Journal for Educational Research Online
Journal für Bildungsforschung Online
Volume 12 (2020), No. 2, 114–165

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A longitudinal analysis of reciprocal relations between students' well-being and academic achievement

Abstract

Besides acquisition of academic competencies, well-being is an important educational goal and it has been shown that both outcomes are mutually dependent. However, until now, most studies used cross-sectional designs so that the direction of the relation is not yet fully understood. In the present study we used longitudinal data from students attending grades 5 to 9 who participated in the National Educational Panel Study (NEPS). We analyzed reciprocal relations between different facets of well-being (i.e., physical, cognitive, emotional) and academic achievement. Furthermore, we examined differences between gender and type of school in these reciprocal relations. Results revealed mainly positive reciprocal relations between academic achievement and different indicators of well-being. However, multi-group models did not show differences between gender and type of school. Implications for future research and educational practice are discussed.

Keywords

Academic achievement; Cross-lagged-panel analysis; Gender; Students' well-being; Type of school

Eine Längsschnittanalyse der wechselseitigen Beziehungen zwischen schulischem Wohlbefinden und akademischer Leistung

Zusammenfassung

Neben dem Kompetenzerwerb stellt Wohlbefinden ein wichtiges Bildungsziel dar und es konnte gezeigt werden, dass beide Variablen voneinander abhän-

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gen. Bis jetzt liegen allerdings im Wesentlichen Befunde aus Querschnittsstudien vor, sodass die Richtung des Zusammenhangs noch nicht vollständig geklärt ist. In der vorliegenden Studie wurden längsschnittliche Daten von Schülerinnen und Schülern der 5. bis zur 9. Klasse genutzt, die an der nationalen Bildungspanelstudie (NEPS) teilgenommen hatten. Untersucht wurden reziproke Zusammenhänge zwischen verschiedenen Facetten von Wohlbefinden (körperlich, kognitiv, emotional) und schulischer Leistung. Weiterhin wurden in Bezug auf diese reziproken Zusammenhänge Unterschiede zwischen Geschlechtern und Schulformen analysiert. Die Ergebnisse zeigten vor allem positive wechselseitige Beziehungen zwischen schulischer Leistung und verschiedenen Indikatoren des Wohlbefindens. Mehrgruppenmodelle ergaben jedoch keine Hinweise auf Unterschiede zwischen Geschlechtern oder Schulformen. Implikationen für Forschung und Bildungspraxis werden diskutiert.

Schlagworte
Cross-Lagged-Panel Analyse; Geschlecht; Leistung; Schulform; Wohlbefinden von Schülerinnen und Schülern

1. Introduction

The Organisation for Economic Co-operation and Development (OECD, 2017) stated that students should feel well at school so that they are motivated to learn and perform well. This demand reflects the importance of students' well-being for student achievement and stresses that there is a relation between well-being and achievement. The importance of students' well-being is also emphasized by being understood as an important educational goal, beside acquisition of academic competencies (van Petegem, Aelterman, Rossel, & Creemers, 2006). Furthermore, these two educational outcomes reflect central indicators of students' positive functioning and are most likely mutually dependent (e.g., Bücker, Nuraydin, Simonsmeier, Schneider, & Luhmann, 2018; Suldo, Riley, & Shaffner, 2006). Seligman, Ernst, Gillham, Reivich, and Linkins (2009) emphasized the importance of school for well-being due to the relation between learning, emotions, and well-being. According to the worldwide prevalence rate for schoolchildrens' depression, Seligman and colleagues (2009, p. 293) even advocate to teach "skills for happiness" at school so that students can handle demanding situations better, feel and learn well.

Although acquisition of academic competencies and well-being are both important educational goals, not much is known on their relation and mutual impact on their development. On grounds of the importance of well-being for learning, more research on student well-being was done in the last years. However, studies were mainly cross-sectional and often focused rather on single aspects of students' well-being instead of considering multiple facets of this complex construct

(Heffner, & Antaramian, 2016). Furthermore, the results of these studies are heterogeneous, whereby a current meta-analysis reported a small to medium-sized positive relation between well-being and academic achievement (Bücker et al., 2018). Nevertheless, the question of the direction between these constructs is still unanswered. Theoretically, the direction can be postulated from academic achievement to well-being as well as vice versa (see e.g., broaden-and-build-theory, Fredrickson, 2001; self-determination-theory, Ryan, & Deci, 2000). A third option could be that there is no causal relation between both constructs, although they are associated with each other. Moreover, the direction might vary for different groups of students: For example, boys and girls differ in their evaluation of school and satisfaction with life (e.g., Hascher, & Hagenauer, 2011; Palsdottir, Asgeirsdottir, & Sigfusdottir, 2012). Furthermore, type of school is an important factor for academic achievement and for well-being (Chang, McBride-Chang, Stewart, & Au, 2003). Differences between these groups of students could have an impact on the relation between well-being and academic achievement.

Altogether, there is still a need for further research in order to shed light on the direction in the relation between academic achievement and well-being and to identify important influencing factors and moderators, especially in a long-term perspective.

2. Theoretical background

2.1 Students' well-being

Whereas well-being has formerly been defined by means of objective measures like wealth or the fact that a person is married (Wilson, 1967), nowadays research often concentrates on subjective well-being (SWB). SWB is a multi-dimensional and broad construct (Seligman, 2011). However, a clear and widely accepted definition is still missing. Taken as a whole, SWB is referred to as how a person feels and thinks about his or her life in general, as well as concerning a certain domain (Diener, 1984; Diener, Suh, Lucas, & Smith, 1999).

There are several theoretical approaches of SWB. One of the most used approaches is the hedonic one (Eid, & Larsen, 2008; Ryan, & Deci, 2001). The hedonic approach distinguishes cognitive and affective components (Diener, 1984; Diener et al., 1999). The cognitive component comprises cognitive evaluations in the form of global and domain-specific satisfaction (Diener, Inglehart, & Tay, 2013). Global life satisfaction includes all life-evaluative attitudes and beliefs, whereas the domain-specific can be directed and refers to a particular area such as school (Schimmack, 2008). Concerning the affective component Bradburn (1969) already differentiated between positive and negative affect (e.g., joy vs. learned helplessness). Even though it has initially been stated that both components are independent from each other (Bradburn, 1969) the relation between positive and

negative affect has been debated controversially (e.g., Diener et al., 1999; Diener, & Emmons, 1984; Russell, & Carroll, 1999). Furthermore, there are two other important aspects which are of relevance for SWB (WHO, 2014): physical and social well-being. The physical component of SWB comprises measures like absent days as well as subjective evaluations of one's health (Richter, & Hurrelmann, 2009). Social well-being encompasses the evaluation of, for example, social relationships.

For a long time, students' SWB was not in focus of psychological research (Hascher, 2008). However, recently there has been more research on students' SWB. In general, empirical studies in European countries such as Czech Republic, Germany or Switzerland showed that students feel well in school, are satisfied with school and do not indicate physical complaints on a high level (e.g., Hascher, 2007; Urhahne, & Zhu, 2015). However, students also reported school-related worries, especially concerning grading and achievement (Hascher, 2007). Furthermore, it has been shown that SWB decreases with age (e.g., Casas, & González-Carrasco, 2019; Rohlfs, 2011), whereby for most countries the decline starts around age of 10 (Casas, & González-Carrasco, 2019). Thus, the examination of the relation between SWB and academic achievement seems to be of special importance in the group of adolescents.

