increase in MS over time.

Another complex component of the dynamic system pertains to the change in UV-extrinsic. Our results showed that the slope of UV-extrinsic was significantly related to the slope of UV-intrinsic (with a large effect size). We examined this finding further by conducting supplementary analysis as we did with MS. A closer look at the change of UV-extrinsic with covariates included showed that the trajectory of UV-extrinsic appeared to be affected by school ability ($\beta = .05$, $p < .01$). Therefore, we examined the means of UV-extrinsic slope across different types of schools. The results further confirmed that UV-extrinsic remained relatively stable across different types of schools: M= −.24 (p =.501) for low-ability schools, M = −.048 ($p$ =.210) for medium-ability schools, and M = .054 ($p$ =.168) for high ability schools, though there is a trend toward an increase. Given these findings, the positive correlation between the slopes of UV-extrinsic and UV-intrinsic means that the more stable UV-extrinsic is, the slower UV-intrinsic declines.

To understand better the mechanism in which motivation and metacognitive strategies function during individuals academic development, it is essential to explore in greater depth the complexities underlying the static function of these variables as long proposed by self-regulated learning scholars (Ben-Eliyahu & Bernacki, 2015; Zimmerman, 2008). The concurrent changes identified between MS and UV-intrinsic, between UV-intrinsic and -extrinsic, and between MS and achievement in our study reveals that the processes of learning not only depend on the characteristics of a learner, but also as a function of other variables which are all developing in parallel (Ben-Eliyahu & Bernacki, 2015). Neglect of such dynamic relations is deemed to provide an incomplete picture of how these key variables function during academic development. Perhaps, drawing attention to and providing empirical evidence of these dynamic relationships is one of the most important contributions of the current study. In summary, the findings on individual and concurrent trajectories are:

1. Students' UV-extrinsic is stable but UV-intrinsic declines across time.
2. Achievement increases across time.
3. Students whose MS increased faster also enjoyed larger achievement gains over time.
4. Students whose MS increased faster experienced a slower decline in their UV-intrinsic.

Taken together, our study extends existing theorizing on motivation and SRL which have mostly been confined to examining static relationships among variables. Though expectancy-value researchers and self-regulated learning scholars have explicitly argued that their theoretical models are recursive and dynamic, few empirical studies explicitly take a longitudinal approach that simultaneously models individual and concurrent trajectories. Past studies have mostly used a cross-sectional design or a pre- and post- design. Our study shows that motivational constructs, MS, and achievement are dynamic mutually and reciprocally reinforcing each other across time. The crucial importance of MS is reflected in the fact that its increase is associated with increases in achievement and less decline in UV-intrinsic. Hence, it suggests that MS might be an especially important factor to consider in student learning and achievement.

### Limitations

Despite its strengths, our study has a number of limitations. First, our measures of MS relied on self-reports. Although there is a long tradition of using self-reports for MS (Bruso & Stefaniak, 2016; Schellings & Van Hout-Wolters, 2011), more recent studies emphasize the need to complement self-reports with behavioral measures of MS (Veenman et al., 2006). Including both self-reported and behavioral measures of MS may yield new insights.

Second, because of logistical constraints such as schools being unwilling to participate in the crucial last year of secondary school as students are preparing for high stakes final year examinations), we were not able to collect student responses during their last year in secondary school. Therefore, we were not able to produce data showing whether the change pattern was sustained until the end of secondary school study. Future studies may consider collecting data over the whole secondary school career.

Third, our measure of achievement was a standardized test. While this enabled us to aggregate the data of students across schools because they all answered the same standardized test (for students of the same year level), a different picture might have emerged if we used students' teacher-assigned marks instead. Perhaps, UV and MS might be more strongly linked to teacher-assigned marks compared to a standardized test and teacher-assigned marks might also be more psychologically salient for students.

Fourth, our measures had different grain sizes. The constructs of UV-intrinsic, UV-extrinsic, and MS were measured at the general school domain, while achievement was operationalized using an English test. Past studies on achievement have shown that students' achievement scores in various subject domains are highly correlated with each other (OECD, 2015) which motivated our decision to use an English test as the outcome measure. Using a standardized achievement test in one subject also simplified our data collection purposes and enhanced comparability across schools. However, future studies can use a broader measure of achievement, perhaps by including other subjects, in order to more fully capture students' achievement.

Last, we only focused on metacognitive strategies in terms of self-regulated learning. However, recent studies have shown that self-regulated learners also regulate their emotions (Ben-Eliyahu, 2019; Ben-Eliyahu & Linnenbrink-Garcia, 2013) and motivation (Miele & Scholer, 2018; Scholer et al., 2018) among others. Future studies can also incorporate emotional elements and explore their dynamic relations with motivational and achievement outcomes.

## Conclusions

The current study examined the individual and concurrent trajectories of UV-extrinsic, UV-intrinsic, MS, and achievement. In terms of individual trajectories, we observed that students' achievement generally improved across time and that UV-extrinsic was generally stable. However, we found a declining trend in UV-intrinsic across all students. Given the apparent positive role of UV-intrinsic in learning and motivation, this is an area that educators and researchers need to focus on. In terms of concurrent trajectories, we found the existence of dynamic relations among these variables.

To conclude, our research presents a dynamic picture of students' motivation and learning. UV, MS, and achievement are closely related to each other with changes in one construct affecting changes in another. Further research studying complex dynamic relationships among critical psychological processes related to learning and motivation, which have long been theoretically acknowledged but have been left empirically unexamined, should be encouraged.

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