The role of the learning environment in adolescents' motivational development

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Abstract

Past research has continuously shown that motivation in school declines across adolescence. To counteract potential declines in educational practice, the present study examines the motivational development of early and middle adolescent students within one school year and across two distinctive learning environments: a conventional teacher-directed learning environment and an individualized student-directed learning environment based on competency matrices. Based on a sample of 1153 ($M_{age} = 13.97$, $SD = 1.37$, 49% girls) students from grades 7 to 10, latent change analyses were conducted to examine within-school year changes in general self-efficacy and intrinsic value. Significant interaction effects of age and learning environment suggest that motivational trajectories may diverge from the consistent motivational declines that have been demonstrated by past research. Students from both learning environments differed in their general self-efficacy, but not in their intrinsic value.

Keywords Motivation · Intrinsic motivation · Self-efficacy · Learning environments · Development

Introduction

For decades, empirical research has repeatedly shown that motivation in school decreases during adolescence. These declines have mostly been attributed to school transitions and to the lack of adaptivity of learning environments to maturing students (Eccles & Midgley, 1989; Eccles & Wigfield, 2020). In other words, students develop throughout adolescence in terms of physical and psychological maturation; however, their learning environments do not meet the needs of developing adolescents according to the stage-environment fit theory (Eccles & Midgley, 1989; see Rosenzweig et al., 2019), which was recently integrated into situated expectancy-value theory (SEVT; Eccles & Wigfield, 2020). While a vast body of research on motivation continuously exhibits determinants of fostering motivation in educational processes, a distinctive feature of students' experience in school, namely the learning environment, has been widely neglected (Kulakow & Raufelder, 2020). The present study

has been conceptualized to address this important blind spot in educational research and simultaneously examine whether motivational declines can also be identified within a school year.

Motivation and its development throughout adolescence

According to SEVT, two key determinants of motivation are self-efficacy (i.e., success expectancy) and intrinsic value. Intrinsic value relates to the anticipated enjoyment of engaging in activities, while self-efficacy refers to expectancies of success or students' beliefs in their own ability to accomplish upcoming tasks.

Self-efficacy can be defined as the individual evaluation of capability to perform and succeed in certain behaviors (Bandura, 1997). Contrary to other capability beliefs, self-efficacy places a stronger focus on the individual conviction to be able to succeed rather than to evaluate individual prerequisites (Bong & Skaalvik, 2003). While research on self-efficacy has mainly been domain specific, there has also been a growing research body concerning higher-order manifestations of self-efficacy that subsume domain specificity in favor of more overarching generalizations (e.g., Caroli, 2014). Bardach et al. (2019)

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conclude that differences in higher-order factors such as general self-efficacy might even represent stronger effects. This might be particularly true since domain-specific differences often cancel each other out. Self-efficacy has been shown to be beneficial for numerous educational outcomes such as increased achievement, persistence and effort, and self-regulation as well as reduced test anxiety (Tang & Westwood, 2007; Kitsantas & Zimmerman, 2008; Salami & Ogundokun, 2009; Schnell et al., 2015; Hoigaard et al., 2015; Raufelder & Ringeisen, 2016; Rossi et al., 2020) and is highly contextualized (Bandura, 1997). Individuals develop an “enduring interest in activities at which they feel efficacious and from which they derive self-satisfaction” (Bandura, 1997, p. 219). Longitudinal research on the development of self-efficacy has yielded quite ambiguous results. While some studies have exhibited a tendency of decline (Anderman et al., 1999; Urdan & Midgley, 2003), others have found the opposite: continuous increases in self-efficacy with age (Zimmerman & Martinez-Pons, 1990; Shell et al., 1995; Reeve & Lee, 2014). However, whereas the former studies relied on general self-efficacy, the latter had a higher degree of specificity (i.e., reference to a certain class or subject).

Intrinsic value, which has often been called interest value, refers to “the anticipated enjoyment one expects to gain from doing the task for purposes of making choices and as the enjoyment one gets when doing the task” (Eccles & Wigfield, 2020). Additionally, and similarly to self-efficacy, Wigfield & Eccles (2020) propose that although these constructs are highly situation-specific, there are also hierarchies of these subjective task values that are predictive of students’ task and activity choices. In that definition, it shares the properties of what Deci & Ryan (2000, p. 70) refers to as intrinsic motivation—“the inherent tendency to seek out novelty and challenges, to extend and exercise one’s capabilities, to explore, and to learn.” However, it should be noted that despite the conceptual overlap of both constructs (i.e., intrinsic value and intrinsic motivation), they “come from distinct theoretical perspectives and so have different intellectual roots” (Eccles & Wigfield, 2020, p. 73).