2.2 Students' SWB and its relation to academic achievement

Students' SWB and academic achievement are important indicators of their positive psychological functioning (e.g., Suldo et al., 2006). The direction of the relation between SWB and academic achievement can be explained from both sides: Academic achievement could cause SWB as well as SWB could influence academic achievement. The first mechanism is explainable for example by means of the self-determination theory (SDT; Ryan, & Deci, 2000). The SDT assumes that certain psychological needs (autonomy, competence, and relatedness) are of importance for personality growth, social development, intrinsic motivation, and also for SWB. According to this, students' academic achievement as a reflection of the fulfillment of the psychological need of competence may influence students' SWB. The second possible path direction from SWB to academic achievement might be explainable for example by the broaden-and-build theory of positive affect (Fredrickson, 2001). This theory claims that the experience of positive affect as an important component of SWB broadens people's momentary thought-action repertoires. This enables a person to think more flexible and, therefore, might lead to higher achievement. Beneficial for the relation between positive affect and achievement might be that positive affect is also associated with mastery goals (Linnenbrink, & Pintrich, 2002). Additionally, negative affect is negatively related to academic achievement (Gumora, & Arsenio, 2002). Apart from these two theoretical approaches that could explain a causal relation it is also possible that the constructs are associated in a non-causal manner.

While some studies did not find a significant correlation between these two outcomes (Huebner, 1991; Huebner, & Adlerman, 1993), numerous studies have given evidence for an interrelation between SWB and academic achievement (Bird, & Markle, 2012; Bücker et al., 2018; Crede, Wirthwein, McElvany, & Steinmayr, 2015; Pietarinen, Soini, & Pyhältö, 2014; Suldo, Shaffer, & Riley, 2008). A meta-analysis from Bücker et al. (2018) revealed that there is a medium-sized positive relation between the two constructs.[1] Additionally, there is evidence that higher achievement leads to lower levels of psychopathology (Suldo, & Shaffer, 2008). However, most of the studies were cross-sectional. Only few studies analyzed the causal relation between SWB and academic achievement. For example, Steinmayr, Crede, McElvany, and Wirthwein (2016) found that students' great point average in grade 11 predicted changes in life satisfaction in grade 12 positively. Because the evidence from longitudinal data is rare and only certain age groups have been considered, the causal direction of the relation between students' SWB and academic achievement is not yet fully understood.

Beside the interplay between SWB in general and academic achievement, academic achievement is also associated with a positive health behavior and perception of one's own health (Eide, Showalter, & Goldhaber, 2010; Lavy, & Sand, 2012; Sigfúsdóttir, Kristjánsson, & Allegrante, 2007; Véronneau, & Dishion, 2012; Zajacova, Lynch, & Espenshade, 2005). Furthermore, studies which mainly focused on adolescents found a positive correlation between life satisfaction and academic achievement (e.g., Heffner, & Antaramian, 2016; Proctor et al., 2010). Concerning school, it was reported that life satisfaction is positively related to school grades (Gilman, & Huebner, 2006; Verkuyten, & Thijs, 2002). Moreover, students' perception of school satisfaction predicted positively students' perception of their academic achievement (e.g., Samdal, Wold, & Bronis, 1999). Concerning negative aspects of students' SWB, studies showed a negative relation to academic achievement. Studies have shown that *learned helplessness*[2] is negatively related to academic achievement: In particular, learned helplessness in the third grade predicted achievement test scores in grade 5 negatively (Fincham, Hokoda, & Sanders, 1989).

2.3 Gender and type of school as possible influencing factors on the relation between students' SWB and academic achievement

One factor which might explain differences in the relation between SWB and academic achievement is gender. There are some studies which found sex differences in certain areas of SWB: In contrast to boys, girls stated more often physical issues and experience of stress; whereas boys reported a less positive attitude to-

1 SWB was operationalized in the meta-analysis according to Diener's (1984) definition.
2 The concept of *learned helplessness* (Seligman, 1972) describes the subjective conviction that one has lost the ability to change one's own life situation, because of repeated negative experiences.

wards school (Hascher, & Hagenauer, 2011; Palsdottir et al., 2012). Corresponding to this, it has been found repeatedly that girls in contrast to boys are in general more satisfied with school (Czerwenka et al., 1990; Haecker, & Werres, 1983; Hascher, & Winkler-Ebner, 2010). However, it seems that girls are more prone to learned helplessness compared to boys, especially in the domain of mathematics (Dweck, 1986; Farmer, & Vispoel, 1990). Concerning other important facets of SWB, like social problems or self-esteem, no differences between boys and girls were discovered (Hascher, & Hagenauer, 2011). In the overall picture, some differences become apparent between sexes concerning SWB whereby there are more facets in which girls have lower values than facets in which boys have lower values. So far, however, there is an ambiguous results pattern concerning gender differences in SWB (Gysin, 2017, p. 107). Given that girls tend to have better grades than boys (e.g., Berger, Alcalay, Torretti, & Milicic, 2011), it seems possible that there are gender-specific differences regarding the relation between SWB and academic achievement in that way that in girls these constructs are not as high and positively associated as in boys. A possible explanation could be that girls compensate lower well-being with a higher readiness to perform well in school. In other domains this phenomenon has been referred to by a higher "conformity of girls towards school requirements" (e.g., Sparfeldt, Buch, Schwarz, Jachmann, & Rost, 2009). Up to now, the evidence for a moderating effect of gender is sparse and inconclusive: Herman, Lambert, Reinke, and Ialongo (2008) found a moderating effect of gender in a mediation model from academic competence in the first grade over perceived control in grade six on depression in seventh grade. In contrast, there is also evidence that gender does not influence the path coefficients between academic achievement and SWB. For example, a current meta-analysis found no moderating effect of gender on the relation between SWB and academic achievement (Bücker et al., 2018).

Another factor which might lead to differences in the relation between SWB and academic achievement is type of school. One study found differences in SWB between students attending different types of school (Fend, Knörzer, Nagl, Specht, & Väth-Szusdziara, 1976). Additionally, Chang et al. (2003) assume that type of school is an important factor for well-being on the one hand, but also for achievement on the other hand. A relation between school type and well-being might be explainable by differential learning environments. Students from different school types differ in achievement as well as in other student characteristics like motivation. For instance, motivational characteristics of high school students (Gymnasium) were significantly more distinct than of students of other school types. These differences may be a result of student compositional effects, different curricula or also different teacher preparation programs (e.g., Baumert, Maaz, Stanat, & Watermann, 2009; Diedrich et al. 2019). The evidence for a moderating effect of type of school on the relation between SWB and academic achievement is still scarce. Opdenakker and van Damme (2000) found differential relations between achievement motivation and well-being dependent on school characteristics like an orderly learning environment. Assuming that the learning environments

differ between schools (Baumert et al., 2009) a moderating effect of type of school on the relation between SWB and academic achievement could also be plausible. However, Bücker et al. (2018) did not find an impact on the relation between student SWB and academic achievement through type of school.

3. Research questions

Due to the vital importance of SWB for students and its relation to academic achievement, we investigated the question of reciprocal relations between these constructs. Previous studies mainly used cross-sectional data and focused on only few aspects of SWB. Therefore, the direction of the relation between students' SWB and academic achievement is not yet fully understood. Because theoretical arguments support mutual effects in both directions, we pursued an explorative approach in the present study. Furthermore, several facets of SWB were taken into account and the critical age period of secondary school was focused. Additionally, we examined factors that might influence the mutual effects like gender and type of school because research on these moderating variables is sparse. The following research questions were analyzed:

1. Do reciprocal relations exist between academic achievement and a) physical well-being, b) cognitive well-being, and c) emotional well-being?
2. Do the reciprocal patterns differ between a) gender and b) type of school?

