European Journal of Psychology of Education
https://doi.org/10.1007/s10212-024-00825-6

Academic self-concept, achievement, and goal orientations in different learning environments

Olga Steinberg[1,2] · **Stefan Kulakow**[1,3] · **Diana Raufelder**[1,3]

Received: 22 September 2023 / Revised: 19 February 2024 / Accepted: 26 February 2024

Abstract
Stage-Environment Fit Theory underlines the role of learning environments and their match with students' needs as crucial for students' motivation and learning. This study explores the mediation role of goal orientations in the interplay of academic self-concept and achievement in mathematics and verbal domains in student-directed and teacher-directed learning environments. The sample consists of 1153 adolescent students ($M_{age\ t1} = 13.97$; $SD = 1.37$, 49% girls) from Germany. Multi-group cross-lagged panel analyses confirm the Reciprocal Effects Model for the student-directed learning environment only, as reciprocal relation of academic self-concept and grades over time has been found. The extension of the Reciprocal Effects Model with goal orientations as mediators could not be confirmed for any learning environment.

Keywords Achievement goals · Academic self-concept · Student-directed learning environment · Teacher-directed learning environment · Achievement

Theoretical background

Adolescence presents a particularly challenging developmental period for all students. It is notorious for declines in academic self-concept (e.g., Nagy et al., 2010; Pesu et al., 2016), academic motivation (e.g., Gnambs & Hanfstingl, 2016), and reduced performance in educational settings (e.g., Wijsman et al., 2016). The Stage-Environment Fit Theory (Eccles & Midgey, 1989) attributes the origins of these negative trends to a mismatch between students' developmental needs and their learning environments. In other words, the changes in classrooms settings and new grading standards, as well as increased academic demands from multiple teachers, do not go together with adolescent students' neurobiological, cognitive,

✉ Olga Steinberg
olga.steinberg@uni-greifswald.de

[1] University of Greifswald, Greifswald, Germany

[2] Department of Psychology, University of Greifswald, Franz-Mehring Str.47, 17489 Greifswald, Germany

[3] Department of Educational Science, University of Greifswald, Ernst-Lohmeyer-Platz 3, 17489 Greifswald, Germany

Published online: 25 March 2024

and social needs (Steinberg & Morris, 2001). Empirical research on the interplay of adolescent students' self-concepts, achievement, and motivation has traditionally been focused on teacher-directed learning (TDL) environments (e.g., Bakadorova & Raufelder, 2020; Marsh & Craven, 2006; Marsh & Martin, 2011), while student-directed learning environments (SDL) remain less explored so far. While in TDL a teacher is responsible for students' progress, SDL persuades with an individually tailored program, when a student takes over the responsibility for the learning goals, educational needs, and outcomes, while teachers facilitate the progress. As in general, individualized instruction is most beneficial for each particular learner (Watts-Taffe et al., 2012), student-directed learning per se is designed to better meet students' needs. At the same time, SDL may theoretically be challenging at this age, as adolescents may not yet have fully developed the cognition-, emotion-, and behavior-regulating skills (Smith et al., 2013; Steinberg, 2005). The existing empirical research however taps at positive associations of SDL and motivation, mastery goals, and positive emotions in secondary school settings (Schweder & Raufelder, 2023, 2024).

The present study explores the interplay between academic self-concept, achievement, and goal orientations in both TDL and SDL. The overarching goal is to test (a) whether there are reciprocal associations between domain-specific academic self-concepts and grades over time in both learning environments, in line with the Reciprocal Effects Model (Marsh, 1990; Marsh & Craven, 2006; Marsh & Martin, 2011), and (b) whether mastery and performance goal orientations would mediate these associations, extending the Reciprocal Effects Model.

Academic self-concepts, achievement, and goal orientations

Academic self-concept refers to a student's perception of their own school-related abilities (Shavelson et al., 1976). It is a complex domain-specific construct with multiple dimensions for comparison (e.g., individual or criterial (Spinath et al., 2012)). In this study, criterion-unsensitive, domain-specific academic self-concepts have been explored that depict students' perceptions of their own competence in academic settings. Empirical studies show that academic self-concept is a significant predictor of educational outcomes, including goal orientations, academic achievement, and career aspirations (e.g., Barker et al., 2005; Denissen et al., 2007; Marsh & Craven, 2006). While in pre-adolescence, academic self-concept and achievement-related outcomes exhibit weak correlations, during adolescence, these correlations strengthen and become more stable (Marsh, 1989). Age-related differences are relevant not only for the association between these variables but also for their magnitude (Marsh, 1989; Perinelli et al., 2022). Gender-related findings tap at domain-specific effects: girls tend to report higher verbal self-concepts, whereas boys tend to report higher mathematical self-concepts (Heyder et al., 2017; Mejía-Rodríguez et al., 2020; Skaalvik & Skaalvik, 2004).

The Reciprocal Effects Model (Marsh, 1990; Marsh & Craven, 2006; Marsh & Martin, 2011) suggests that students' academic self-concept and achievement are interdependent. In other words, the higher a student's academic self-concept, the higher their achievement is, and vice versa. This model is supported by empirical research across all stages of schooling process in TDL environments (e.g., Guay et al., 2003; Marsh & Craven, 2006; Marsh & Martin, 2011) in mathematic and verbal domains (Jacobs et al., 2002; Pesu et al., 2016). While the mathematics domain is characterized by a student's beliefs about their own abilities in mathematics (Opacic & Kadijevic, 1997), verbal

self-concept refers to a student's beliefs about their own written and oral language skills, including reading comprehension (Locher et al., 2021). The domain-specific research within the internal/external frame of reference model (Marsh, 1986) suggests that positive effects between academic self-concept and achievement could be confirmed within, but not across the verbal and mathematic domains; and therefore, the domains should be studied separately.

The existing domain-specific findings on the associations of academic self-concepts and achievement within the domains suggest differentiated results for verbal and mathematic models: while Retelsdorf and colleagues (Retelsdorf et al., 2014) found stronger effects from reading achievement to reading self-concept that vice versa, the longitudinal five-wave model for mathematics (Arens et al., 2017) showed robustness of the reciprocal effects in both directions. A meta-analysis of longitudinal studies (Wu et al., 2021) suggests students' age is a statistically significant moderator of the effect of achievement on academic self-concept, while both age, achievement level, and type of achievement measurements are important to consider for the effect of academic self-concept on achievement.

Various approaches have been employed to integrate academic motivation into the Reciprocal Effects Model (see Green et al., 2006). It has been directly integrated (see Green et al., 2006), tested as a mediator (e.g., Bakadorova & Raufelder, 2020), or considered a moderator variable (Valentine & DuBois, 2005). Despite the encouragement by Valentine and DuBois (2005) almost 20 years ago to "include these [motivation] variables more frequently when studying the relationship between self-beliefs and achievement" (p. 72), only a few longitudinal studies follow this recommendation. This may be attributed to theoretical diversity, differing operationalizations of motivational constructs (see Green et al., 2006), and the distinction of domain-specific and domain-unspecific studies. Building on a recent domain-unspecific study that demonstrated mastery goal orientation partially mediates the association between academic self-concept and achievement (Bakadorova & Raufelder, 2020), the present study aims to replicate this finding in a sample of secondary school students, taking a domain-specific approach and exploring potential differences between TDL and SDL.

In academic settings, achievement goals are often regarded as tendencies for approach or avoidance orientations within achievement motivation (Weiner, 1990). As such, goal orientation theory is a social-cognitive theory of achievement motivation that investigates why students engage in their academic work. There exist several frameworks that differentiate between approach and avoidance goal orientations. Thus, Elliot and MacGregor (2001) differentiate between mastery approach, mastery avoidance, performance approach, and performance avoidance goal orientations. Niemivirta et al. (2019), in turn, regard mastery goal orientation as either extrinsic or intrinsic, and add work avoidance orientation. While differentiation between different orientations of mastery goals should be treated carefully and needs further exploration (see Bong, 2009), decades of research agree on the differentiation between performance approach and performance avoidance orientation. Following the trichotomous framework of achievement goal theory (Elliott & Church, 1997), empirically supported by many works (e.g., Hulleman et al., 2010; Pekrun et al., 2006), this study differentiates among mastery, and performance-approach and performance-avoidance goal orientations. In a school setting, mastery goals aim at increasing competence (Ames, 1992) and directly relate to self-regulated learning strategies (Pintrich, 2000). Performance goals, in turn, foster comparison and competition to increase individual ability perception (Covington, 2000). While performance-approach goal orientations aim to demonstrate competence and outperform others, performance-avoidance goal orientations relate to the wish to perform not worse than others and hide incompetence (e.g., Darnon et al., 2007; Pintrich, 2000).

A variety of studies shows that academic self-concept and goal orientations are highly interdependent constructs that are rooted in social comparison processes (e.g., Niepel et al., 2014; Huguet et al., 2009; Middleton & Midgey, 1997). However, academic self-concept presents the more stable variable that further defines students' motivational orientations (Yeung et al., 2012). In the present study, the assumption by Barker et al. (2005) has been followed, that "variables drawn from self-concept and goal theories taken together will provide a fuller explanation of academic achievement than is possible with either self-concept or motivational goal variables alone" (p. 1).

The existing findings on the associations of verbal and mathematics academic self-concepts, goal orientations, and achievement in adolescence are inconsistent: Niepel et al. (2014) examine the relationship between academic self-concept and goals by cross-lagged panel models with achievement as an outcome variable. The results suggest academic self-concept in mathematics (grade 8) is positively predicted by performance-approach goals (grade 6), and is negatively predicted by performance-avoidance goals (grade 6), but not mastery goals. In addition, no goal orientation reveals a direct association with achievement. A study of Preckel and Brunner (2015), in turn, shows that mathematic self-concept and performance goals are reciprocally related; however, only mastery goals reciprocally associate with academic achievement. In contrast, the research of Seaton et al. (2014) reports positive reciprocal relations between performance approach goals and achievement in mathematics. The mastery goal orientation was reinforced by mathematic achievement, but not at every time point. Yet another study by Paulick and colleagues (Paulick et al., 2013) finds positive longitudinal reciprocal relationships between mastery approach goals and achievement. In addition, a domain-specific study on causality among academic self-concept, achievement, and goal orientations in mathematics and verbal domains shows that the causal relation may be domain-specific (Barker et al., 2005). Specifically, in verbal domain, goals affect achievement through the perception of self, while in mathematics domain, self-concept affects achievement through goal orientations.