Person-oriented studies conducted within the framework of expectancy-value theory (EVT) have demonstrated that intrinsic value and success expectancy are highly correlated, although there is usually one group of students present that exhibit high expectancies but low intrinsic value (Lazarides & Dicke et al., 2019; Lazarides & Dietrich et al., 2019). While there have generally been high stabilities of these patterns in these studies, numerous students have changed to more or less adaptive profiles throughout adolescence. Consequently, we can assume that there are substantial inter-individual differences in the association of intrinsic value and self-efficacy.

Learning environments as distinctive precursors of motivation

In the shift from EVT to SEVT, Eccles et al. (2020) have highlighted the role of context in educational trajectories. In this way, they more coherently incorporate aspects that have previously been limited to stage environment fit theory (Eccles & Midgley, 1989; Eccles, 1993). Thus, it is assumed that the educational context with various features (e.g., socializers’ beliefs, activity characteristics and demands, possible activities) influences students’ expectancy and value beliefs. More specifically, it is assumed that the majority of motivational declines that have been shown by empirical research can be attributed to a mismatch of the individual needs of students in specific phases of their development and the educational context that should foster learning processes (Eccles & Midgley, 1989). One core problem is that in conventional TDL environments, there is a strict focus on normative comparisons of students’ academic performance rather than on individual development. Moreover, these rather controlling learning environments are established in a time in which adolescents continuously seek for more room for independent decision-making, mainly manifested in the need of autonomy. Accordingly, Rosenzweig and colleagues (2019, p. 624) stated that such “school environment changes can negatively impact many students’ expectancies and values for various academic tasks and subject areas” (Rosenzweig et al., 2019, p. 624).

Interestingly, the majority of empirical motivational research refers to the term *adaptivity* with regard to students’ tendencies to adapt to their learning environments. Thus, adaptive motivation usually refers to students who demonstrate high values of motivation, whereas maladaptive motivation refers to those who demonstrate low values (e.g., Kolić-Vehovec et al., 2008; Collie & Martin, 2017; Lazarides & Dicke et al., 2019). However, if we consider the theoretical backgrounds that (a) “lack of fit between children at this stage of life and the classroom environments they experience” (Eccles & Midgley, 1989, p. 174), (b) “caregiving environments nonetheless strongly affect these intrinsic properties to learn” (Ryan & Deci, 2017, p. 352), and (c) “efficacy beliefs [...] are differentiated across domains and contexts” (Zimmerman, 1997, p. 216)—it becomes apparent that contexts, such as specific learning environments may be more or less adaptive to students’ needs, which in turn may have repercussions on their motivation.

Furthermore, features of the educational context (i.e., adaptive prerequisites) are usually captured by aggregated classroom and school variables (Lüdtke et al., 2008; Marsh et al., 2012; Bardach et al., 2020). For example, Morin

et al. (2014) demonstrated that aggregated classroom climate (i.e., classroom goals, challenge, teacher caring) had positive effects on students' self-efficacy. However, this line of empirical research is built on the assumption that all learning environments are basically the same and differ only with regard to the magnitude of those climate variables. In contrast, a study has shown that differences between learning environments can persist even after controlling for classroom-level differences (Kulakow, 2020b).

However, the question that arises is—when are learning environments adaptive? From our point of view, a major hindrance to achieving adaptivity is the dependence of conventional learning environments on the teacher: in traditional teacher-directed learning environments, teachers have to simultaneously determine learning goals, select appropriate material, choose methods to enhance variability, evaluate performance, and provide a supportive climate—at best, for each student individually. It is no wonder that many teachers prefer ability-grouped classes, because these help teachers address their students' needs more adequately (Chorzempa & Graham, 2006). In that way, Eccles and colleagues (1991, p. 533) state that particularly after the transition from elementary schools to secondary schools, students face “greater emphasis on teacher control and discipline, a less personal and positive teacher-student relationship, and fewer opportunities for student decision-making, choice, and self-management.” In other words, students' basic needs for autonomy, competence and social relatedness—as stated in self-determination theory (SDT; Deci & Ryan, 1985)—are less satisfied in TDL in secondary schools. However, satisfying adolescents' needs is critically important for maintaining adolescents' motivation in school (Gnambs & Hanfstingl, 2016; Ryan & Deci, 2017). Supplemented with increases in whole-class instruction and between-class ability grouping, which is typical for the traditional teacher-directed learning (TDL) environments that still endure and dominate in-class learning since decades, it is questionable how such learning environments can be adaptive to students' needs.