4. Method

4.1 Participants

Longitudinal data analysis with three points of measurement (t_1 = grade 5, t_2 = grade 7, t_3 = grade 9) was based on data of the Starting Cohort 3 of the National Educational Panel Study (NEPS; Blossfeld, Roßbach, & Maurice, 2011). The original NEPS sample consisted of 4,335 students on t_1, 6,012 students on t_2 and 5,779 students on t_3 who attended one of the traditional academic tracks of the German secondary school system ("Hauptschule", "Realschule", "Gymnasium")[3]. We concentrated on students who attended the same school over the time intervals of interest ($N_{1\text{-}3}$ = 2,993, $N_{2\text{-}3}$ = 4,303) and excluded individuals who skipped or repeated classes between the corresponding intervals. The latter step led to an exclusion of 89 of the individuals who participated from t_1 on and 118 of the individuals who participated on t_2 and t_3. Finally, individuals with untypically high age were excluded from data: This concerned two of the individuals who participated from

3 The sample size was increased in the NEPS between grades 6 and 7. Therefore, the number of students who participated on t_2 and t_3 was higher than those who participated on t_1.

t_1 on and five of the individuals who participated on t_2 and t_3, respectively.[4] Our final sample comprised 2,902 students (49.7 % female)[5] who participated constantly within the interval from t_1 to t_3 and 4,180 students (49.5 % female) who participated constantly within the interval from t_2 to t_3. On the first point of measurement, in grade 5, students were on average 10.75 years old (*SD* = 0.48). On the second point of measurement, in grade 7, students were on average 12.77 years old (*SD* = 0.50)[6]. Sample characteristics for the different types of school are displayed in Table 1.

Table 1: Sample characteristics for different types of school

	t_1			t_2-t_3		
	Hauptschule	Realschule	Gymnasium	Hauptschule	Realschule	Gymnasium
N	363	789	1750	583	1176	2431
% female	43.0	48.3	51.7	44.1	45.6	52.6
M_{age} (SD_{age})	11.10 (0.59)	10.85 (0.47)	10.63 (0.40)	13.12 (0.62)	12.88 (0.50)	12.63 (0.41)

4.2 Instruments

4.2.1 Academic achievement

For the measurement of reading competence (RC) as well as mathematical competence (MC) we used tests from the NEPS (Blossfeld et al., 2011). The reading comprehension test examined students' RC in grades 5, 7, and 9. The test consisted of a total of 25 tasks which differed in difficulty. The weighted likelihood estimates (WLE) revealed good reliabilities for all points of measurement (t_1: WLE reliability = .77; t_2: WLE reliability = .79; t_3: WLE reliability = .79; Gehrer, Zimmermann, Artelt, & Weinert, 2012). MC was examined in grades 5, 7, and 9 and consisted of 25 tasks, as well. Again, reliabilities were good for all points of measurement (t_1: WLE reliability = .78; t_2: WLE reliability = .72; t_3: WLE reliability = .81; Neumann et al., 2013).

In our analyses, the corrected weighted likelihood estimates (for a detailed description see Scharl, Fischer, Gnambs, & Rohm, 2017) of these competence tests were used as global test scores.

4 The age of these individuals differed by more than four standard deviations from sample mean age.

5 In most waves there were missing values concerning sex of the students. We replaced missing values on this dichotomous variable with the median indication of sex over all other waves.

6 Due to different numbers of individuals who participated within the interval from t_1-t_3 and t_2-t_3, respectively, the mean age differed between these subsamples.

4.2.2 SWB

Questionnaires were administered in the classroom in order to obtain data of students. Because data for academic achievement was available for grades 5, 7, and 9, we focused on constructs of SWB that had been measured longitudinally in at least two of these grades. In order to measure physical well-being we used two indicators: students' self-estimated health and number of days of absence from school. Self-estimated health served as subjective indicator for general physical well-being and was measured by a single item ("How would you describe your health status in general?") on a 5-point scale (1 = *very poor*, 2 = *poor*, 3 = *fair*, 4 = *good*, 5 = *very good*)[7]. Days of absence from school served as objective indicator for school-related physical well-being. Students responded on the item by indicating a single number from 0 to 99.

For the measurement of cognitive well-being we used the *satisfaction scale* that was included in the questionnaire of the NEPS. The scale comprised six items that ask respondents about their satisfaction concerning different life-domains (overall, wealth, health, family, friends, and school). Students responded to each item on an 11-point scale ranging from 0 (= *completely dissatisfied*) to 10 (= *completely satisfied*). We separated the scale into the variable satisfaction with school which was assessed with one item ("How satisfied are you with your school situation?") and the variable satisfaction with life which comprised the remaining five items (e.g., "How satisfied are you, currently, with your life as a whole?") in order to oppose these two domains of SWB to each other. Measurement invariance testing showed that at least configural invariance could be assumed for the variable satisfaction with life (see Appendix D, Tables D3 and D4).

To measure emotional well-being, we used the helplessness scale. The instrument that is used in NEPS is based on a scale by Jerusalem and Schwarzer (1993) who derived items to measure the construct of learned helplessness (Seligman, 1972). The scale originally comprised five items that measure school-related helplessness in general. In the NEPS, the scale was duplicated to measure school-related helplessness for the subjects "German" and "Mathematics" (In the following we will refer to these scales by using the terms "helplessness German" and "helplessness Math"). Participants responded to the items (e.g., "No matter how much I try in German, my grades won´t get better") on a 4-point scale ranging from 1 (= *completely disagree*) to 4 (= *completely agree*). Measurement invariance testing revealed that configural invariance was only given if items 4 and 5 of the subscale helplessness German, as well as items 1 and 2 of the subscale helplessness Math were excluded in a two-factor model (see Appendix D, Tables D1 and D2). Therefore, we ran our analyses with two latent factors measured by 3 items each.

7 In order to simplify interpretation of scores and relations with other variables, we reversed the self-estimated health scale. It was originally ranked as follows: 1 = *very good*, 2 = *good*, 3 = *fair*, 4 = *poor*, 5 = *very poor*.

4.2.3 Moderating variables: Gender and type of school

For the examination of our second research question, we included gender (female vs. male) and type of school in our analysis. The latter was a three-staged factor differentiated into the traditional academic tracks of the German secondary school system: The lowest track ("Hauptschule"), the intermediate track ("Realschule"), and the highest track ("Gymnasium").

4.3 Data analysis

All analyses were conducted in *R* (Version 3.6.3; R Core Team, 2020). Descriptive statistics were calculated for all variables. Furthermore, differences between sexes, school types and measurement occasions were analyzed by means of ANOVAs and *t*-tests. We computed partial eta-squared and *d*-values for dependent *t*-tests (see Morris, & DeShon, 2002) to quantify the effect sizes of the different test-statistics. Post-hoc tests were corrected with the Bonferroni-Holm method.

Prior to the examination of our research questions, we tested measurement invariance for those variables that were measured by multiple-item scales (see section 4.2). We followed the suggestions of other authors, which described four main steps: configural, metric, scalar, and residual invariance (e.g., Putnick, & Bornstein, 2016; Widaman, & Reise, 1997). Indicator-specific covariances were included within measurement invariance analyses over points of measurement.

In order to answer our first research question three different longitudinal cross-lagged panel models were specified. In each model we investigated the reciprocal relations between academic achievement and one facet of SWB. While the relations from academic achievement with physical and emotional well-being, respectively, were calculated over two points of measurement, in the model investigating the relation between academic achievement and cognitive well-being three points of measurement were considered. Therefore, we were able to include random intercepts in the latter model to separate the within-person development from stable between-person differences (see Hamaker, Kuiper, & Grasman, 2015). To take into account that constructs only measured by a single item (i.e., days of absence, self-estimated health, satisfaction with school) were not measured perfectly reliable, we modeled each of the respective variables as single indicators of a latent variable and specified a value of 0.85 for the reliability (e.g., Jöreskog, & Sörbom, 1982; Petrescu, 2013). The global test scores of MC and RC were handled in the same way, whereby fallibility was taken into account by using the reliabilities of the single measurement occasions (see section 4.1). All latent variables that were included in a single model were allowed to correlate on each of the different occasions. However, in the random intercepts cross-lagged panel model we constrained covariances between the factors capturing the individuals' stable scores over all waves (random intercepts) and exogenous within-person factors to zero. For the investigation of our second research question, multi-group models with gender and

type of school, respectively, were established to examine the moderating function of these variables. For each of the moderating variables, a model with free estimation of regression parameters for all factor levels was compared to a model that restricted the regression parameters for all factor levels to be equal.