Overall, the existing research shows no unity on the causal ordering of academic self-concepts, goal orientations, and achievement, and suggests possible domain-specific differences. There are more studies in the domain of mathematics than in the verbal domain. In addition, all studies so far have been conducted in TDL, while students' academic self-concepts and goal orientations in TDL and SDL may differ.

Learning environment as a potential moderator

While some research focuses on differential roles of learning environments, as linked to teachers' instruction (e.g., Trautwein et al., 2006), there are only few studies (e.g., Ryser et al., 1995) that contrast academic self-concepts of students from different learning settings. This may be due to the fact that TDL approach is widely practiced in schools. TDL is traditionally characterized by teacher-directed systematic instruction of students, aimed at transmission of basic skills, facts, and information (Rosenshine & Stevens, 1984).

However, nowadays SDL gains in importance in school practice, as either a supplement or a substitute to TDL. The term SDL stems from self-directed learning, originally used in adult education (Knowles, 1975), and refers to self-directed learning in school-related contexts. The central aim of SDL is the development of learner autonomy (Armstrong, 2010); and therefore, SDL embraces students' both self-regulated *and* self-determined learning *within and beyond* a certain educational situation. SDL is also a broader

construct in terms of a learner's degree of control and ability to choose a learning activity, even though in some papers the terms "SDL" and "self-regulated learning" are used interchangeably (for an overview, see e.g., Saks & Leijen, 2014). Several studies show that SDL is associated with academic achievement (Chou & Chen, 2008; Lounsbury et al., 2009), and students who use and choose activities that match their interest and abilities (Hussain et al., 2011) tend to show higher achievement scores as compared to students in traditional TDL settings, even though SDL rather focuses mastery of competencies rather than grade improvement.

In school practice, SDL is often addressed by use of competency grids (Kulakow, 2020). Competency grids help students self-diagnose their learning needs, identify their goals and resources for learning, set own learning strategies, and evaluate the results. Empirical studies with adolescents that contrast SDL and TDL show higher autonomy, mastery goals, and academic self-concepts among SDL students (Kulakow, 2020; Schweder et al., 2019, Schweder & Raufelder, 2021), and also higher achievement (Orawiwatnakul & Wichadee, 2017). Longitudinal research shows that students from SDL have more positive motivation development in secondary school (Raufelder & Kulakow, 2021) due to individual control of own learning progress, continuous self-reflection, individualized feedback from teachers, less social comparison to peers, and, generally, better need satisfaction as stated in the Stage-Environment Fit Theory (e.g., O'Mara et al., 2006; Schweder et al., 2019; Schweder & Raufelder, 2021).

By combining the Stage-Environment Fit Theory and Reciprocal Effects Model, the present study has the goal of testing whether (a) consistent with the Reciprocal Effects Model (Marsh & Craven, 2006; Marsh & Martin, 2011; Marsh, 1990) there is a reciprocal association between domain-specific academic self-concepts and grades over time in both verbal and mathematics domains in both SDL and TDL, and whether (b) Reciprocal Effects Model may be extended by goal orientations as mediators.

Hypotheses

Previous studies revealed higher academic self-concept (Kulakow, 2020), mastery goal orientation (Schweder, 2020; Schweder et al., 2019), and achievement results (Orawiwatnakul & Wichadee, 2017) for students in SDL as compared to students in TDL. As such, learning environments have shown to be a distinctive factor not only in mean differences of variables, but also in the associations of variables. Accordingly, it was hypothesized (H1a), that there are substantial differences in the longitudinal associations of mathematic and verbal self-concepts and grades between students from TDL and SDL environments. In detail, we expect students in SDL to score higher on all variables. We also expect mastery goals to mediate the relation between academic self-concepts and grades in SDL as compared to TDL. The Reciprocal Effects are expected to be stronger in mathematics than in verbal model. In extension of the Reciprocal Effects Model, (H1b) goal orientations were tested as possible mediators. Since there is only one study so far (Bakadorova & Raufelder, 2020) that regards mastery goals as a mediator in the Reciprocal Effects Model, and, according to other studies, a different arrangement of these variables may be possible (e.g., Valentine & Dubois, 2005), H1b is exploratory in nature. As there might be domain-specific differences in the interplay of academic self-concept, goal orientations, and achievement (Barker et al., 2005), the hypotheses are tested for the mathematics and verbal domains separately.

Method

Participants and procedure

In total, 1153 students ($M_{age} = 13.97$; $SD = 1.37$, 49% girls; grades 7–10) participated in the current study. The students attended 57 classrooms in six secondary schools in the north of Germany (place of data collection was removed in the review process for anonymization). They were first surveyed during the winter term 2015/2016 (t1) and approached again 0.5 years later (t2). Of the six schools, three used SDL, based on competency grids; the other three followed TDL. The schools of the TDL group were randomly sampled. The SDL schools were chosen according to the following criteria: (1) use of competency matrices comprised part of the curriculum and was consequently applied; and (2) practice of SDL for at least 6 years, so that, besides occasional school changes, students would know only this instructional approach in secondary school. To ensure the ethical standards of the 1964 Declaration of Helsinki and of the German Psychological Society, all participants and their parents provided written informed consent.

After all necessary permissions were signed, two trained research assistants approached the students, distributed the questionnaires and reiterated the goal of the study and the anonymity of data collection, and explained the use of the Likert scales. They remained present throughout the data collection.

Measures

Domain-specific academic self-concepts

Self-concepts for mathematics (mathematics domain) and German (native language, verbal domain) were assessed with two scales from the PISA 2000 questionnaire (Artelt et al., 2004). Both scales consist of three items, each ranging from "1" ("not true at all") to "4" ("completely true"). The mathematics self-concept scale (e.g., "I have always been good at math") achieved good reliability at both measurement points ($\omega_{T1} = 0.87$, $\omega_{T2} = 0.87$). The verbal self-concept scale (e.g., "I learn fast in my German class") achieved adequate reliability ($\omega_{T1} = 0.67$, $\omega_{T2} = 0.73$).

Goal orientations

To capture students' goal orientations, the scales by Spinath and colleagues (Spinath et al., 2012) have been used. Answers were rated on a 5-point Likert scale, from "1" ("not true at all") to "5" ("completely true"). The subscale mastery goal orientation featured eight items (e.g., "At school, I like to learn as much as possible"), with reliability of $\omega_{T1} = 0.82$. The subscale approach-performance goal orientation consisted of seven items (e.g., "In school, I want to get better grades and feedback than others") and achieved proper internal consistency ($\omega_{T1} = 0.79$). The avoidance-performance goals subscale consisted of eight items (e.g., "In school, I try to avoid that other students think that I was stupid") and exhibited good reliability ($\omega_{T1} = 0.84$). Goal orientations were tested as potential mediators, so only students' ratings on these variables at t1 have been used.

Grades

At both waves, students' self-reported grades in the respective subjects from their certificates at the end of the previous school term have been collected. German school grades range from "1" (best possible outcome) to "6" (worst possible outcome). Accordingly, in the Math model the corresponding Math grade was utilized, whereas the German grade was used in the German model. The grades were reverse recoded in the process of data analyses for better interpretation of the results, so that higher scores reflect greater achievement. Additionally, the German grades with the LGVT 6–12 (Schneider et al., 2007) have been considered in the verbal model as covariates to address potential bias of self-report.

Covariates

The existing studies show that girls tend to report higher verbal self-concepts, whereas boys tend to report higher mathematical self-concepts (Heyder et al., 2017; Mejía-Rodríguez et al., 2020; Skaalvik & Skaalvik, 2004). Therefore, students' gender was included as a covariate. Students' age was also incorporated into the model as a control variable, as the existing studies show age-related differences in the development of academic self-concepts, goal orientations, and achievement (Marsh, 1989; Perinelli et al., 2022).

Missing data

The present study was subject to a certain degree of missingness. Across all observed values, 6.94% were missing, as a result of 427 incomplete cases. Missingness across all 41 observed variables varied between 0 and 33.22%. To investigate whether missingness would lead to a substantial bias, missing data patterns were examined. The most prominent missing data pattern was caused by dropping out of the study ($n = 306$) at t2.

A series of Bonferroni corrected t tests was run on the manifest variables to examine whether the students who dropped out of the study differed significantly in the t1 variables from those who remained. Students who dropped out had significantly worse grades in mathematics ($t(693.23) = -4.54$, $p_{adj} < 0.01$). In the models, full information maximum likelihood (FIML) estimation was used to compensate all missing data. In the presence of missingness, FIML estimation has proved to be superior to other missing data techniques (e.g., listwise deletion), and leads to less biased estimates while retaining statistical power (Schafer & Graham, 2002).

Statistical analyses

To examine the hypotheses, multi-group cross-lagged panel analyses with additional indirect effects in Mplus 8.5 (Muthén & Muthén, 1998–2017) have been conducted. The models examine reciprocal effects from one construct at one point of measurement on another construct (i.e., cross-lagged effect) and simultaneously to the same construct at a later point of measurement (i.e., autoregressive effect) (Geiser, 2013; Kearney, 2017). The (1) verbal model and (2) mathematics model included autoregressive paths (i.e., stability of self-concept and grades) and cross-lagged paths (i.e., reciprocal effects of self-concept on grades). Additionally, the t1 achievement goal orientations were included as mediators. The indirect effects were estimated using the delta method with symmetric confidence intervals (MacKinnon, 2008). The effects were considered as

significant if the 95% confidence interval did not include 0. For direct effects, the conventional $p < 0.05$ criterion was applied. The cross-lagged effect sizes were estimated as recommended by Orth and colleagues (Orth et al., 2022).