Student-directed learning environments on the basis of competency matrices

In recent years, educational practice has seen an influx of alternative learning environments that challenge traditional views of how learning and instruction typically work. Generally, these learning environments are subsumed under the umbrella term of student directedness (Knowles, 1975). These student-directed learning (SDL) environments aim to be adaptive to students' needs through instructional practice that tries to tailor learning processes more individually (Baeten et al., 2010): by taking students' interests into consideration, providing flexible learning conditions and individualized learning objectives and offering phases in

which students are responsible for their own learning students' need of autonomy can be satisfied (Benware & Deci, 1984; Vansteenkiste et al., 2004; Benita et al., 2014). By providing opportunities for self-assessment, offering feedback (suggestions of specific steps for improvement) that supports actions, and including students when setting learning objectives, students' need of competence can be satisfied (Pianta et al., 2003; Hattie, 2009; Niemiec & Ryan, 2009; see Schweder & Raufelder, 2021a, b). One such student-directed learning (SDL) environment that is receiving increasing attention in Germany builds its instruction and learning processes on the work with competency matrices. In this way, as in many other forms of classroom organization, the instructional process is partly decoupled from the teacher in such a way that teachers can support individual students without stopping or blocking learning processes for other students (Kulakow, 2020b). While competency matrices have a long history of being used as a means for assessment and evaluation (Stevens et al., 2013; Lesmond et al., 2017), they have also recently been discovered as a means for instruction and the coordination of learning processes. Initially, students' initial competence level is determined across different subjects and across different subject domains (i.e., competence domains). Schools handle this determination of the initial position within the competency matrix differently: they either conduct some form of summative assessment which should approximate the zone of proximal development (Vygotsky, 1978) or they determine the initial position by means of students' self-assessment to encourage metacognitive thinking. Depending on that initial sub-competence level, students are enabled to access material that helps them to develop that respective competence following a task-based learning approach (Schweder et al., 2019; Kulakow, 2020b). Subsequently, depending on the tasks and sub-competence levels at hand, they engage in evaluation with respective solutions or with the support of peers and teachers. Implicitly, this learning environment thereby follows the cyclical model of self-regulation (Zimmerman, 2000). In that learning environment, instruction is generally independent of the teacher, who can in turn focus on individual support, classroom management and a general positive climate, which fosters students' need satisfaction of social relatedness.

However, there is limited research that contrasts students' motivational development in different learning environments. Prior research that compared students in SDL and TDL environments is mostly based on cross-sectional designs and mean value differences between groups (Schweder, 2019; Schweder et al., 2019; Kulakow, 2020b). These studies have shown that students in SDL report higher mean values of autonomy, interest, flow, elaboration, persistence, mastery goals and positive emotions as well as higher self-efficacy and academic self-concept compared to

students in TDL (Kulakow, 2020a; b; Schweder & Raufelder, 2021a, b; Schweder et al., 2020). However, none of these studies examined motivational trajectories over time. The present study was conceptualized to fill this research gap.

Hypotheses

Based on SEVT and the empirical results outlined above, the present study examines the following hypotheses:

H1: Generally, there is a negative development of intrinsic value and self-efficacy from T1 to T2, since students' intrinsic motivation and self-efficacy tend to decrease during adolescence (Anderman et al., 1999; Urdan & Midgley, 2003; Otis et al., 2005; Gnambs & Hanfstingl, 2016) and during a school year (Corpus et al., 2009).

H2: Changes in students' self-efficacy are associated with changes in their intrinsic value.

H3: Age and group membership (SDL vs. TDL) predict the change in both intrinsic value and self-efficacy.

H4: The interaction of age and group membership additionally functions as a predictor of the changes in both self-efficacy and intrinsic value.

Methods

Sample

The first round of data collection took place in the 2015 winter term of the German school year. In this first round, 1153 adolescent students aged 12 to 18 years from grades 7 to 10 ($M_{age} = 13.97$, $SD = 1.37$, 49% girls) from six secondary schools in the federal states of Berlin, Mecklenburg-West Pomerania, North Rhine-Westphalia, and Schleswig-Holstein were asked to complete the survey instruments. The second round of data collection took place in the 2016 summer term, wherein 775 adolescent ($M_{age} = 14.27$, $SD = 1.25$, 49% girls) students from the original sample were surveyed again. The dropout rate between both points of measurement was 22.8%.