For testing measurement invariance and all analyses, the package "lavaan" (Rosseel, 2012) was used. The parameters of the models were calculated by means of maximum likelihood estimation with robust standard errors and scaled test statistic that is asymptotically equal to the Yuan-Bentler test statistic (Rosseel, 2012). To evaluate model fit, we used robust estimators of the different fit measures (see Brosseau-Liard, Savalei, & Li, 2012). Because the χ^2-difference-test is vulnerable in case of large samples, we used ΔCFI for the comparison of nested models instead. We followed the suggestions by Cheung and Rensvold (2002) to prefer the restricted model if ΔCFI is equal to or greater than -.01. The hierarchical structure of the data was taken into account (ICCs are displayed in Tables C1 and C2; see Appendix C). For this purpose the identification number of the students' schools (Blossfeld, & Roßbach, 2019) was considered as cluster variable in our analyses to compute robust standard errors of the parameters estimated in the structural equation models. Finally, missing data was handled within the structural equation models through full information maximum likelihood method.

5. Results

5.1 Descriptive results

In Table A1 (see Appendix A) means and standard deviations of the variables we used in our analyses are summarized. As can be seen in the Table, means of satisfaction with life decreased over time ($F(2,4412) = 185.78$, $p < .001$, $\eta_p^2 = .08$), whereby scores differed significantly between classes 5 and 7 ($t(2487) = 13.99$, $p < .001$, $d = -0.28$) and between classes 7 and 9 ($t(2485) = 7.72$, $p < .001$, $d = -0.16$). Means of satisfaction with school also decreased over time ($F(2,4752) = 226.29$, $p < .001$, $\eta_p^2 = .09$). Scores differed significantly between classes 5 and 7 ($t(2556) = 17.82$, $p < .001$, $d = -0.36$) and between classes 7 and 9 ($t(2556) = 3.57$, $p < .001$, $d = -0.06$). The same statistics are displayed in Appendix A separately for gender (Table A2) and type of school (Table A3). Satisfaction with life did not differ between gender ($F(1,2205) = 0.52$, $p = .47$, $\eta_p^2 = .00$), whereas girls showed on average a higher satisfaction with school ($F(1,2375) = 14.37$, $p < .001$, $\eta_p^2 = .01$). A further trend became apparent insofar that boys compared to girls reported a higher helplessness in school subject "German" ($F(1,3334) = 96.19$, $p < .001$, $\eta_p^2 = .03$), whereby girls reported a higher helplessness in school subject "Math" than boys ($F(1,3313) = 73.20$, $p < .001$, $\eta_p^2 = .02$). Descriptive results for type of school showed that scores in days of absence ($F(2,2937) = 13.79$, $p < .001$, $\eta_p^2 = .01$), helplessness German ($F(2,3333) = 39.31$, $p < .001$, $\eta_p^2 = .02$),

and helplessness Math ($F(2,3312) = 30.73$, $p < .001$, $\eta_p^2 = .02$) differed significantly between students attending different types of school. Table A3 shows that scores on these measures were highest in students attending "Hauptschule" and lowest in students attending "Gymnasium". Results reversed for the variables satisfaction with school ($F(2,2374) = 28.11$, $p < .001$, $\eta_p^2 = .02$) and satisfaction with life ($F(2,2204) = 15.45$, $p < .001$, $\eta_p^2 = .01$), meaning that these scores were highest in students attending "Gymnasium" and lowest in students attending "Hauptschule". In general, it has to be noted that the means of most of the measures were not close to the center of the scale.

Correlations between all variables of interest except for type of school can be seen in Appendix B (Table B1). The table contains mostly statistically significant relations that followed theory-based expectations. It has to be noted, however, that the relations of competence measures with self-estimated health and with satisfaction with life were smaller and reached a less high level of significance compared to relations between other variables.

5.2 Reciprocal relations between SWB and academic achievement

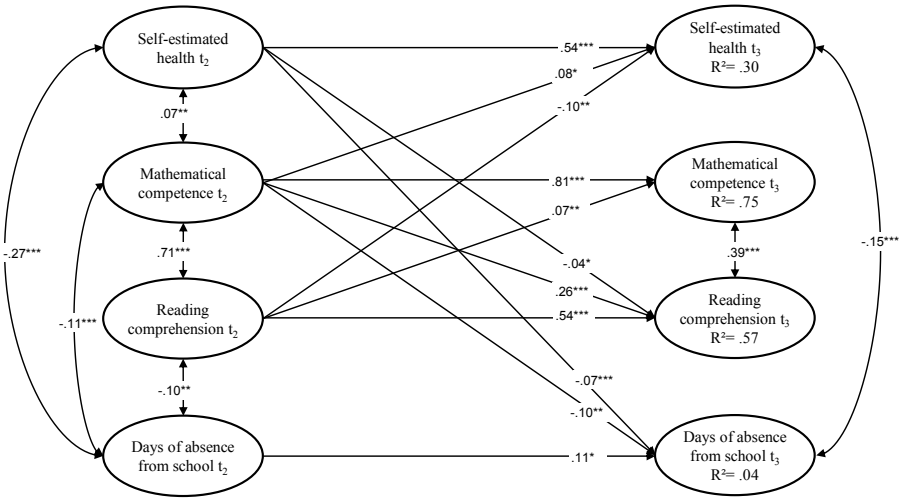
5.2.1 Reciprocal relations between physical well-being and academic achievement

The results for our first research question can be seen in Figure 1. The path from MC on t_2 on days of absence from school on t_3 was significant ($\beta = -.10$, $p = .001$), whereas the contrary path from days of absence on t_2 on MC on t_3 was not. The restriction of the corresponding cross-lagged regression parameters (from days of absence on mathematical competence and vice versa) to being equal was not detrimental to model fit ($\Delta CFI = -.001$)[8]. Hence, we assumed that the longitudinal association from MC on t_2 on days of absence from school on t_3 was not stronger than vice versa. We did not find reciprocal relations between days of absence from school and RC.

The analysis of reciprocal relations between self-estimated health and competence measures revealed a positive longitudinal association between MC on t_2 and self-estimated health on t_3 ($\beta = .08$, $p = .020$), but not vice versa. Restricting the corresponding regression parameters to being equal was not detrimental to model fit ($\Delta CFI = .000$). Conversely, the relation between RC and self-estimated health was reciprocal: The paths from RC on t_2 on self-estimated health on t_3 ($\beta = -.10$, $p = .001$), as well as vice versa ($\beta = -.04$, $p = .032$) were both significantly negative. But again, there was no evidence that the regression parameters differed in strength ($\Delta CFI = .000$).

8 Comparison by means of the χ^2-difference test revealed a significant difference ($\Delta\chi^2(1) = 13.69$, $p < .001$).

Figure 1: Reciprocal relations between physical well-being (measured by self-estimated health and days of absence from school) and academic achievement (MC and RC) from grade 7 to grade 9.