A multiple-group approach was used to determine whether there are any significant differences in the autoregressive and lagged regression coefficients between students from SDL and TDL. With this method, group variations in regression coefficients can be identified as moderating or interaction effects (Mulder & Hamaker, 2021). More specifically, a model in which all regression coefficients and covariates are constrained to be the same across the groups is contrasted with a multiple group CLPM with no constraints across the groups. It is possible to determine whether or not (some of) the lagged coefficients differ between the groups using the χ^2-difference test (Self & Liang, 1987).

Model fit was evaluated by χ^2, RMSEA, SRMR, and CFI (Hu & Bentler, 1999). Typically, a good fit to the data is indicated by CFI higher than 0.90, RMSEA less than 0.05, and SRMR less than 0.08. The prevailing consensus is that CFI values higher than 0.95 and RMSEA and SRMR values lower than 0.05 or 0.06 indicate a strong fit to the data.

All models were specified using the MLR estimator. In order to address the multilevel nature of the dataset (i.e., students nested in classes: $n_{classes\ SDL} = 36$; $n_{classes\ TDL} = 21$; average number of students in class = 18.14), *type is complex* that adjusts standard errors by adding sampling weights to the estimates in relation to the clusters has been used (Asparouhov, 2005).

Results

Descriptive statistics and measurement invariance

Table 1 shows the descriptive statistics, while Table 2 demonstrates bivariate correlations between all variables.

Before the scales were summarized into variables, we conducted confirmatory factor analyses to examine whether the underlying constructs were adequately measured by the scales indicators. Subsequently, we added parameter restrictions in a step-wise manner following the approach by Little (2013) to ensure measurement invariance across groups and time. The corresponding analyses are provided in the Electronic Supplement 1.

Mathematic self-concept

A multi-group cross-lagged panel model was run for both learning environments. This model fit the data well ($\chi^2(12) = 24.071$, $p = 0.02$, CFI = 0.99, RMSEA [90% CI] = 0.042 [0.016–0.066], SRMR = 0.02). Subsequently, a model in which all paths were invariant across groups was run, which also showed acceptable fit indices: $\chi^2(40) = 63.96$, $p < 0.05$; CFI = 0.99, RMSEA = 0.032 (0.016–0.046); SRMR = 0.05. The χ^2-difference test of these two nested models yields $\Delta\chi^2(28) = 41.69$, $p < 0.05$, which implies that the autoregressive and lagged effects of self-concept and achievement as well as the covariances appear not to be the same for students from TDL and SDL.

Table 1 Descriptive statistics

	SDL						TDL					
	M	*SD*	Range	Skewness	Kurtosis	ICC	*M*	Range	*SD*	Skewness	Kurtosis	ICC
1 math grade T1	2.81	1.04	1	0.27	−0.41	0.14	3.08	1.01	1	0.32	0.01	0.11
2 math grade T2	2.71	1.00	1	0.42	0.22	0.21	3.09	0.98	1	0.06	−0.22	0.16
3 German grade T1	2.66	0.88	1	0.48	0.57	0.18	2.77	0.83	1	0.23	−0.15	0.11
4 German grade T2	2.61	0.89	1	0.19	0.11	0.16	2.79	0.8	1	0.35	0.15	0.22
5 reading comprehension T1	52.42	9.36	26	−0.17	−0.14	0.10	51.13	8.08	28	−0.21	0.51	0.01
6 reading speed T1	50.41	8.15	27	0.47	0.42	0.08	51.09	8.94	7	0.32	2.75	0.05
7 verbal self-concept T1	2.90	0.58	1.33	−0.11	−0.38	0.02	3.00	0.62	1	−0.41	−0.23	0.07
8 verbal self-concept T2	2.99	0.62	1	−0.27	−0.35	0.05	3.00	0.61	1	−0.55	0.30	0.11
9 math self-concept T1	2.41	0.86	1	0.24	−0.91	0.01	2.29	0.87	1	0.38	−0.82	0.03
10 math self-concept T2	2.44	0.87	1	0.19	−0.83	0.03	2.35	0.89	1	0.26	−0.91	0.05
11 mastery goals T1	3.56	0.71	1	−0.6	0.61	0.04	3.56	0.67	1.25	−0.48	0.49	0.01
12 performance approach goalsT1	3.05	0.74	1	−0.23	−0.07	0.05	3.26	0.71	1	−0.31	0.48	0.00
13 performance vaoidance goals T1	2.49	0.82	1	0.03	−0.59	0.05	2.78	0.8	1	0.17	−0.07	0.00
14 age	13.85	1.32	11	0.33	−0.71	0.54	14.22	1.42	11	0.21	−0.49	0.76
15 gender	0.51	0.5	0–1	−0.06	−2.00	0.00	0.48	0.5	0–1	0.06	−2.01	0.00

Reading comprehension and reading speed were standard scores based on grade norms; gender was assessed dichotomized as 0 = girls; 1 = boys

Table 2 Intercorrelations for SDL and TDL

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SDL														
1 math grade T1	0.61***	0.45***	0.30***	0.20***	0.15***	0.21***	0.14**	0.57***	0.48***	0.19***	−0.01	−0.08*	−0.29***	0.06
2 math grade T2	0.57***	0.32***	0.47***	0.23***	−0.09	0.19***	0.18***	0.49***	0.60***	0.15**	−0.09*	−0.18***	−0.17***	0.04
3 German grade T1	0.50***	0.31***	0.56***	0.31***	0.25***	0.49***	0.38***	−0.05	−0.02	0.20***	0.03	−0.10**	−0.19***	−0.14***
4 German grade T2	0.33***	0.49***	0.53***	0.31***	0.22***	0.42***	0.50***	−0.04	−0.08	0.17***	−0.03	−0.16***	−0.12**	−0.15**
5 reading comprehension T1	0.05	0.17*	0.04	−0.15	0.53***	0.21***	0.21***	0.04	0.03	0.04	−0.12**	−0.16***	−0.14**	0.04
6 reading speed T1	−0.03	−0.04	0.09	−0.12	0.47***	0.18***	0.14**	0.05	0.01	0.01	−0.05	−0.09*	−0.18***	0.01
7 verbal self-concept T1	0.20***	0.15*	0.52***	−0.47***	0.05	0.05	0.51***	0.05	0.05	0.27***	0.07*	−0.11**	−0.06	−0.07
8 verbal self-concept T2	0.10	0.09	0.36***	−0.51***	0.07	0.04	0.60***	0.07	0.07	0.22***	0.05	−0.14**	−0.05	−0.12**
9 math self-concept T1	0.63***	0.58***	0.16**	−0.16**	0.07	−0.02	0.04	−0.03	0.71***	0.17***	0.10**	−0.02	−0.08*	0.20***
10 math self-concept T2	0.46***	0.63***	0.11	−0.14*	0.07	−0.06	0.01	0.02	0.72***	0.11**	0.01	−0.08	−0.09*	0.18***
11 mastery goals T1	0.14**	0.11	0.19***	−0.20**	0.10	0.05	0.20***	0.22***	0.26***	0.17**	0.43***	0.11**	−0.11**	−0.01
12 performance approach goals T1	0.05	0.01	0.07	−0.06	0.08	0.06	0.14**	0.18**	0.15**	0.12	0.51***	0.58***	0.00	0.02

Table 2 (continued)

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13 performance avoidance goals T1	−0.11	−0.07	−0.09	0.08	−0.05	−0.01	−0.1	−0.02	−0.01	−0.05	0.13**	0.60***	−0.03	0.04
14 age	−0.06	−0.25***	−0.04	0.17**	−0.02	−0.09	0.01	−0.11	−0.11*	−0.17**	0.09	0.04	−0.07	0.03
15 gender	0.07	0.10	−0.15**	0.14*	0.09	0.00	−0.14**	−0.14*	0.26***	0.24***	0.05	0.02	−0.04	−0.03

Upper triangle, SDL; *lower triangle*, TDL; significance at *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Gender: 0 = girls; 1 = boys. Reading comprehension and reading speed were standard scores based on grade norms

SDL—direct and indirect effects

Figure 1 depicts direct and indirect effects and covariates between the variables in SDL. The Reciprocal Effects Model was confirmed, as academic self-concept and achievement in math were reciprocally interwoven over time. The effect sizes can be interpreted as large as standardized coefficients are 0.12 and higher (Orth et al., 2022). However, no statistically significant indirect path could be found. The model explained 43.8% of variance in grades ($R^2 = 0.49$) and 53.3% of variance in academic self-concept ($R^2 = 0.53$) at t2. Interestingly, mathematic academic self-concept at t1 was significantly associated with performance-approach goals, whereas grades in general were negatively associated with performance-avoidance goals; and grades at t1 positively associated with mastery goals. Boys reported higher academic self-concept at t1 and t2, whereas older students reported lower academic self-concept at t1.