Three schools were purposely chosen that have an individualized SDL environment with competency matrices at their core. In the pool of potential schools, we only considered those that met the following criteria: (1) The use of competency matrices as the main instructional practice has been present in the school for so long that study participants have only been exposed to this learning environment in their secondary school lives. (2) Competence matrices are used in all major subjects (i.e., German, mathematics, second language). (3) Apart from specific teacher interventions, students can generally decide for themselves which subjects they want to work on.

Based on these criteria, only three schools were eligible, all of which are urban low-track and mixed-track schools ($N_{classes} = 36$). Since no rural and no high-track schools are present in this sample, for the comparison group—the TDL group—a restricted random sample was chosen; this also excluded rural and low-track schools to achieve comparability ($N_{classes} = 21$). These schools have a traditional TDL environment at the core of their instructional practices.

Procedure

To comply with school and privacy laws as well as with ethical standards (American Psychological Association, 2002), a strict procedure was adhered to. First, since in Germany the collection of data in schools has to be approved by the government, permission to conduct the study was granted by the Ministry of Education, Science, and Culture of the federal state of Mecklenburg-Vorpommern, the Senate Administration for Education, Youth, and Family of the federal state of Berlin, the Ministry of Education and Science of the federal state of Schleswig-Holstein, and the Ministry of Schools and Education of the federal state of North Rhine-Westphalia. Second, the schools were approached. Third, letters were distributed to students and teachers explaining the goals of the study, the voluntary nature of participation, and the assurance of anonymity. To ensure this anonymity in the longitudinal assessment, students were first pseudonymized. For that, random codes were generated for each student and were stored by the principal investigator. After the second wave of data collection, these lists containing pseudonyms and students' name were deleted.

On the day of data collection, two research assistants were present throughout the survey. They repeated the goals, the voluntary nature of participation, and the data protection to the students, and they then explained how to use the questionnaire, particularly the Likert scales. Moreover, if necessary, they answered any questions about the nature of the questions and explained any ambiguous items.

Measures

Self-efficacy

Using the German version of the general self-efficacy scale (Jerusalem & Schwarzer, 1999), students answered 10 items (e.g., "I can find a solution for every problem") on a 4-point Likert scale ranging from 1 ("not true") to 4 ("exactly true") to evaluate their self-efficacy. McDonald's Omega indicated good reliability ($\omega_{T1} = 0.86$; $\omega_{T2} = 0.87$).

Intrinsic value

Using the version of the Academic Self-Regulation Questionnaire (Ryan & Connell, 1989) adapted and validated for German students (Müller et al., 2007), intrinsic value was measured with five items on a 5-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”; e.g., “I work and learn in class because it is enjoyable”). The scale exhibited a good reliability ($\omega_{T1} = 0.86$, $\omega_{T2} = 0.86$). In the absence of suitable validated and established measurement instruments for German students, we operationalized intrinsic value using intrinsic motivation.

Statistical analyses

All statistical analyses were performed with Mplus 8.1 (Muthén & Muthén, 1998–2017) using the robust maximum likelihood (MLR) estimator. Because the data of the present sample underlie a nested structure (students in classes), the complex modeling procedure (type = complex) was followed, which corrects the estimated standard errors for nested structure in data (Hox, 2002).

Initially, descriptive statistics and measurement invariance tests were estimated. Subsequently, structural equation models were conceptualized to test the hypotheses. With latent change models, both intraindividual and inter-individual differences in change over time can be identified (Steyer et al., 1997; Steyer et al., 2000; Hamagami & McArdle, 2001; McArdle, 2009). The Steyer et al. (1997) parametrization was utilized where the latent variables at T1 were measured using the indicators at T1 and T2 and the latent differences (i.e., Δ intrinsic value, Δ self-efficacy) were identified using solely the indicators at T2.

The analyses are built on a two-step procedure: First, to examine the change and general development of intrinsic value and self-efficacy from T1 to T2, an unconditional latent change model was estimated solely for intrinsic value and self-efficacy. Second, a conditional latent change model with intrinsic value and self-efficacy in one model was designed to detect the associations between the changes in intrinsic value and self-efficacy over time. Furthermore, the group variable, which distinguishes between students from SDL environments and students from TDL environments, was included as the predictor variable of the change in intrinsic value and self-efficacy. Since the sample is constituted of 7th to 10th graders, age was also included as a potential predictor variable of the change in intrinsic value and self-efficacy. Finally, an interaction term of age and group was included as a predictor variable to test whether both age and group membership explain the change in students' intrinsic value and self-efficacy. To counteract a potential inflation of type I error rate, all significance values were adjusted with the

Benjamini and Hochberg (1995) procedure, which control the false discovery rate of the hypotheses.