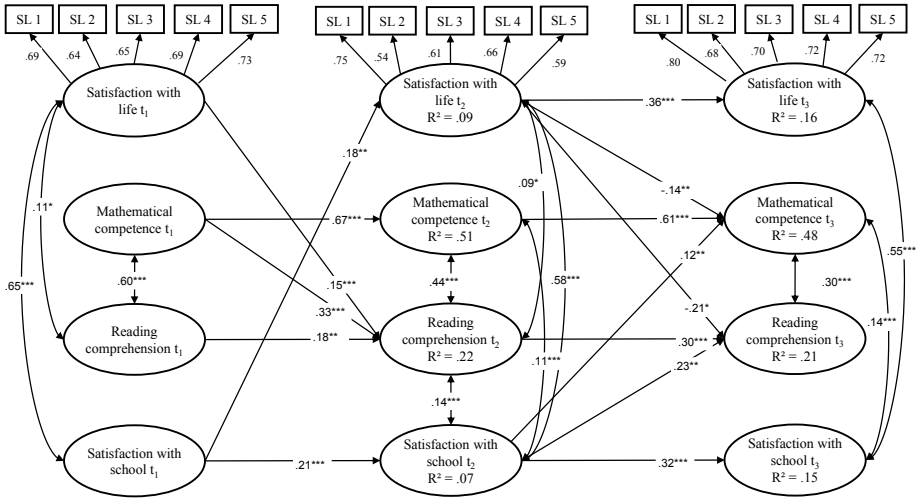


Notes. N = 4159. Fit measures are not reported because the model is saturated. All latent variables are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
**p* < .05. ***p* < .01. ****p* < .001.

5.2.2 Reciprocal relations between cognitive well-being and academic achievement

Figure 2 displays reciprocal relations between cognitive well-being and academic achievement: While there was no reciprocal relation between satisfaction with life and MC between t_1 and t_2, the path from satisfaction with life on t_2 on MC on t_3 got significant (β = -.14, *p* = .005). However, a comparison with the corresponding path from MC on t_2 on satisfaction with life on t_3 did not reveal a significant difference in strength (ΔCFI = .000). Higher satisfaction with life on t_1 was associated with higher RC on t_2 (β = .15, *p* < .001) whereas the corresponding path between t_2 and t_3 was significantly negative (β = -.21, *p* = .013). In both cases, however, the restriction of paths from satisfaction with life on RC and vice versa to being equal was not detrimental to model fit ($\Delta CFI_{1,2}$ = .000; $\Delta CFI_{2,3}$ = .000). Concerning satisfaction with school we identified a unidirectional association of satisfaction with school on t_2 on MC on t_3 (β = .12, *p* = .004). Restriction of cross-lagged path from satisfaction with school on t_2 on MC on t_3 and vice versa to being equal was not detrimental to model fit (ΔCFI = .000). We obtained similar results for the reciprocal relation between satisfaction with school and RC: Higher satisfaction with school on t_2 was associated with higher scores in RC on t_3 (β = .23, *p* = .002). This association was, however, not stronger than from RC on t_2 on satisfaction with school on t_3 (ΔCFI = .000).

Figure 2: Reciprocal relations between cognitive well-being (measured by satisfaction with life and satisfaction with school) and academic achievement (MC and RC) from grade 5 to grade 9.



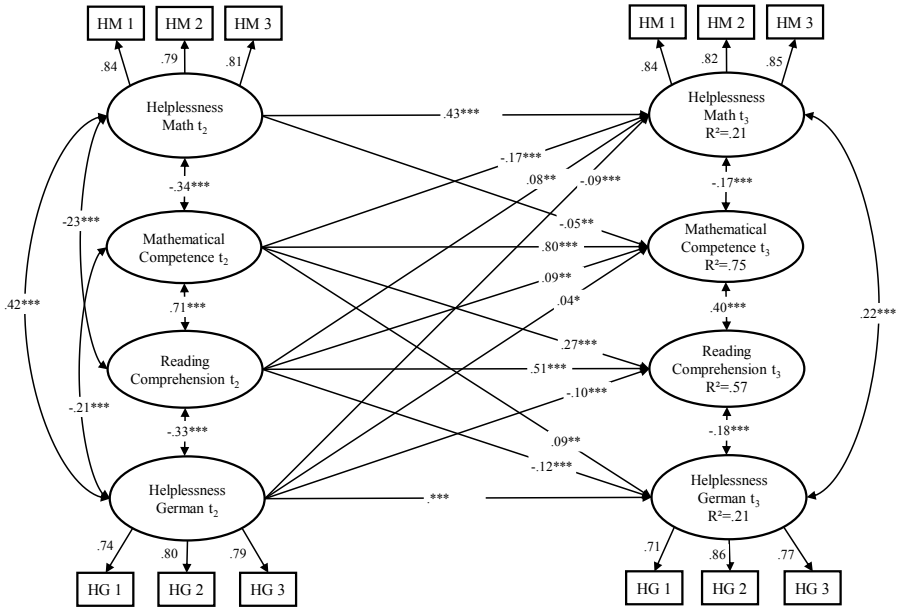
Notes. N = 2899. $\chi^2(187)$ = 479.51, AIC = 232205.43, BIC = 233023.61, CFI = .989, TLI = 0.979, RMSEA = .028, SRMR = .025. Variables "Mathematical competence", "Reading comprehension" and "Satisfaction with school" are measured by single indicators which have not been included in the figure. Latent variables that model random intercepts have not been included in the figure for clarity purposes. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

5.2.3 Reciprocal relations between emotional well-being and academic achievement

Figure 3 displays the pattern of reciprocal relations between emotional well-being and academic achievement. We observed a negative reciprocal relation between helplessness Math and MC: Higher helplessness Math on t_2 was associated with lower MC on t_3 (β = -.05, p = .002) and vice versa (β = -.17, p < .001). However, the longitudinal relation between helplessness Math and RC was unidirectional, whereby higher scores in RC on t_2 were associated with higher helplessness Math on t_3 (β = .08, p = .008). Helplessness German showed reciprocal relations with both competence measures: Higher helplessness German on t_2 was associated with higher scores in MC on t_3 (β = .04, p = .030) and the path from MC on t_2 on helplessness German on t_3 was significantly positive as well (β = .09, p = .006). Moreover, helplessness German on t_2 was negatively associated with RC on t_3 (β = -.10, p < .001) and vice versa (β = -.12, p < .001). When the opposite regression parameters from a competence measure on a measure of emotional well-being and vice versa were compared to each other we did not find differences in the strength of paths for any of the reciprocal relations (all ΔCFIs = .000)[9].

9 The χ^2-difference test revealed that the associations from RC on t_2 on helplessness German on t_3 and vice versa differed significantly from each other ($\Delta\chi^2(1)$ = 7.14, p < .01).

Figure 3: Reciprocal relations between emotional well-being (measured by helplessness German and helplessness Math, respectively) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. N = 4159. $\chi^2(80)$ = 354.51, AIC = 130731.60, BIC = 131187.58, CFI = .989, TLI = 0.983, RMSEA = .031, SRMR = .022. Variables "Mathematical competence" and "Reading comprehension" are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

5.3 Effects of moderating variables on the reciprocal relations between SWB and academic achievement

Model comparisons examining potential moderating effects of gender and type of school on the reciprocal relations between well-being (physical, cognitive, emotional) and academic achievement are displayed in Table 2. As can be seen, Δ*CFI* values suggested that the restriction of regression parameters to being equal between sexes and types of school, respectively, was not detrimental to model fit in any of the models. This implies that the moderating variables did not have an effect on the reciprocal relations between SWB and academic achievement. Nevertheless, in the following some descriptive differences in the patterns of reciprocal relations between academic achievement and different facets of SWB are described.

5.3.1 Moderating effects on the reciprocal relations between physical well-being and academic achievement

Reciprocal relations between physical well-being and academic achievement are displayed in Figures E1 and E2 (see Appendix E) for boys and girls, respectively. As can be seen, significant associations between MC on t_2 and self-estimated health ($\beta = .12$, $p = .024$) and days of absence ($\beta = -.16$, $p < .001$), respectively, on t_3 could only be observed for female students. However, the restriction of the corresponding paths to being equal for both sexes, did reveal a significant difference neither for the association between MC and self-estimated health ($\Delta CFI = -.001$)[10] nor for the association between MC and days of absence ($\Delta CFI = .000$).