TDL—direct and indirect effects

Figure 2 demonstrates direct and indirect effects and covariates between the variables for TDL. The Reciprocal Effects Model was not confirmed, as academic self-concept is associated with achievement in mathematics over time but not vice versa. The effect size of academic self-concept and achievement over time can be interpreted as large ($\beta = 0.33$)

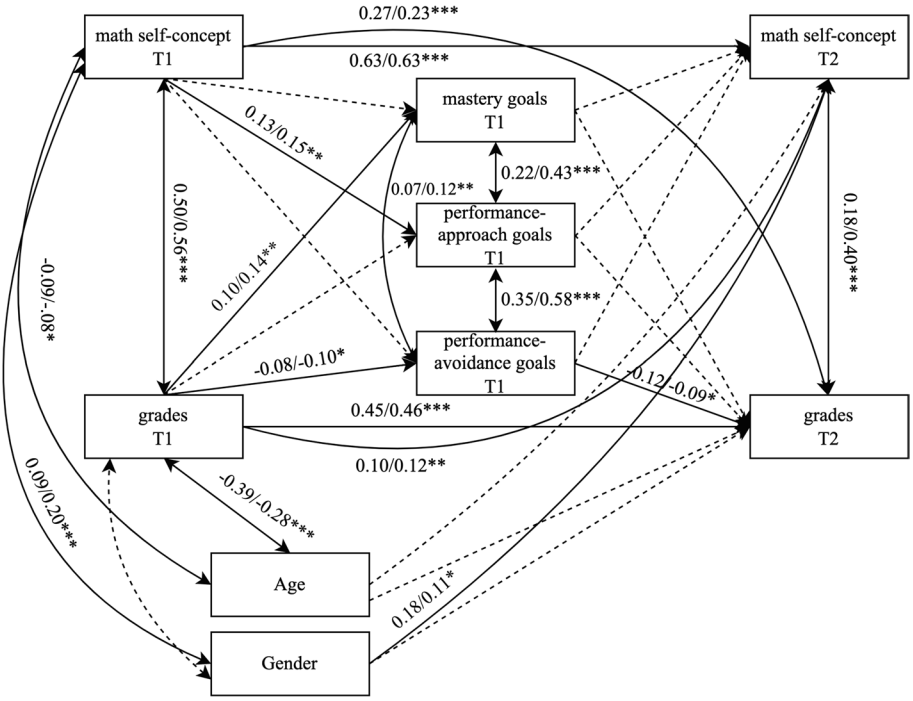

Fig. 1 Multi-group cross-lagged panel model with indirect effects for students in SDL environments in mathematics. Note: Estimates are shown as unstandardized (first position) and standardized (second position) values; only significant effects are displayed; non-significant path are shown in dotted lines; $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

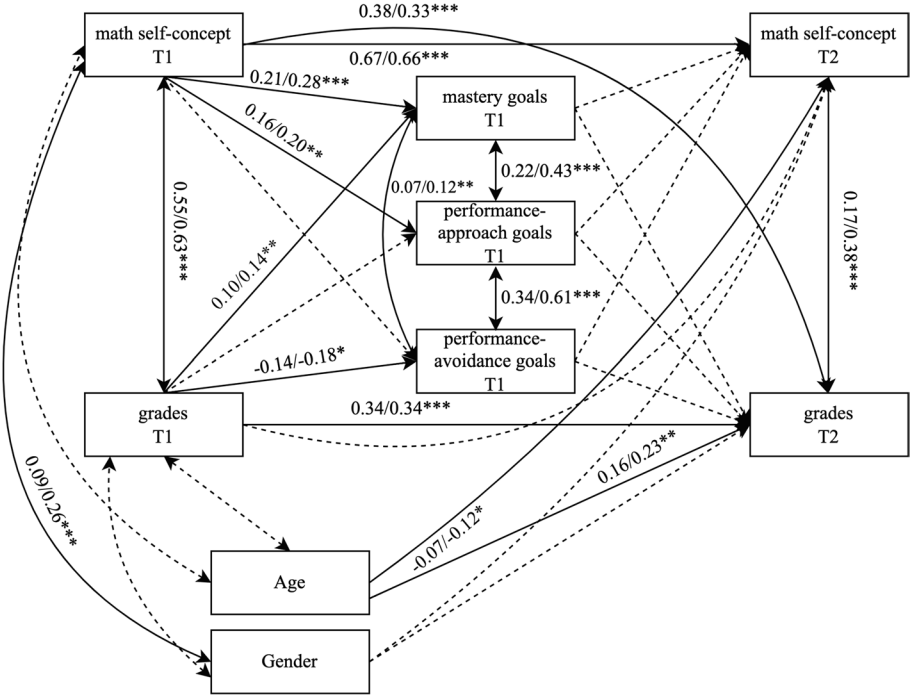

Fig. 2 Multi-group cross-lagged panel model with indirect effects for students in TDL environments in mathematics. Note: Estimates are shown as unstandardized (first position) and standardized (second position) values; only significant effects are displayed; non-significant paths are shown in dotted lines; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

(Orth et al., 2022). However, no statistically significant indirect path could be found. Students with higher academic self-concept tend to follow a mastery or performance-approach goal orientation, whereas grades negatively associate with the performance-avoidance goal orientation. The model explained 45.0% of variance in grades ($R^2 = 0.45$) and 52.7% of variance in academic self-concept ($R^2 = 0.53$) at t2. Boys reported higher academic self-concept at t1, whereas older students reported lower academic self-concept at t2.

Verbal self-concept

A multi-group cross-lagged panel model was run and fit the data well: χ^2 (24) = 51.22, $p < 0.05$; CFI = 0.98, RMSEA = 0.044 (0.027–0.061); SRMR = 0.26). Subsequently, a model in which all paths are invariant across groups was run, which also showed acceptable fit indices: ($\chi^2(64) = 92.192$, $p < 0.05$, CFI = 0.98, RMSEA [90% CI] = 0.028 [0.013–0.040], SRMR = 0.05). The χ^2-difference test of these two nested models yields $\Delta\chi^2(41) = 44.59$, $p > 0.05$, which implies that statistically both models fit equally well (Werner & Schermelleh-Engel, 2010). In the next step, all paths and covariances, which were statistically non-significant in both groups, have been set to be free across groups. This model with all statistically significant paths invariant across groups and all non-significant paths free across groups showed acceptable fit indices: χ^2 (51) = 89.32, $p < 0.05$; CFI = 0.97, RMSEA = 0.036 (0.023–0.048); SRMR = 0.55). The χ^2-difference test

between this model and the prior one yields $\Delta\chi^2(33) = 48.02$, $p < 0.05$, which implies that the statistically significant autoregressive and lagged effects of self-concept and achievement as well as the covariances appear not to be the same between students from TDL and SDL.

SDL—direct and indirect effects

Figure 3 depicts all direct and indirect effects as well as the covariates between the variables for students in SDL. The Reciprocal Effects Model was confirmed for the verbal domain. The effect sizes can be interpreted as large ($\beta = 0.16$) (Orth et al., 2022). However, no statistically significant indirect paths could be found. Students with higher verbal self-concept tend to follow a mastery or performance-approach goal orientation, whereas grades negatively associated with the performance-avoidance goal orientation. The model explained 38.2% of variance in grades ($R^2 = 0.38$) and 30.9% of variance in academic self-concept ($R^2 = 0.31$) at t2. Boys reported lower academic self-concept and poorer grades at t2. The better the students' results in the reading comprehension and speed test, the better their grades and the higher their academic self-concept at t1 were.

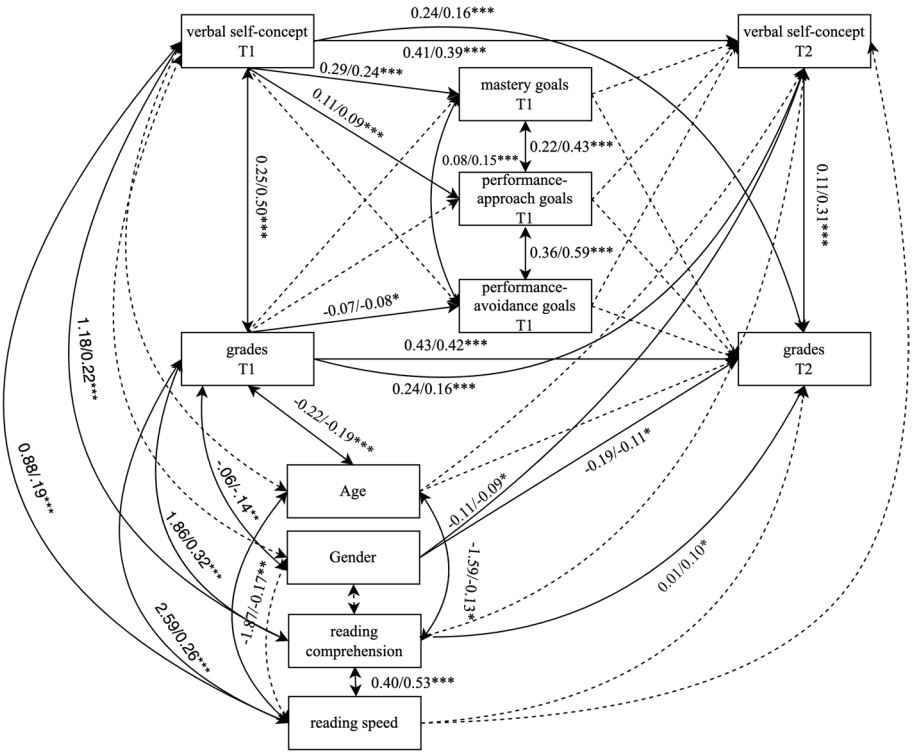

Fig. 3 Multi-group cross-lagged panel model with indirect effects for students in SDL environments in German (verbal domain). Note: Estimates are shown as unstandardized (first position) and standardized (second position) values; only significant effects are displayed; non-significant paths are shown in dotted lines; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

TDL—direct and indirect effects

Figure 4 depicts all direct and indirect effects as well as the covariates between the variables for students in TDL. The Reciprocal Effects Model could not be confirmed for students in TDL. The effect size from verbal self-concept to subsequent achievement can be estimated as large ($\beta = 0.23$) (Orth et al., 2022). Additionally, no statistically significant indirect path could be found. Students with higher academic self-concept tend to follow a mastery or performance-approach goal orientation, whereas students with better grades, are likely to follow a mastery goal orientation. The model explained 37.3% of variance in grades ($R^2 = 0.37$) and 37.6% of variance in academic self-concept ($R^2 = 0.38$) at t2. Boys reported lower academic self-concept at t1, whereas older students tend to report poorer grades and lower academic self-concept at t2. Interestingly, students' results in the reading comprehension and speed test had no association to their grades or verbal self-concepts.