As is common in statistical analyses, the following parameters have been considered to identify the quality of each structural equation model (e.g., Hu & Bentler, 1999; Schweizer, 2010; West et al., 2012): Besides the χ^2 -statistic that is sensitive to sample size (Marsh et al., 2005; Kline, 2016), the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) were used as indicators. An acceptable fit to the data is reflected by CFI values greater than 0.90 and RMSEA and SRMR values lower than. If the CFI value is greater than 0.95 and the RMSEA and SRMR values are lower than 0.06 and 0.08 respectively, the models reflect good fit to the data.

Of the 1153 cases used in the study, 393 (34%) were affected by missing data. Across the 34 observed variables, missingness varied between 0.00% and 32.78%. Due to the extensive critique of traditional techniques of removing all missing data (listwise deletion) or mean imputation (Little & Rubin, 1987, 1989; Schafer & Graham, 2002), the presented analyses are based on the full information maximum likelihood (FIML) approach that, in contrast to these traditional techniques, reduces bias. More precisely, maximum likelihood estimation increases the precision of the parameter estimates while simultaneously maintaining statistical power. The FIML approach was conducted under the *missing at random* assumption (Rubin, 1987).

Results

Initially, latent bivariate correlations between the interest and self-efficacy measures and their descriptive statistics were conducted (see Table 1).

In the next step, measurement invariance testing for all variables was conducted following a stepwise procedure as recommended by Brown (2015). The fit indices of the subsequent models (see Table 2) were all below the thresholds recommended by Chen (2007), which implies strong factorial invariance. These guidelines state that a more restricted model replicates the data better if χ^2 is insignificant (Satorra & Bentler, 2001) and that models are favored if Δ RMSEA $\leq .015$, Δ CFI $\leq .010$, and Δ SRMR $\leq .010$ (Chen, 2007). Strong factorial invariance is a precondition of conducting latent change models.

Latent change models

To test H1 and H2, an unconditional latent change model was used to investigate the change in intrinsic value and self-efficacy from T2 to the initial state (T1). This unconditional latent change model (see Fig. 1) showed a good model

Table 1 Bivariate latent correlations, means, range, standard deviations, skewness (SE), kurtosis (SE)

	Mean	SD	Range	Skewness (SE)	Kurtosis (SE)	2	3	4	5	6
Time 1										
1 Intrinsic value	2.82	0.85	1–5	0.72 (0.07)	−1.48 (0.14)	0.48*	0.64*	0.40*	−0.08*	−0.09*
2 Self-efficacy	2.67	0.53	1–4	0.05 (0.07)	−.07 (0.14)		0.29*	0.62*	0.01	−0.24*
Time 2										
3 Intrinsic motivation	2.79	0.86	1–5	−0.10 (0.09)	−0.22 (0.18)			0.40*	−0.05	−0.03
4 Self-efficacy	2.65	0.54	1–4	−.23 (0.09)	0.47 (0.18)				0.02	−0.17*
Predictor variables										
5 Age	13.97	1.37	11–18							0.13
6 Group			0–1							

* $p < 0.05$; The correlation coefficients are standardized; group: 0 = students from student-centered learning environments, 1 = students from teacher-directed learning environments

Table 2 Summary of results for tests of longitudinal measurement invariance

Model	df	χ^2	p	CFI	RMSEA	90% CI	SRMR	Δ CFI	Δ RMSEA	Δ SRMR
Intrinsic value										
1 Configural MI	34	150.07	<0.001	0.97	0.05	[0.05–0.06]	0.04	–	–	–
2 Metric MI	38	161.49	<0.001	0.97	0.05	[0.05–0.06]	0.04	0.002	0.001	0.006
3 Scalar MI	42	173.37	<0.001	0.96	0.05	[0.04–0.06]	0.04	0.002	0.001	0.004
Self-efficacy										
1 Configural MI	169	432.23	<0.001	0.95	0.04	[0.03–0.04]	0.04	–	–	–
2 Metric MI	178	444.05	<0.001	0.95	0.04	[0.03–0.04]	0.04	0	0.001	0.003
3 Scalar MI	186	458.13	<0.001	0.95	0.04	[0.03–0.04]	0.04	0.001	0	0