Patterns of reciprocal relations between SWB and academic achievement for different types of schools can be obtained from figures F1, F2, and F3 (see Appendix F). They show only small differences in the pattern of reciprocal relations: The most prominent differences were that MC on t_2 was not associated with days of absence on t_3 for students attending "Realschule" and that days of absence on t_2 were negatively associated with MC on t_3 only in students attending "Gymnasium". The restriction of the corresponding paths to being equal for all types of school did not affect model fit (all $\Delta CFIs = -.001$)[11].

5.3.2 Moderating effects on the reciprocal relations between cognitive well-being and academic achievement

Concerning gender, the comparison of the patterns of reciprocal relations (see Figures G1 and G2; Appendix G) did not reveal any striking differences between female and male students.

With a view on figures H1, H2, and H3 (see Appendix H) it becomes apparent that there were also no noteworthy differences in the pattern of reciprocal relations between cognitive well-being and academic achievement dependent on different types of schools.

5.3.3 Moderating effects on the reciprocal relations between emotional well-being and academic achievement

The patterns of reciprocal relations between emotional well-being and academic achievement separately for male and female students are displayed in Figures I1 and I2 (see Appendix I). We did not obtain significant paths from helplessness

10 The χ^2-difference test revealed a significant difference ($\Delta\chi^2(1) = 14.67$, $p < .001$).

11 The χ^2-difference test revealed a significant difference between types of school concerning the association between days of absence on t_2 and MC on t_3 ($\Delta\chi^2(2) = 21.03$, $p < .001$).

Table 2: Model comparisons examining the potential moderating effects of gender and type of school on the reciprocal relations between well-being (physical, cognitive, emotional) and academic achievement

Facet	Moderator	Model	χ^2(df)	$\Delta\chi^2$(df)	*p*	AIC	BIC	CFI	ΔCFI
Physical well-being	Gender	Unrestricted	0 (0)			95083.31	95640.61	1.000	
		Restricted	62.68 (16)	62.68 (16)	< .001	95117.16	95573.14	.994	-.006
	Type of school	Unrestricted	0 (0)			93228.11	94064.06	1.000	
		Restricted	57.21 (32)	57.21 (32)	< .01	93235.81	93869.11	.994	-.006
Cognitive well-being	Gender	Unrestricted	706.75 (374)			231535.25	233171.61	.984	
		Restricted	767.15 (406)	60.40 (32)	< .01	231540.39	232985.65	.983	-.001
	Type of school	Unrestricted	913.82 (561)			229162.78	231617.33	.981	
		Restricted	1014.70 (625)	100.16 (64)	< .01	229139.58	231211.91	.980	-.001
Emotional well-being	Gender	Unrestricted	451.97 (160)			130008.33	130920.29	.988	
		Restricted	474.64 (176)	23.85 (16)	.093	130004.92	130815.54	.988	.000
	Type of school	Unrestricted	492.83 (240)			128021.95	129389.89	.989	
		Restricted	552.10 (272)	59.81 (32)	< .01	128032.00	129197.27	.987	-.002

Math on t_2 on MC on t_3 and from RC on t_2 on helplessness German on t_3 for female students. However, the restriction of the corresponding paths to being equal for both sexes was not detrimental to model fit (all ΔCFIs = .000).

Figures J1, J2, and J3 (see Appendix J) show the reciprocal relations between emotional well-being and academic achievement separately for different types of school. It can be seen that the pattern of reciprocal associations of students attending "Hauptschule" did show nearly no significant paths. The restriction of single paths to being equal for all types of school, however, was not detrimental to model fit in any of the cases (all ΔCFIs = .000).

6. Discussion

Due to the importance of students' SWB and academic achievement for educational success, this study investigated reciprocal relations between several facets of SWB and academic achievement in adolescents. Additionally, it was analyzed whether these reciprocal relations differ for gender and for type of school.

6.1 Reciprocal relations between SWB and academic achievement

In accordance with previous research (Bird, & Markle, 2012; Bücker et al., 2018; Crede et al., 2015; Pietarinen et al., 2014; Suldo et al., 2008), we found mainly positive relations between indicators of students' SWB and academic achievement. Regarding physical well-being, results revealed that MC played a crucial role for SWB even though the effect sizes were relatively small: MC in grade 7 was significantly associated with both indicators of physical well-being in grade 9, whereas we did not find associations between measures of physical well-being in grade 7 and MC in grade 9. A possible explanation could be that higher MC constitutes the fulfillment of the psychological need of competence (see Ryan, & Deci, 2000) which in turn has a positive impact on the physical well-being of students. However, we also found that RC and self-estimated health had a negative longitudinal relation that was of reciprocal nature. This is a surprising finding, even though these relations were very small and we did not find significant bivariate correlations between both measures. The examination of reciprocal relations between cognitive well-being and academic achievement revealed that satisfaction with life in grade 5 was positively associated with changes in RC in grade 7 while paths from satisfaction with life in grade 7 on MC and RC in grade 9 indicated a negative longitudinal relation. Whereas the former result coincides with prior research that reports positive longitudinal associations between satisfaction with life and school grades (e.g., Ng, Huebner, & Hills, 2015), the latter result seems to be in conflict to these earlier findings. Additionally, higher satisfaction with school in grade 7 was associated

with higher scores in MC and RC in grade 9. Finally, we found mainly negative reciprocal relations between the negative facet of emotional well-being (i.e., helplessness) and academic achievement. Cross-lagged paths between helplessness Math and MC, as well as between helplessness German and RC were negative which fits to theory as well as prior research (e.g., Fincham et al., 1989). Furthermore, we observed a positive reciprocal relation between helplessness German and MC and a positive association between RC in grade 7 and helplessness Math in grade 9. This result can be interpreted analogously to earlier findings that found negative associations from verbal and math achievement on self-concept in the respective other domain (Möller, Pohlmann, Köller, & Marsh, 2009). The underlying internal/external frame of reference model which states that students evaluate their achievement in a given subject not only in relation to the achievement of others but in relation to their own achievement in other subjects, as well (e.g., Möller et al., 2009), could also be an explanation for the positive effects we found between academic achievement in one subject and helplessness in another subject.

Overall, we found evidence that there are reciprocal relations between SWB and academic achievement, whereby it was dependent on the considered facet of well-being if more paths from measures of competence on measures of SWB were statistically significant or vice versa. It has to be noted, however, that we did not find differences in the strength of reciprocal paths. With regard to the direction of the relation, the results do not provide an explicit answer. Therefore, our results neither support only the SDT (Ryan, & Deci, 2000) nor only the broaden-and-build theory (Fredrickson, 2001).

6.2 Effects of moderating variables on the reciprocal relations between SWB and academic achievement

In general, there was no evidence for moderating effects of the variables gender and type of school. As mentioned earlier, findings in relation to moderating effects of these variables on the relation between SWB and academic achievement are sparse and heterogenous: Single studies suggest moderating effects of gender (Herman et al., 2008) and type of school (Opdenakker, & van Damme, 2000). In contrast, our results support earlier findings that did report neither moderating effects of gender nor of type of school on the relation between SWB and academic achievement (cf., Bücker et al., 2018). However, it has to be considered that we used ΔCFI in our analyses to examine moderating effects of the variables gender and type of school. This measure is relatively conservative in comparison with $\Delta\chi^2$.