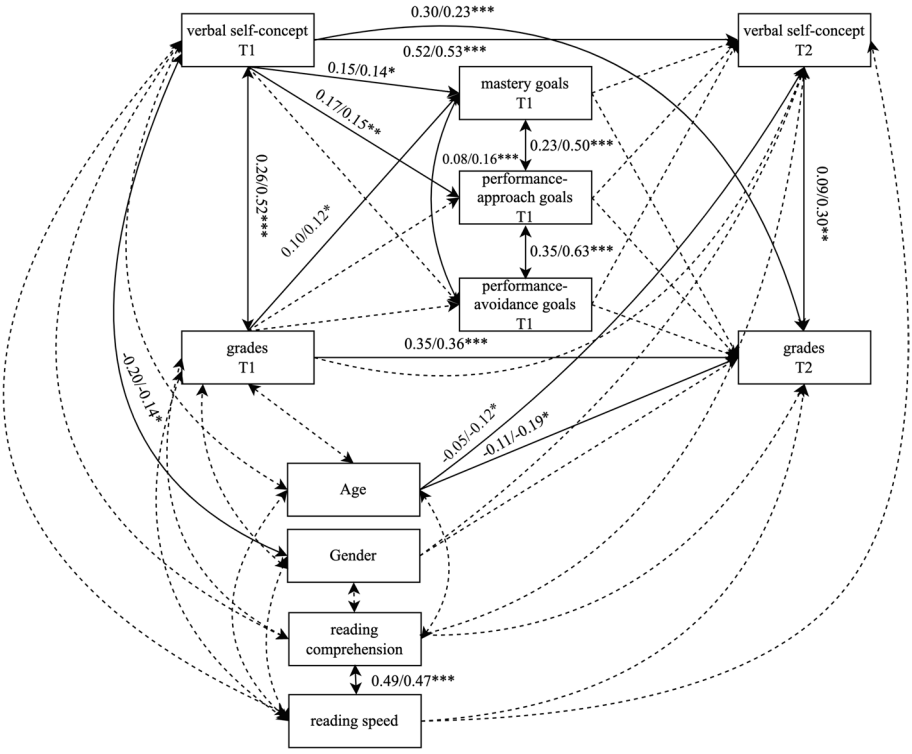

Fig. 4 Multi-group cross-lagged panel model with indirect effects for students in TDL environments in German (verbal domain). Note: Estimates are shown as unstandardized (first position) and standardized (second position) values; only significant effects are displayed; non-significant paths are shown in dotted lines; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Discussion

Based on the Stage-Environment Fit Theory and the Reciprocal Effects Model, the major aim of the current study was to test whether (a) there is a reciprocal association between domain-specific academic self-concepts and grades over time in both SDL and TDL and whether (b)—in extension of the Reciprocal Effects Model—students' goal orientations would mediate this association.

In line with H1a, substantial differences between students from TDL and SDL environments could be found for both mathematics and verbal domains. The Reciprocal Effects Model could only be confirmed for SDL environment for verbal and mathematics models alike. It may be explained by a suggestion, that in SDL, due to large degree of self-determination and self-regulation students may perceive their achievements as a part of their academic self-concepts, so these concepts are better interrelated over time (in this study: 0.5 years of secondary school). There may be several reasons why the Reciprocal Effects Model did not function in the TDL. First, in TDL grades are externally assigned by teachers and might be less associated with students' academic self-concepts over time. Second, as students in the study attended to "intermediate" track (see Arens et al., 2018 for more details on German tracking), their academic self-concepts may be vulnerable and rather associated with previously obtained last years' grades (e.g., Kastens & van Wickeren, 2023). This finding shows that more research on the longitudinal interplay of self-concepts and grades especially in "intermediate" track is needed, as previous research found domain-specific associations between academic self-concepts and grades in both academic and vocational tracks (however, not over time) (Arens et al., 2018). The findings of the study show in TDL/"intermediate" track, the longitudinal association between self-concept and achievement may be unidirectional, supporting the self-enhancement model (Jones & Grieneeks, 1970) that postulates that prior school self-concept leads to later academic achievement, for both verbal and mathematic domains. In addition, (a) there exist other studies (e.g., Skaalvik & Hagtvet, 1990) that do not confirm the reciprocal effects, possibly due to developmental changes and educational demands in secondary schools or statistical differences between the model(s) that different author(s) use (see more in Burns et al. (2020)). In detail, the between-person differences in self-concept may have caused the reciprocal effects in "traditional" CLPM analyses (Burns et al., 2020; Hübner et al., 2023).

In contrast to H1b, none of the goal orientations functioned as a mediator between academic self-concept and achievement in both domains. This finding stands in line with some of the existing research (e.g., Seaton et al., 2014; Steinmayr et al., 2019) that presents academic self-concept as a more important predictor of academic success than goal orientations. The direct effects between the constructs in both models support previous research (e.g., Marsh et al., 2015; Retelsdorf et al., 2014), such as both verbal and mathematics self-concepts significantly associated with achievement in each subject within time at both measurement points. Even though goal orientations did not mediate the association between academic self-concept and achievement, both verbal and mathematics models for SDL and TDL showed domain-specific differences in the interplay of academic self-concepts, grades, and goal orientations. For SDL model in mathematics, the mathematic academic self-concept was positively associated with performance-approach, but not mastery or performance-avoidance goal orientations. In contrast, for the SDL verbal model, the verbal academic self-concept positively associated with both mastery and performance-approach goal orientations. While the result for the verbal model stands in line with the existing learning

environment unspecific research (e.g., Jiang et al., 2014; Lee et al., 2014), and underline the importance of a positive academic self-concept in practical terms, the results for the mathematics model are somewhat surprising. According to the properties and characteristics of SDL, one would rather expect mastery than performance goal orientations to associate with the academic self-concept. This finding suggests that, first, social comparison processes (e.g., comparison of own results on competency grids to the progress of peers) in SDL may be underestimated. Second, it might mean that there might be substantial differences in SDL environments, depending on how they are established in practice (in thus study SDL in class was addressed by use of competency grids). Third, as the verbal model included reading speed and comprehension as covariates, and mathematics did not, that could indicate that more complex assessment of achievement, than grades, is warranted in future studies. In turn, the grades at t1 negatively associated in SDL with performance-avoidance goals in verbal and mathematics models alike. In other words, the better grades the students reported, the less performance-avoidance goals they revealed. One possible explanation in school environment could lie in the nature of feedback and the absence of expectation of grading for task the students get in SDL, as some studies (e.g., Pulfrey et al., 2011) show that in particular that students' expectation of a grade for task accomplishment consistently led to greater adoption of performance-avoidance goal orientations.

The TDL models in mathematics and verbal domains alike show academic self-concept is positively associated with mastery goals and performance-approach goals, but not performance-avoidance goals, which stands in line with the existing research (e.g., Jiang et al., 2014; Lee, et al., 2014). Interestingly, grades in both domains are positively associated with mastery goal orientations, which also some other existing studies report (e.g., Sparfeldt et al., 2015), but were not related to performance-approach goal orientations. This finding might indicate that while performance-approach goals relate to one's wish to outperform others, grades might be not a reliable indicator of competence demonstration in school context. Thus, students might rather exhibit their skills in participating in group discussions or engaging in extracurricular activities that do not directly impact their grades.

Gender played an important role for both verbal and mathematical self-concepts for SDL and TDL students. This finding is supported by previous TDL-based studies that state that while girls report higher verbal self-concepts, boys tend to report higher mathematical self-concepts (e.g., Heyder et al., 2017; Mejía-Rodríguez et al., 2020; Skaalvik & Skaalvik, 2004). Age-related differences were, however, only relevant for TDL students, suggested by previous research: older students tend to have lower academic self-concepts and worse grades (Perinelli et al., 2022). This finding may suggest that academic self-concepts of students in SDL are less sensitive to (or exhibit slower changes) in the process of maturation, which means use of SDL practices among adolescents may present a working practical intervention aimed at diminishing the age-specific academic self-concept decline.

Overall, the results show further research on the reciprocal associations between domain-specific academic self-concepts and achievement in "intermediate track" is needed, using statistical models that consider between-person differences. In the "traditional" TDL setting, academic self-concept might be a stronger component than achievement. In contrast, to that, for students in SDL, the Reciprocal Effects Model was confirmed, i.e., that academic self-concept and grades were balanced variables. Goal orientations did not prove to be mediators for both learning environments alike.

Strengths and limitations

One of the limitations of the study is the use of self-reported data, even though criticism towards self-report data may as well address non-self-report data (Chan, 2009). Future studies should include multiple sources of data, such as teachers, parents, or peers to gather multiple perspectives. Also, the data was first collected in 2015, while school environments may have further developed since then. Furthermore, there is substantial criticism with regard to the use of self-reported grades as students' achievement indicator (Kuncel et al., 2005) as self-reported grades tend to overestimate the actual grades. However, previous research has shown that self-report of grades (in the German school system) is sufficiently reliable (e.g., Dickhäuser & Plenter, 2005), and even though there are slight variations in longitudinal research within domains, self-reported grades are an adequate measure to address achievement in school context (Sticca et al., 2017). In addition, this study controlled for reading speed and comprehension in the verbal model. Unfortunately, no supplementary achievement tests in mathematics were conducted in this study.

Another limitation is that while the study uses a domain-specific approach, the achievement goal orientations were assessed domain-unspecifically. However, achievement goals have been found to be highly domain-unspecific (e.g., Hornstra et al., 2016). Recent research on the role of conceptualizing items that measure achievement motivation in data collection process (Michel et al., 2020) shows that domain-specific variance can be explained by self-concept and self-esteem, but not by domain-specific achievement motivation. In other words, goal orientations are either domain-unspecific in general or hard to grasp by domain-specification of items in the process of data collection, which should definitely be addressed in further studies. Furthermore, the independent and mediation variables were measured both at T1; and therefore, the directionality of the paths in the SEM is presumed to be conceptual rather than causal. Finally, the study design fails to disentangle trait from state variance, as recommended in the revised latent state trait theory (Steyer et al., 2015); and therefore, the findings should be treated with caution and further tested in a random-intercept cross-lagged model.

A clear strength of the study is the domain-specific exploration of the effects of mastery, and performance-approach and performance-avoidance goal orientations in the Reciprocal Effects Model in two learning environments, which has not been done before. Another important strength is clarity in definitions of academic self-concept and SDL, as the existing literature shows (a) considerable confusion and interchangeable use of the terms "self-concept" and "self-efficacy," as well as (b) interchangeable use of the terms "self-directed learning" and "self-regulated learning," even in definition of the term itself (for an overview, see Saks & Leijen, 2014). Considering this fact, future studies on both academic self-concept and SDL should focus on clear definitions of terms under research and interpret existing results with caution.