MI measurement invariance

fit: $\chi^2(410) = 796.36$, $p < 0.001$; CFI = 0.96, RMSEA = 0.03 (0.03–0.03); SRMR = 0.04). In contrast to H1, the mean values of the change parameters show that there is no significant development of intrinsic value and self-efficacy over time: Neither intrinsic value's mean ($\Delta M = -0.03$, $p_{BH} = 0.321$; $\sigma^2 = 0.19$, $p_{BH} = 0.002$), nor self-efficacy's mean ($\Delta M = -0.01$, $p_{BH} = 0.641$; $\sigma^2 = 0.19$, $p_{BH} = 0.002$) significantly decreased from T1 to T2. However, the significant variances in the changes indicate substantial interindividual differences in the intraindividual changes. Furthermore, the variance of the initial state of intrinsic value is significant ($\sigma^2 = 0.57$, $p_{BH} = 0.002$) as is the initial state of self-efficacy ($\sigma^2 = 0.23$, $p_{BH} = 0.002$), which indicates that the students in this sample differed significantly in terms of intrinsic value and self-efficacy at T1. Figure 1 shows all significant associations between the initial state of intrinsic value and self-efficacy and their development over time. The results show that the initial state value of intrinsic value is significantly associated with the initial state value of self-efficacy ($\phi = 0.18$, $SE = 0.02$, $p_{BH} = 0.002$). The initial state value of intrinsic value is significantly associated with the change score of intrinsic value ($\phi = -0.21$, $SE = 0.03$, $p_{BH} = 0.002$) but not with the change score of self-efficacy ($\phi = -0.03$,

$SE = 0.02$, $p_{BH} = 0.212$). In turn, the initial state value of self-efficacy is significantly associated with both the change score of intrinsic value ($\phi = -0.07$, $SE = 0.23$, $p_{BH} = 0.002$) and the change score of self-efficacy ($\phi = -0.09$, $SE = 0.01$, $p_{BH} = 0.002$). In line with H2, the changes in intrinsic value and self-efficacy between T1 and T2 are positively associated ($\phi = 0.11$, $SE = 0.02$, $p_{BH} = 0.002$).

To test H3 and H4, a conditional latent change model with age, the grouping variable (i.e., learning environment) and the interaction term of age and group variable as predictor variables was conceptualized (see Fig. 2). This conditional latent change model also showed a good model fit: $\chi^2(488) = 926.21$, $p < 0.001$; CFI = 0.96, RMSEA = 0.03 (0.03–0.03); SRMR = 0.04). Confirming H3, the results show that age ($\beta = 0.16$, $SE = 0.08$, $p_{BH} = 0.045$) and group membership ($\beta = 1.42$, $SE = 0.52$, $p_{BH} = 0.009$) positively predict the change in intrinsic value. However, only group membership ($\beta = 1.45$, $SE = 0.47$, $p_{BH} = 0.004$) significantly predicts the change in self-efficacy; age does not ($\beta = 0.11$, $SE = 0.07$, $p_{BH} = 0.145$).

Furthermore, and in line with H4, the interaction term predicts the changes in both intrinsic value ($\beta = -1.43$, $SE = 0.54$, $p_{BH} = 0.011$) and self-efficacy ($\beta = -1.43$, $SE =$

Fig. 1 Unconditional latent change model of the development of self-efficacy and intrinsic value from T1 to T2; t1 = Time 1; t2 = Time2; Significant effects are shown as unstandardized coefficients (B) in boldface and standardized coefficients (β) in second position; solid pathways are significant at $p < 0.05$

0.51, $p_{BH} = 0.008$; see Figs. 3 and 4). As shown in Figs. 3 and 4, the older the students in SDL are, the higher the changes (decline) in both intrinsic value and self-efficacy are. In TDL it is exactly the opposite: the older the students in TDL are, the smaller the changes in both intrinsic value and self-efficacy are.

Discussion

Based on SEVT, the present study was intended to examine the longitudinal development of intrinsic value and self-efficacy in the course of adolescence and across different learning environments. To deepen our understanding of motivational trajectories, the study investigated how different learning environments might counteract the motivational declines that have been regularly revealed in prior research (Otis et al., 2005; Gnambs & Hanfstingl, 2016).