6.3 Strengths and Limitations

A clear strength of the present study is the approach to analyze reciprocal relations between academic achievement and SWB. For this purpose, in our analyses,

we used longitudinal data with two or even three measurement time points. In the research field of students' well-being, the usage of longitudinal data is an important extension to the mainly cross-sectional studies which have been conducted in the past. Another quality of our study is the large sample size which promises a high external validity of our results. A further strength of the present investigation is that the multidimensionality of SWB was met by including several facets of the construct and taking into account at least one important factor for each of these. The consideration of more than one or two SWB constructs helped to get a fine grained picture on the different relations between SWB and academic achievement. Additionally, the study offers important insights for two different domains of academic achievement which are both of high importance because mathematics and reading are two main key competencies. Last but not least, we analyzed differential effects for gender and school types.

Nevertheless, it is important to be aware of some limitations when interpreting the results of the present study. First, even though we used longitudinal data to investigate the reciprocal relations between academic achievement and well-being, we could only use data of two different points of measurement in two of our models. In these models we could, therefore, not distinguish stable variability between persons from within person variance (Hamaker et al., 2015) which may lead to spurious results. Furthermore, the minimum interval between two points of measurement was two years in each model. Because of this relatively large time lag, short term effects might not be detected and longitudinal associations should be interpreted with caution. Second, even though we included several aspects of SWB, the operationalization of SWB was not completely satisfying: One of the reasons was that some constructs had been surveyed rarely and not parallel with other important constructs in the NEPS. For example, indicators for the domain-specific social component of SWB (e.g., social inclusion in class) had only been measured in grades 6–8, whereas indicators for academic achievement like RC and MC had been measured in grades 5, 7, and 9. Therefore, a longitudinal analysis including this facet was not possible. Another problem concerning operationalization of SWB was that some constructs were measured with single items. Even though we corrected for reliability by modeling them as single indicators of latent variables, single items are prone to contain random and nonrandom errors (Bollen, 1989, p. 151). Moreover, constructs measured by multiple indicators did partly show low levels of measurement invariance. Especially, the satisfaction scale did rarely reach levels higher than metric invariance. Concerning the results of the present study it should be considered that latent mean differences can only be interpreted reliably when high levels of measurement invariance are given (e.g., Putnick, & Bornstein, 2016). Furthermore, we considered the nesting of students in different schools but we were neither able to account for variability between German states nor to consider the nesting of students in classes. This may have affected the estimation of standard errors. Another factor that could have had an impact on the results is that the sample sizes of the different types of school differed a lot.

Finally, we did not consider possible controls and third variables. On the one hand we did not include controls for pre-existing differences in achievement like socioeconomic status and ethnic heritage (e.g., Dicke et al., 2018). On the other hand we did not include variables that may mediate the relation between SWB and academic achievement. Following the SDT (Ryan, & Deci, 2000), one mechanism explaining the relation from academic achievement on SWB could be that a good performance in school causes a higher self-concept and that this in turn could enhance well-being. Furthermore, effects from SWB on academic achievement could be explained by a mediation model, too: positive emotions could lead to an increase in interest and creativity which in turn could improve performance in school (e.g., Fredrickson, 2001).

6.4 Implications for future research and educational practice

The present study revealed new insights concerning the relation between SWB and academic achievement. However, further research is needed to support the presented findings. As has been mentioned above, the construct of SWB was not operationalized satisfyingly. To be able to draw conclusions which are more content-related, future studies should consider a greater number of facets of SWB to satisfy the complexity of the construct and should analyze students' SWB by means of well-validated instruments. Furthermore, it would be desirable to investigate the reciprocal relation between SWB and academic achievement on basis of at least three points of measurement and shorter time lags between each of them. This would enable researchers to distinguish stable variability between persons from within person variance (Hamaker et al., 2015).

Moreover, future studies should examine effects of additional variables. In this regard, variables like socioeconomic status and ethnic heritage should be included to control for pre-existing differences in achievement. The role of variables like self-concept, interest and divergent thinking that possibly mediate the relation between SWB and academic achievement should be investigated, as well. Because we found evidence that – especially – higher scores in MC were associated with higher scores of several aspects of SWB on a later time, it would be interesting to investigate a possible mediation through self-concept in mathematics on this relation. Furthermore, recent findings suggest that the association between positive emotions and academic achievement might be mediated through motivation (Mega, Ronconi, & De Beni, 2014). Therefore, it would be interesting to investigate if these results apply on other facets of well-being as well. Another desideratum in this context might be to investigate influences of variables on higher hierarchical levels on students' SWB or academic achievement. For example, the role of compositional effects of classes or the big-fish-little-pond-effect (Marsh, & Parker, 1984), which explains differences in academic self-concepts could be related to SWB of students. Big-fish-little-pond-effects are a result of academic achievement groupage which is very prominent in Germany (Köller, 2004). Additionally, teachers' SWB

should also be investigated more deeply, because teachers' SWB might have an influence on quality of teacher-student relationships, which, in turn, could influence the emotional-motivational characteristics of students. In order to study such research questions that require consideration of variables on the class (or the school) level, multi-level models should be specified to determine, for example, cross-level effects.

After a replication of the results, also implications for educational practice are possible. Due to the importance of students' SWB (e.g., satisfaction with school) for academic achievement, it would be thinkable to emphasize its relevance in training programs for teachers or to involve it in university curricula of teacher students. Furthermore, the influence of mathematical competence on SWB has to be investigated more deeply to derive implications for educational practice: If, for example, self-concept would mediate the relation between mathematical competence and well-being, intervention programs might be developed in order to strengthen mathematical self-concept of students, which also may have positive influences on their SWB.

Acknowledgements

This paper uses data from the National Educational Panel Study (NEPS): Starting Cohort Grade 5, doi:10.5157/NEPS:SC3:8.0.1. From 2008 to 2013, NEPS data was collected as part of the Framework Program for the Promotion of Empirical Educational Research funded by the German Federal Ministry of Education and Research (BMBF). As of 2014, NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg in cooperation with a nationwide network.

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Appendix

Appendix A

Table A1: Means, standard deviations and skewness for the variables used in the analyses of the present study

	Grade 5[a]		Grade 7		Grade 9	
Variable	*M* (*SD*)	Skewness	*M* (*SD*)	Skewness	*M* (*SD*)	Skewness
DA	-		1.44 (4.09)	10.79	1.36 (2.52)	3.95
SH	-		4.25 (0.78)	-0.94	4.14 (0.80)	-0.77
SL	8.89 (1.51)	-3.14	8.39 (1.43)[a]	-1.62 [a]	8.13 (1.66)[a]	-1.73[a]
SS	8.06 (2.25)	-1.59	7.10 (2.31)[a]	-1.00 [a]	6.94 (2.26)[a]	-0.97[a]
HG	-		1.77 (0.69)	0.87	1.80 (0.69)	0.68
HM	-		1.68 (0.71)	0.96	1.74 (0.75)	0.85
MC	0.24 (1.14)	0.00	0.89 (1.22)	-0.01	0.15 (1.20)	0.20
RC	0.24 (1.23)	0.17	0.84 (1.37)	0.20	0.10 (1.13)	0.20

Notes. n = 4180. DA = Days of absence from school, SH = Self-estimated health, SL = Satisfaction with life, SS = Satisfaction with school, HG = Helplessness German, HM = Helplessness Math, MC = Mathematical competence, RC = Reading competence. Values for MC and RC are WLEs.
[a]n = 2902 students.