Conclusions

The present study tested an extension of the Reciprocal Effects Model by including the three different goal orientations as possible mediators, and explore possible differences from students from SDL and TDL. The Reciprocal Effects Model effects could only be confirmed for SDL, and the extension by goal orientations as mediators could not be

confirmed. In practical terms, this means that while in SDL academic self-concept and achievement are interwoven, in TDL settings more attention should be paid to the formation of positive and realistic academic self-concepts of students through helpful teacher feedback (e.g., Burnett, 2003) rather than grades, as it would improve not only current but also future achievement.

In sum, the results expand the existing findings: while for general academic self-concept mastery goal orientation functions as a mediator in the Reciprocal Effects Model (Bakadorova & Raufelder, 2020), this finding could not be confirmed for the verbal/mathematics domains. In addition, the present findings uncover differences in the interplay of academic self-concepts, grades, and goal orientations between SDL and TDL which underlines the importance of learning environments for both theoretical and practical implications.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10212-024-00825-6.Acknowledgements The authors would like to thank the principals, teachers, and students for their cooperation in making these studies possible.

Author contribution Writing (introduction and discussion): Olga Steinberg.
Conceptualization, methodology, investigation, data collection: Stefan Kulakow.
Writing (introduction and discussion): Diana Raufelder.

Funding Open Access funding enabled and organized by Projekt DEAL.

Data availability Data will be made available on request.

Declarations

Ethics approval and consent to participate To ensure the ethical standards of the 1964 Declaration of Helsinki and of the German Psychological Society, all participants and their parents provided written informed consent.

Consent for publication All participants have given informed consent for publication.

Competing interests The authors declare no competing interests.

References

Ames, C. (1992). Achievement goals and the classroom motivational climate. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 327–348). Lawrence Erlbaum Associates Inc.

Arens, A. K., Marsh, H. W., Pekrun, R., Lichtenfeld, S., Murayama, K., & vom Hofe, R. (2017). Math self-concept, grades, and achievement test scores: Long-term reciprocal effects across five waves and three achievement tracks. *Journal of Educational Psychology, 109*(5), 621–634. https://doi.org/10.1037/edu0000163

Arens, A. K., Becker, M., & Möller, J. (2018). The internal/external frame of reference (I/E) model: Extension to five school subjects and invariance across German secondary school ability tracks. *Learning and Individual Differences, 67*, 143–155. https://doi.org/10.1016/j.lindif.2018.07.005

Armstrong, K. J. (2010). Self-directed learning in athletic training education. *Athletic Therapy Today, 15*(1), 19–22. https://doi.org/10.1123/att.15.1.19

Artelt, C., Baumert, J., Julius-McElvany, N., & Peschar, J. (2004). Das Lernen lernen: Voraussetzung für lebensbegleitendes Lernen. Ergebnisse von PISA 2000 [Learners for life: Student approaches to learning. Results from PISA 2000]. OECD.

Asparouhov, T. (2005). Sampling weights in latent variable modeling. *Structural Equation Modeling, 12*(3), 411–434. https://doi.org/10.1207/s15328007sem1203_4

Bakadorova, O., & Raufelder, D. (2020). The relationship of school self-concept, goal orientations and achievement during adolescence. *Self and Identity, 3*. https://doi.org/10.1080/15298868.2019.1581082

Barker, K. L., Dowson, M. N., & McInerney, D. M. (2005). Effects between motivational goals, academic self-concept and academic achievement: What is the causal ordering? Australian Association For Research In Education 2005 Conference Papers. Retrieved from https://www.aare.edu.au/data/publications/2005/bar05373.pdf. Accessed 13 Mar 2024

Bong, M. (2009). Age-related differences in achievement goal differentiation. *Journal of Educational Psychology*, *101*(4), 879–896. https://psycnet.apa.org/doi/10.1037/a0015945.

Burnett, P. (2003). The impact of teacher feedback on student self-talk and self-concept in reading and mathematics. *The Journal of Classroom Interaction, 38*(1), 11–16.

Burns, R. A., Crisp, D. A., & Burns, R. B. (2020). Re-examining the reciprocal effects model of self-concept, self-efficacy, and academic achievement in a comparison of the Cross-Lagged Panel and Random-Intercept Cross-Lagged Panel frameworks. *The British Journal of Educational Psychology, 90*(1), 77–91. https://doi.org/10.1111/bjep.12265

Chan, D. (2009). So why ask me? Are self-report data really that bad? In C. E. Lance & R. J. Vandenberg (Eds.), *Statistical and methodological myths and urban legends: Doctrine, verity and fable in the organizational and social sciences* (pp. 311–338). Routledge.

Chou, P., & Chen, W. (2008). Exploratory study of the relationship between self-directed learning and academic performance in a web-based learning environment. *Online Journal of Distance Learning Administration, 11*(1), 15–26.

Covington, M. V. (2000). Goal theory, motivation, and school achievement: An integrative review. *Annual Review of Psychology, 51*, 171–200. https://doi.org/10.1146/annurev.psych.51.1.171

Darnon, C., Harackiewicz, J. M., Butera, F., Gabriel, M., & Quiamzade, A. (2007). Performance-approach and performance-avoidance goals: When uncertainty makes a difference. *Personality and Social Psychology Bulletin, 33*(6), 813–827. https://doi.org/10.1177/0146167207301022

Denissen, J. J., Zarrett, N. R., & Eccles, J. S. (2007). I like to do it, I'm able, and I know I am: Longitudinal couplings between domain-specific achievement, self-concept, and interest. *Child Development, 78*(2), 430–447. https://doi.org/10.1111/j.1467-8624.2007.01007.x

Dickhäuser, O., & Plenter, I. (2005). "Letztes Halbjahr stand ich zwei". Zur Akkuratheit selbst berichteter Noten [On the accuracy of self-reported school marks]. *Zeitschrift Für Padagogische Psychologie [german Journal of Educational Psychology], 19*, 219–224. https://doi.org/10.1024/1010-0652.19.4.219

Eccles, J. S., & Midgley, C. (1989). Stage/Environment Fit: Developmentally Appropriate Classrooms for Early Adolescence. In R. E. Ames, & Ames, C. (Eds.), *Research on Motivation in Education* (Vol. 3, pp. 139–186). New York: Academic Press.

Elliot, A. J., & Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology, 72*(1), 218–232. https://doi.org/10.1037/0022-3514.72.1.218

ElliotMacGregor, A. J. (2001). A 2 X 2 achievement goal framework. *Journal of Personality and Social Psychology, 80*(3), 501–519. https://doi.org/10.1037/0022-3514.80.3.501

Geiser, C. (2013). *Data analysis with Mplus*. Guilford Press.

Gnambs, T., & Hanfstingl, B. (2016). The decline of academic motivation during adolescence: An accelerated longitudinal cohort analysis on the effect of psychological need satisfaction. *Educational Psychology, 36*(9), 1691–1705. https://doi.org/10.1080/01443410.2015.1113236

Green, J., Nelson, G., Martin, A. J., & Marsh, H. (2006). The causal ordering of self-concept and academic motivation and its effect on academic achievement. *International Education Journal, 7*(4), 534–546.

Guay, F., Marsh, H. W., & Boivin, M. (2003). Academic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology, 95*(1), 124–136. https://doi.org/10.1037/0022-0663.95.1.124

Heyder, A., Kessels, U., & Steinmayr, R. (2017). Explaining academic-track boys' underachievement in language grades: Not a lack of aptitude but students' motivational beliefs and parents' perceptions? *British Journal of Educational Psychology, 87*, 205–223. https://doi.org/10.1111/bjep.12145

Hornstra, L., van der Veen, I., & Peetsma,T. (2016). Domain-specificity of motivation: A longitudinal study in upper primary school. *Learning and Individual Differences, 51*, 167–178. https://doi.org/10.1016/j.lindif.2016.08.012

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hübner, N., Wagner, W., Zitzmann, S., & Nagengast, B. (2023). How strong is the evidence for a causal reciprocal effect? Contrasting traditional and new methods to investigate the reciprocal effects model of self-concept and achievement. *Educational Psychology Review, 35*, 6. https://doi.org/10.1007/s10648-023-09724-6

Huguet, P., Dumas, F., Marsh, H., Wheeler, L., Seaton, M., Nezlek, J., Suls, J., & Régner, I. (2009). Clarifying the role of social comparison in the big-fish-little-pond effect (BFLPE): an integrative study. *Journal of Personality and Social Psychology, 97*(1), 156–170. https://doi.org/10.1037/a0015558

Hulleman, C. S., Schrager, S. M., Bodmann, S. M., & Harackiewicz, J. M. (2010). A meta-analytic review of achievement goal measures: Different labels for the same constructs or different constructs with similar labels? *Psychological Bulletin, 136*(3), 422–449. https://doi.org/10.1037/a0018947

Hussain, S., Anwar, S., & Majoka, M. I. (2011). Effect of peer group activity-based learning on students' academic achievement in physics at secondary level. *International Journal of Academic Research, 3*, 940–944.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*(2), 509–527. https://doi.org/10.1111/1467-8624.00421

Jiang, Y., Song, J., Lee, M., & Bong, M. (2014). Self-efficacy and achievement goals as motivational links between perceived contexts and achievement. *Educational Psychology, 34*(1), 92–117. https://doi.org/10.1080/01443410.2013.863831

Jones, J. G., & Grieneeks, L. (1970). Measures of self-perception as predictor of scholastic performance. *Journal of Educational Research, 63*, 201–203.