H1 proposed a decline in both intrinsic value and self-efficacy within a school year for all age groups. This hypothesis is not supported by our data. Overall, our data indicates stability of both variables. However, significant variances

indicate that there are indeed students whose intrinsic value and self-efficacy decline within a school year. However, these students are complemented by others who exhibited either increases or stability in intrinsic value and self-efficacy, which in turn cancel each other out. With regard to self-efficacy, this finding adds to prior research that has found both increase and decrease during adolescence (Zimmerman & Martinez-Pons, 1990; Shell et al., 1995; Shell et al., 1995; Anderman et al., 1999; Urda & Midgley, 2003; Reeve & Lee, 2014). However, this finding directly contradicts research that has shown that intrinsic value continuously decreases (Otis et al., 2005; Corpus et al., 2009; Gnambs & Hanfstingl, 2016). Potential reasons might lie in the sample of our study: While many other studies were conducted on complete random samples, our dataset consists only of students from lower- and mixed-track secondary schools. To our knowledge, there are only a few studies that investigated motivational differences across different educational tracks (e.g., Schaffner et al., 2016). For example, a longitudinal study on intrinsic reading motivation among German secondary students revealed a systematical decrease that was similar across school tracks (Miyamoto

Fig. 2 Conditional latent change model with age, group variable and interaction term (age*group) as predictor variables of the development of self-efficacy and intrinsic value from T1 to T2. T1 = Time

1; T2 = Time 2; Significant effects are shown as unstandardized coefficients (B) in boldface and standardized coefficients (β) in second position; solid pathways are significant at $p < 0.05$

Fig. 3 Interaction of group and age on the change of intrinsic value from T1 to T2. *SCL* students from student-centered learning environments, *TDL* students from teacher-directed learning environments

et al., 2020). The results based on the German PISA data from 2012 show that students in high-track schools report more interest in math and higher self-efficacy compared to students from all other school types (Schiepe-Tiska & Schmidtner, 2013). Furthermore, Huang and O'Neil (1997) identified lower self-efficacy among students from low-track schools. Because our sample only consists of students from low- and mixed-track schools, one could assume floor effects because baseline levels of motivation are lower and are

generally less prone to decline. Alternatively, these results could also indicate a stronger need to add covariates to the models. In the study conducted by Gnamb and Hanfstingl (2016), for example, intrinsic motivation did not decline after controlling for students' need support.

H2 was confirmed since developmental changes in students' self-efficacy are significantly associated with their changes in intrinsic value over the course of a school year. This finding is in line with the SEVT (Eccles & Wigfield,

Fig. 4 Interaction of group and age on the change of self-efficacy from T1 to T2. *SCL* students from student-centered learning environments, *TDL* students from teacher-directed learning environments

2020), which includes a reciprocal relationship between success expectancies (i.e., self-efficacy) and subjective task values (i.e., intrinsic value). Accordingly, studies have shown that self-efficacy and intrinsic value are positively associated (Brown, 2010; Bartimote-Aufflick et al., 2016). The result further supports Bandura's (1986) contention that self-efficacy acts as an intrinsic motivator.

H3 was partly confirmed since both age and group membership positively predict the change in intrinsic value. However, group membership (and not age) predicts the change in self-efficacy. More precisely, the older students get, the more changes (declines) in intrinsic value increase throughout a school year. While prior research has often demonstrated that grade 9 is the nadir of motivational decline (Fredricks & Eccles, 2002; Watt, 2004), our findings indicate that this decline might continue in grade 10, which was also found in a study of students from Austria (Gnambs & Hanfstingl, 2016). Furthermore, the finding that age did not predict changes in self-efficacy supports research indicating that self-efficacy is more determined by environmental factors such as actual performances, learning environments, and social experiences (Schunk & Meece, 2006). Accordingly, our results show that group membership positively predicts change in self-efficacy as well as change in intrinsic value. This means that students in TDL and SDL environments significantly differ in their change scores. This finding supports SEVT by highlighting the role of context in students' development of success expectancies and task values. It further supports research that has shown that the quality of the learning environment is essential for students' self-efficacy (Meece et al., 2003) and intrinsic motivation (Ryan & Deci, 2017). Additionally, the next discussed results concerning H4 highlight the essential role of the learning environment since the motivational trajectories of students from SDL and TDL were completely opposite.

H4 proposed that the interaction of age and learning environment predicts motivational development throughout a school year. The results of the conditional latent change model support this hypothesis. Based on previous evidence (Schweder et al., 2019; Kulakow, 2020a), it was assumed that early adolescent students in particular benefit from the SDL environment. In accordance with SEVT (Eccles et al., 2020), it could be demonstrated that depending on the learning environment and age, students exhibit quite different motivational trajectories: while students from SDL demonstrated small decreases in early adolescence, older students in SDL reported increases during one school year. The early adolescent decreases might be a result of the double change situation: (1) change from primary school to secondary school and (2) change from TDL to SDL. SDL is characterized by high student responsibility, which students coming from TDL primary school environments are not used to. Students have to continuously monitor and plan their learning processes and have their progress reflected. While in conventional TDL environments learning goals for future months and years are hardly ever noticeable to students, the competency matrices in SDL make these goals transparent. Thus, the matrices also show all the learning goals for the future and consequently all the goals that students have not yet achieved. Especially in early adolescence, this transparency might add significant pressure to students paired with doubts about the feasibility of ever achieving all these goals. As students get older and shift into middle and late adolescence, the feasibility of achieving all goals might become recognizable for them, which might convey stronger feelings of control over their learning processes. Similarly, Meece and colleagues (2003) highlight the importance of such learning environments. According to their results, adolescents reported greater positive forms of motivation, such as self-efficacy, when schools and teachers emphasized