Kastens, C., & van Wickeren, M. (2023). Empirische Arbeit: Effekte der Gymnasialempfehlung auf die Entwicklung von Kompetenzerleben, Interesse und Lernverhalten am Ende der Grundschulzeit: Mehr als eine Frage der Leistung?. [Empirical work: Effects of gymnasium recommendation on the development of competence, interest and learning behavior at the end of primary school: More than a question of performance?]. *Psychologie in Erziehung und Unterricht*, https://reinhardt-journals.de/index.php/peu/article/view/155170/6501. https://doi.org/10.2378/peu2023.art07d

Kearney, M. W. (2017). Cross-lagged panel analysis. In M. R. Allen (Ed.), *SAGE encyclopedia of communication research methods.* SAGE.

Knowles, M. S. (1975). *Self-directed learning*. Association Press.

Kulakow, D. (2020). Academic self-concept and achievement motivation among adolescent students in different learning environments: Does competence-support matter? *Learning and Motivation, 70*, 101632. https://doi.org/10.1016/j.lmot.2020.101632

Kuncel, N. R., Credé, M., & Thomas, L. L. (2005). The validity of self-reported grade point averages, class ranks, and test scores: A meta-analysis and review of the literature. *Review of Educational Research, 75*(1), 63–82. https://doi.org/10.3102/00346543075001063

Lee, K., Ning, F., & Goh, H. C. (2014). Interaction between cognitive and non-cognitive factors: The influences of academic goal orientation and working memory on mathematical performance. *Educational Psychology, 34*(1), 73–91. https://doi.org/10.1080/01443410.2013.836158

Little, T. D. (2013). *Longitudinal Structural Equation modeling*. Guilford Press.

Locher, F. M., Becker, S., Schiefer, I., & Pfost, M. (2021). Mechanisms mediating the relation between reading self-concept and reading comprehension. *European Journal of Psychology of Education, 36*, 1–20. https://doi.org/10.1007/s10212-020-00463-8

Lounsbury, J., Levy, J., Park, S., Gibson, L., & Smith, R. (2009). An investigation of the construct validity of the personality trait of self-directed learning. *Learning and Individual Differences, 19*, 411–418. https://doi.org/10.1016/j.lindif.2009.03.001

MacKinnon, D. P. (2008). *Introduction to statistical mediation analysis*. Lawrence Erlbaum Associates.

Marsh, H. W. (1986). Verbal and math self-concepts: An internal/external frame of reference model. *American Educational Research Journal, 23*(1), 129–149. https://doi.org/10.2307/1163048

Marsh, H. W. (1989). Age and sex effects in multiple dimensions of self-concept: Preadolescence to early adulthood. *Journal of Educational Psychology, 81*(3), 417–430. https://doi.org/10.1037/0022-0663.81.3.417

Marsh, H. W. (1990). A multidimensional, hierarchical model of self-concept: Theoretical and empirical justification. *Educational Psychology Review, 2*, 77–172. https://doi.org/10.1007/BF01322177

Marsh, H. W., & Craven, R. G. (2006). Reciprocal effects of self-concept and performance from a multidimensional perspective. Beyond seductive pleasure and unidimensional perspectives. *Perspectives on Psychological Science, 1*, 133–163. https://doi.org/10.1111/j.1745-6916.2006.00010.x

Marsh, H. W., & Martin, A. J. (2011). Academic self-concept and academic achievement: Relations and causal ordering. *British Journal of Educational Psychology, 81*(1), 59–77.

Marsh, H. W., Lüdtke, O., Nagengast, B., Trautwein, U., Abduljabbar, A. S., Abdelfattah, F., & Jansen, M. (2015). Dimensional comparison theory: Paradoxical relations between self-beliefs and achievements in multiple domains. *Learning and Instruction, 35*, 16–32. https://doi.org/10.1016/j.learninstruc.2014.08.005

Mejía-Rodríguez, A. M., Luyten, H., & Meelissen, M. R. M. (2020). Gender differences in mathematics self-concept across the world: An exploration of student and parent data of TIMSS 2015. *International Journal of Science and Mathematics Education*. https://doi.org/10.1007/s10763-020-10100-x

Michel, Y. A., Steinmayr, R., Frenzel, A. C., & Ziegler, M. (2020). Unpacking domain-specific achievement motivation: The role of contextualising items for test-criterion correlations. *Educational Psychology*. Advance online publication. https://doi.org/10.1080/01443410.2020.1713303

Middleton, M. J., & Midgley, C. (1997). Avoiding the demonstration of lack of ability: An underexplored aspect of goal theory. *Journal of Educational Psychology, 89*(4), 710–718. https://doi.org/10.1037/0022-0663.89.4.710

Mulder, J. D., & Hamaker, E. L. (2021). Three extensions of the random intercept cross-lagged panel model. *Structural Equation Modeling: A Multidisciplinary Journal, 28*(4), 638–648. https://doi.org/10.1080/10705511.2020.1784738

Muthén, B. O., & Muthén, L. K. (1998–2017). *Mplus user's guide* (8th ed.). Muthén & Muthén.

Nagy, G., Watt, H., Eccles, J., Trautwein, U., Lüdtke, O., & Baumert, J. (2010). The development of students' mathematics self-concept in relation to gender: Different countries, different trajectories? *Journal of Research on Adolescence, 20*(2), 482–506. https://doi.org/10.1111/j.1532-7795.2010.00644.x

Niemivirta, M. , Pulkka, A.-T., Tapola, A., & Tuominen, H. (2019). Achievement goal orientations: A person-oriented approach. In Renninger, K. Ann; Hidi, Suzanne E. (Eds.), *The Cambridge handbook of motivation and learning* (pp. 566–616). https://doi.org/10.1017/9781316823279

Niepel, C., Brunner, M., & Preckel, F. (2014). Achievement goals, academic self-concept, and school grades in mathematics: Longitudinal reciprocal relations in above average ability secondary school students. *Contemporary Educational Psychology, 39*(4), 301–313. https://doi.org/10.1016/j.cedpsych.2014.07.002

O'Mara, A. J., Marsh, H. W., Craven, R. G., & Debus, R. L. (2006). Do self-concept interventions make a difference? A synergistic blend of construct validation and meta- analysis. *Educational Psychologist, 41*(3), 181–206. https://doi.org/10.1207/s15326985ep4103_4

Opacic, G., & Kadijevic, D. M. (1997). Mathematical self-concept: An operationalization and its empirical validity. *Psihologija, 30*, 395–412.

Orawiwatnakul, W., & Wichadee, S. (2017). An investigation of undergraduate students' beliefs about autonomous language learning. *International Journal of Instruction, 10*, 117–132. https://www.e-iji.net/dosyalar/iji_2017_1_8.pdf.

Orth, U., Meier, L. L., Bühler, J. L., Dapp, L. C., Krauss, S., Messerli, D., & Robins, & R. W. (2022). Effect size guidelines for cross-lagged effects. Advance online publication. *Psychological Methods*.https://doi.org/10.1037/met0000499

Paulick, I., Watermann, R., & Nückles, M. (2013). Achievement goals and school achievement: The transition to different school tracks in secondary school. *Psychology, 38*(1), 75–86. https://doi.org/10.1016/j.cedpsych.2012.10.003

Pekrun, R., Elliot, A., & Maier, M. A. (2006). Achievement goals and discrete achievement emotions: A theoretical model and prospective test. *Journal of Educational Psychology, 98*(3), 583–597. https://doi.org/10.1037/0022-0663.98.3.583

Perinelli, E., Pisanu, F., Checchi, D., Scalas, L. F., & Fraccaroli, F. (2022). Academic self-concept change in junior high school students and relationships with academic achievement. *Contemporary Educational Psychology, 69*(102071), 1–20. https://doi.org/10.1016/j.cedpsych.2022.102071

Pesu, L., Aunola, K., Viljaranta, J., & Nurmi, J.-E. (2016). The development of adolescents' self-concept of ability through grades 7–9 and the role of parental beliefs. *Frontline Learning Research, 4*(3), 92–109. https://doi.org/10.14786/flr.v4i3.249

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In Boekaerts, M., Pintrich, P.R., & Zeidner, M. (Eds.), *Handbook of self-regulation* (pp. 451–502). https://doi.org/10.1016/B978-012109890-2/50043-3

Preckel, F., & Brunner, M. (2015). Academic self-concept, achievement goals, and achievement: Is their relation the same for academic achievers and underachievers? *Gifted and Talented International, 30*(1), 68–84. https://doi.org/10.1080/15332276.2015.1137458

Pulfrey, C., Buchs, C., & Butera, F. (2011). Why grades engender performance-avoidance goals: The mediating role of autonomous motivation. *Journal of Educational Psychology, 103*(3). https://doi.org/10.1037/a0023911

Raufelder, D., & Kulakow, S. (2021). The role of the learning environment in adolescents' motivational development. *Motivation and Emotion, 45*(3), 299–311. https://doi.org/10.1007/s11031-021-09879-1

Retelsdorf, J., Köller, O., & Möller, J. (2014). Reading achievement and reading self-concept—testing the reciprocal effects model. *Learning and Instruction, 29*, 21–30. https://doi.org/10.1016/j.learninstruc.2013.07.004

Rosenshine, B., & Stevens, R. (1984). Classroom instruction in reading. In P. D. Pearson (Ed.), *Recent research on reading*. Longman.

Ryser, G. R., Beeler, J. E., & McKenzie, C. M. (1995). Effects of a computer-supported intentional learning environment (CSILE) on students' self-concept, self-regulatory behavior, and critical thinking ability. *Journal of Educational Computing Research, 13*, 375–385. https://doi.org/10.2190/XLGB-PXEC-BVXG-GRKN

Saks, K., & Leijen, A. (2014). Distinguishing self-directed and self-regulated learning and measuring them in the E-learning context. *Procedia - Social and Behavioral Sciences, 112*, 190–198. https://doi.org/10.1016/j.sbspro.2014.01.1155

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods, 7*(2), 147–177. https://doi.org/10.1037/1082-989X.7.2.147

Schneider, W., Schlagmüller, M., & Ennemoser, M. (2007). *LGVT 6–12: Lesegeschwindigkeits- und -verständnistest für die Klassen 6–12 [LGVT 6–12: Reading speed and comprehension tests for grades 6–12]*. Hogrefe.