student-directed teaching practices that were intellectually challenging and supportive of individual progress and mastery. These findings might further highlight the role of an ideal fit between students' prerequisites and the learning material and that they enjoy differentiated instruction. Regarding Bandura's (1997) sources of self-efficacy, enactive mastery experience is supposed to be a major determinant of high self-efficacy. Differentiated instruction as provided by the SDL can thus support such enactive mastery experience.

Conversely, students from TDL exhibit relative increases in intrinsic value and self-efficacy in early adolescence, while older students in TDL report decreases. For the latter, the approaching end of secondary education and upcoming examinations might equally create additional stress and pressure that might negatively affect their motivation (Raufelder et al., 2018). Additionally, considering the premises of stage-environment fit theory, it is perhaps no wonder that we continuously see those motivational declines: While students in adolescence continuously strive for more autonomy in their lives, conventional TDL environments often do too little to satisfy adolescents' needs, such as their need for autonomy (Deci & Ryan, 2000). On the contrary, after the transition to secondary schools, students face continuous summative assessments, whole-class instruction, a focus on normative comparisons instead of a focus on individual development. The findings for TDL students further support SEVT (Eccles & Wigfield, 2020) by showing that this learning environment does not meet the needs of developing adolescents such as growing autonomy, more control over their lives, and independent decision making (see Rosenzweig et al., 2019). Accordingly, this learning environment negatively impacts many students' expectancies and values.

Overall, the present study contributes to empirical research on the recently reformulated SEVT (Eccles & Wigfield, 2020). The results support the essential role of the learning environment for students' expectancies and values for academic tasks and areas and as such for their motivation in school. More precisely, it has been shown that students in SDL have a more positive motivational development in the long term except for a decline after school transition accompanied by a change from TDL to SDL. Put simply, a higher degree of student directedness and room for decision making might be important for motivational trajectories.

Strengths, limitations, and future directions

The present study contributes to an important body of research on motivational trajectories. Not only do longitudinal studies like this one show how misleading conventional mean comparisons can be (Kulakow & Raufelder, 2020), it exhibits that learning environments may have distinct influences on adolescents' motivational development and that

certain environmental preconditions may potentially counteract the regularly shown motivational declines that emerge in early adolescence and reach their peak in middle adolescence. These results additionally suggest that educational practice should strive for continuously adding more room for decision-making to learning environments, because these are assumingly more appropriate for adolescents' development in a time, in which they consistently strive for more autonomy in their lives (Eccles & Midgley, 1989).

However, it is limited because it includes only two measurement points, which are not able to identify long-term trajectories over different school years. Furthermore, the study is based on data from students from low-track and mixed-track schools because SDL in high-track schools in Germany is still rare. This study is further limited by using an instrument measuring "intrinsic motivation" instead of "intrinsic value". Although there is a conceptual overlap between both constructs, readers should be aware that both concepts are based on different theoretical perspectives (Eccles & Wigfield, 2020). Future studies that directly assess "intrinsic value" could contribute to verify or falsify the present findings. Additionally, the present study only considered one of the four subjective task values proposed by SEVT. Lastly, particularly because this article demands more detailed inspection of motivational trajectories in contrast to simply comparing mean values, it should be noted that it completely disregards motivational development during summer holidays, although they have already been shown to be relevant for other variables, such as achievement (Cooper et al., 1996).

Besides these limitations, the present study demonstrates that different learning environments affect not only baseline motivation but also its development during one school year for different age groups in adolescence. Future studies with more equally distributed samples and a longitudinal design over different school years should extend this line of research, particularly with a focus on controlling for more classroom- (e.g., goal structures) and teacher-related variables (e.g., teacher self-efficacy, socializers' beliefs). Such investigations could not only substantiate the findings of this study but also provide further evidence of more distal assumptions of SEVT that have not lately been the focus of research (Eccles & Wigfield, 2020).

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