Schweder, S. (2020). Mastery goals, positive emotions and learning behavior in self-directed vs. teacher-directed learning. *European Journal of Psychology of Education, 35*, 205–223. https://doi.org/10.1007/s10212-019-00421-z

Schweder, S., & Raufelder, D. (2021). Needs satisfaction and motivation among adolescent boys and girls during self-directed learning intervention. *Journal of Adolescence, 88*, 1–15. https://doi.org/10.1016/j.adolescence.2021.01.007

Schweder, S., & Raufelder, D. (2023). Self-directed learning in formal education: Longitudinal analysis of multiple goal profiles. *Social Science Research*.

Schweder, S., & Raufelder, D. (2024). Does changing learning environments affect student motivation? *Learning and Instruction, 89*, 101829.

Schweder, S., Raufelder, D., Kulakow, S., & Wulff, T. (2019). How the learning context affects adolescents' goal orientation, effort, and learning strategies. *Journal of Educational Research, 112*(5), 604–614. https://doi.org/10.1080/00220671.20191645085

Seaton, M., Parker, P., Marsh, H. W., Craven, R., & Yeung, A. S. (2014). The reciprocal relations between self-concept, motivation and achievement: Juxtaposing academic self-concept and achievement goal orientations for mathematics success. *An International Journal of Experimental Educational Psychology, 34*, 49–72. https://doi.org/10.1080/01443410.2013.825232

Self, S. G., & Liang, K. Y. (1987). Asymptotic properties of maximum likelihood estimators and likelihood ratio tests under nonstandard conditions. *Journal of the American Statistical Association, 82*, 605–610. https://doi.org/10.2307/2289471

Shavelson, R. J., Hubner, J. J., & Stanton, G.C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research*, *46*(3), 407–441. Retrieved from http://www.jstor.org/stable/1170010.

Skaalvik, E. M., & Hagtvet, K. A. (1990). Academic achievement and self-concept: An analysis of causal predominance in a developmental perspective. *Journal of Personality and Social Psychology, 58*(2), 292–307. https://doi.org/10.1037/0022-3514.58.2.292

Skaalvik, S., & Skaalvik, E. (2004). Gender differences in math and verbal self-concept, performance expectations, and motivation. *Sex Roles, 50*, 241–252. https://doi.org/10.1023/B:SERS.0000015555.40976.e6

Smith, A. R., Chein, J., & Steinberg, L. (2013). Impact of socio-emotional context, brain development, and pubertal maturation on adolescent risk-taking. *Hormones and Behavior, 64*(2), 323–332. https://doi.org/10.1016/j.yhbeh.2013.03.006

Sparfeldt, J.R., Brunnemann, N., Wirthwein, L., Buch, S .R., Schult, J., Rost, D.H. (2015). General versus specific achievement goals: A re-examination. *Learning and Individual Differences, 43,* 170–177. https://psycnet.apa.org/doi/10.1016/j.lindif.2015.08.022.

Spinath, B., Stiensmeier-Pelster, J., Schöne, C., & Dickhäuser, O. (2012). *SELLMO: Skalen zur Erfassung der Lern- und Leistungsmotivation* (2nd rev.) [SELLMO Scales: Scales to access the learning and achievement motivation]. Hogrefe.

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in Cognitive Sciences, 9*(2), 69–74. https://doi.org/10.1016/j.tics.2004.12.005

Steinberg, L., & Morris, A. S. (2001). Adolescent development. *Annual Review of Psychology, 52*(1), 83–110. https://doi.org/10.1146/annurev.psych.52.1.83

Steinmayr, R., Weidinger, A. F., Schwinger, M., & Spinath, B. (2019). The importance of students' motivation for their academic achievement—replicating and extending previous findings. *Frontiers in Psychology, 10*, 1730. https://doi.org/10.3389/fpsyg.2019.01730

Steyer, R., Mayer, A., Geiser, C., & Cole, D. (2015). A theory of states and traits—revised. *Annual Review of Clinical Psychology, 11*(1), 71–98. https://doi.org/10.1146/annurev-clinpsy-032813-153719

Sticca, F., Goetz, T., Bieg, M., Hall, N. C., Eberle, F., & Haag, L. (2017). Examining the accuracy of students' self-reported academic grades from a correlational and a discrepancy perspective: Evidence from a longitudinal study. *PloS One, 12*(11), e0187367. https://doi.org/10.1371/journal.pone.0187367

Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2006). Self-esteem, academic self-concept, and achievement: How the learning environment moderates the dynamics of self-concept. *Journal of Personality and Social Psychology, 90*(2), 334–349. https://doi.org/10.1037/0022-3514.90.2.334

Valentine, J. C., & Dubois, D. L. (2005). Effects of self-beliefs on academic achievement and vice versa. Separating the chicken from the egg. In H. W. Marsh, R. G. Craven, & D. M. McInerney (Eds.), *International advances in self research: New frontiers for self research* (vol. 2, pp. 53–78). Information Age.

Watts-Taffe, S., Laster, B., Broach, L., Marinak, B., McDonald Connor, C., & Walker-Dalhouse, D. (2012). Differentiated instruction: Making informed teacher decisions. *The Reading Teacher, 66*(4), 303–314. https://doi.org/10.1002/TRTR.01126

Weiner, B. (1990). History of motivational research in education. *Journal of Educational Psychology, 82*, 616–622. https://doi.org/10.1037/0022-0663.82.4.616

Werner, C., & Schermelleh-Engel, K. (2010). Deciding between competing models: Chi-square difference tests. In *Introduction to structural equation modeling with LISREL* (pp. 1–3) Retrieved from: https://www.psychologie.uzh.ch/dam/jcr:ffffffff-b371-2797-0000-00000fda8f29/chisquare_diff_en.pdf

Wijsman, L. A., Warrens, M. J., Saab, N., van Driel, J. H., & Westenberg, P. M. (2016). Declining trends in student performance in lower secondary education. *European Journal of Psychology of Education, 31*(4), 595–612. https://doi.org/10.1007/s10212-015-0277-2

Wu, H., Guo, Y., Yang, Y., Zhao., L., & Guo, C. (2021). A meta-analysis of the longitudinal relationship between academic self-concept and academic achievement. *Educational Psychology Review, 33*(2), 1–30. https://doi.org/10.1007/s10648-021-09600-1

Yeung, A., Craven, R., & Kaur, G. (2012). Mastery goal, value and self-concept: What do they predict? *Educational Research, 54*(4). https://doi.org/10.1080/00131881.2012.734728

Olga Steinberg. Department of Psychology, Greifswald University, Franz-Mehring-Straße 47, 17489 Greifswald, Germany. E-mail: olga.steinberg@uni-greifswald.de

Current themes of research:

Academic self-concept in adolescence. Social and motivational relationships with peers and teachers in adolescence. Emergence and development of interest in the school context. Qualitative and quantitative

methods in educational research.

Most relevant publications in the field of Psychology of Education:

Bakadorova, O., Lazarides, R., & Raufelder, D. (2020). *Effects of social and individual school self-concepts on school engagement during adolescence*. European Journal of Psychology of Education, *35*, 73–91. https://doi.org/10.1007/s10212-019-00423-x.

Bakadorova, O., & Raufelder, D. (2020). *The relationship of school self-concept, goal orientations and achievement during adolescence*. Self & Identity, *19*(2), 235–249. https://doi.org/10.1080/15298868.2019.1581082.

Bakadorova, O., & Raufelder, D. (2018). *The essential role of the teacher-student relationship in students' need satisfaction during adolescence*. Journal of Applied Developmental Psychology, 58, 57–65. https://doi.org/10.1016/j.appdev.2018.08.004.

Stefan Kulakow. Department of Educational Science, Greifswald University, Ernst-Lohmeyer-Platz 3, 17489 Greifswald, Germany.

Current themes of research:

Concepts of individualized learning. Concepts for interdisciplinary and inquiry learning. Education and digitalization. Motivation research. Self-regulation research. Quantitative and qualitative educational research.

Most relevant publications in the field of Psychology of Education:

Kulakow, S., Raufelder, D., & Hoferichter, F. (2021). *School-related pressure and parental support as predictors of change in student stress levels from early to middle adolescence*. Journal of Adolescence, 87, 38–51. https://doi.org/10.1016/j.adolescence.2020.12.008.

Kulakow, S., & Raufelder, D. (2020). *Enjoyment benefits adolescents' self-determined motivation in student-centered learning*. International Journal of Educational Research, 103. https://doi.org/10.1016/j.ijer.2020.101635.

Kulakow, S. (2020). *Academic self-concept and achievement motivation among adolescent students in different learning environments: Does competence-support matter?* Learning and Motivation, 70, 1–15. https://doi.org/10.1016/j.lmot.2020.101632.

Diana Raufelder. Department of Educational Science, Greifswald University, Ernst-Lohmeyer Platz 3, 17489 Greifswald, Germany.

Current themes of research:

Socio-emotional teaching and learning factors. Emotion and motivation research. Socio-motivational relationships with peers and teachers in the school context. Self-directed learning. Stress and test anxiety. Educational, upbringing and socialization processes in the school context. Teacher education (e.g., mentoring, reflective practice phases). Empirical educational research.

Most relevant publications in the field of Psychology of Education:

Raufelder, D., Hoferichter, F., Hirvonen, R., & Kiuru, N. (2022). *How students' motivational profiles change during the transition from primary to lower secondary school*. Contemporary Educational Psychology, 71. https://doi.org/10.1016/j.cedpsych.2022.102117.

(Raufelder, D., & Kulakow, S. (2022). *The role of social belonging and exclusion at school and the teacher-student relationship for the development of learned helplessness in adolescents*. British Journal of Educational Psychology, 92(1), 59–81. https://doi.org/10.1111/bjep.12438.

Raufelder*, D., Neumann*, N., Domin, M., Romund, L., Golde, S., Lorenz, R., Gleich, T., Beck, A., & Hoferichter, F. (2021). *Do belonging and social exclusion at school affect structural brain development during adolescence?* Child Development, 92(6), 2213–2223. https://doi.org/10.1111/cdev.13613 *shared first authorship.