Table A2: Means, standard deviations and skewness for the variables used in the analyses of the present study separately for both sexes

	Male[a]						Female[b]					
	Grade 5[c]		Grade 7		Grade 9		Grade 5[d]		Grade 7		Grade 9	
Variable	*M* (*SD*)	Skewness	*M* (*SD*)	Skewness	*M* (*SD*)	Skewness	*M* (*SD*)	Skewness	*M* (*SD*)	Skewness	*M* (*SD*)	Skewness
DA	-		1.63 (4.96)	10.57	1.33 (2.70)	4.51	-		1.24 (2.94)	6.59	1.39 (2.34)	3.05
SH	-		4.26 (0.78)	-1.02	4.22 (0.79)	-0.90	-		4.25 (0.77)	-0.87	4.06 (0.79)	-0.67
SL	8.83 (1.54)	-3.08	8.37 (1.48)[c]	-1.85[c]	8.19 (1.73)[c]	-1.87[c]	8.94 (1.48)	-3.21	8.41 (1.39)[d]	-1.33[d]	8.08 (1.58)[d]	-1.56[d]
SS	7.90 (2.36)	-1.46	6.95 (2.38)[c]	-0.94[c]	6.88 (2.33)[c]	-0.92[c]	8.22 (2.12)	-1.73	7.25 (2.23)[d]	-1.06[d]	7.01 (2.19)[d]	-1.03[d]
HG	-		1.86 (0.72)	0.71	1.90 (0.73)	0.56	-		1.68 (0.65)	1.04	1.70 (0.64)	0.77
HM	-		1.60 (0.69)	1.07	1.64 (0.72)	1.00	-		1.75 (0.71)	0.87	1.84 (0.77)	0.71
MC	0.37 (1.14)	1.21	1.06 (1.27)	-0.02	0.29 (1.25)	0.16	0.11 (1.12)	-0.02	0.73 (1.14)	-0.10	0.00 (1.12)	0.17
RC	0.17 (1.27)	0.16	0.69 (1.39)	0.23	0.01 (1.17)	0.26	0.32 (1.19)	0.21	0.98 (1.32)	0.21	0.21 (1.06)	0.20

Notes. DA = Days of absence from school, SH = Self-estimated health, SL = Satisfaction with life, SS = Satisfaction with school, HG = Helplessness German, HM = Helplessness Math, MC = Mathematical competence, RC = Reading competence. Values for MC and RC are weighted likelihood estimates.
[a]n = 2109, [b]n = 2071, [c]n = 1461, [d]n = 1441.

Table A3: Means and standard deviations for the variables used in the analyses of the present study separately for different types of school

	Hauptschule[a]						Realschule[b]						Gymnasium[c]					
	Grade 5[d]		Grade 7		Grade 9		Grade 5[e]		Grade 7		Grade 9		Grade 5[f]		Grade 7		Grade 9	
Variable	*M* (*SD*)	SK	*M* (*SD*)	SK	*M* (*SD*)	SK	*M* (*SD*)	SK	*M* (*SD*)	SK	*M* (*SD*)	SK	*M* (*SD*)	SK	*M* (*SD*)	SK	*M* (*SD*)	SK
DA	-		2.93 (8.67)	6.31	1.84 (3.21)	3.77	-		1.58 (3.86)	6.64	1.53 (2.92)	4.42	-		1.01 (2.33)	5.14	1.21 (2.23)	3.51
SH	-		4.25 (0.85)	-1.03	4.11 (0.80)	-0.46	-		4.22 (0.77)	-0.85	4.08 (0.80)	-0.78	-		4.29 (0.77)	-1.01	4.17 (0.79)	-0.83
SL	8.48 (1.89)	-2.31	8.23 (1.68)[d]	-1.21[d]	8.15 (1.84)[d]	-1.64[d]	8.63 (1.91)	-2.72	8.34 (1.42)[e]	-1.42	8.03 (1.75)[e]	-1.55	9.08 (1.15)	-3.24	8.44 (1.38)[f]	-1.80[f]	8.17 (1.57)[f]	-1.84[f]
SS	7.33 (2.84)	-1.02	6.76 (2.64)[d]	-0.79[d]	7.02 (2.38)[d]	-0.91[d]	7.68 (2.54)	-1.29	6.82 (2.44)[e]	-0.90	6.78 (2.28)[e]	-0.90	8.37 (1.91)	-1.80	7.29 (2.16)[f]	-1.06[f]	7.00 (2.22)[f]	-1.03[f]
HG	-		2.03 (0.81)	0.46	1.89 (0.76)	0.66	-		1.85 (0.73)	0.73	1.83 (0.69)	0.62	-		1.65 (0.64)	1.05	1.73 (0.68)	0.85
HM	-		1.96 (0.84)	0.53	1.89 (0.84)	0.73	-		1.78 (0.75)	0.79	1.71 (0.72)	0.81	-		1.58 (0.66)	1.17	1.69 (0.73)	0.91
MC	-1.17 (0.91)	0.19	-0.64 (0.97)	0.09	-1.09 (0.91)	0.44	-0.21 (0.84)	-0.00	0.41 (0.97)	0.19	-0.34 (0.93)	0.29	0.73 (0.96)	0.29	1.42 (1.02)	0.17	0.67 (1.06)	0.19
RC	-1.11 (0.98)	0.51	-0.62 (1.10)	0.14	-1.04 (0.83)	0.32	-0.15 (1.04)	0.37	0.30 (1.12)	0.36	-0.26 (0.90)	0.38	0.69 (1.08)	0.37	1.30 (1.23)	0.26	0.55 (1.03)	0.18

Notes. n = 4180. DA = Days of absence from school, SH = Self-estimated health, SL = Satisfaction with life, SS = Satisfaction with school, HG = Helplessness German, HM = Helplessness Math, MC = Mathematical competence, RC = Reading competence, SK = Skewness. Values for MC and RC are weighted likelihood estimates.
[a]n = 583, [b]n = 1176, [c]n = 2431, [d]n = 363, [e]n = 789, [f]n = 1750.

Appendix B

Table B1: Correlations between all variables included in the present study

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
1. DA t_2																				
2. DA t_3	.13***																			
3. SH t_2	-.22***	-.08***																		
4. SH t_3	-.11***	-.15***	.40***																	
5. SL t_1	-.07***	-.03	.16***	.13***																
6. SL t_2	-.11**	-.08**	.45***	.26***	.30***															
7. SL t_3	-.07**	-.11***	.27***	.43***	.20***	.40***														
8. SS t_1	-.06**	-.06**	.13***	.11***	.57***	.25***	.15***													
9. SS t_2	-.11***	-.09***	.27***	.17***	.19***	.50***	.27***	.29***												
10. SS t_3	-.08***	-.12***	.19***	.25***	.11***	.25***	.52***	.16***	.38***											
11. HG t_2	.06**	.09***	-.13***	-.09***	-.15***	-.27***	-.13***	-.21***	-.36***	-.21***										
12. HG t_3	.04	.06**	-.08***	-.06**	-.08***	-.14***	-.12***	-.16***	-.22***	-.26***	.37***									
13. HM t_2	.10***	.08***	-.12***	-.08***	-.13***	-.21***	-.15***	-.17***	-.32***	-.22***	.34***	.13***								
14. HM t_3	.05*	.12***	-.09***	-.11***	-.04	-.13***	-.16***	-.09***	-.21***	-.30***	.08***	.16***	.38***							
15. MC t_1	-.12***	-.12***	.02	-.00	.06**	.00	-.00	.11***	.14***	.10***	-.13***	-.08***	-.25***	-.21***						
16. MC t_2	-.10***	-.11***	.05***	.03	.07***	.03	.02	.11***	.13***	.14***	-.17***	-.06***	-.28***	-.22***	.73***					
17. MC t_3	-.10***	-.13***	.05**	.02	.06**	.01	-.00	.10***	.14***	.16***	-.15***	-.07***	-.28***	-.27***	.70***	.73***				
18. RC t_1	-.10***	-.07***	-.00	-.05*	.07***	-.01	-.05*	.11***	.13***	.07***	-.23***	-.17***	-.16***	-.07***	.62***	.56***	.55***			
19. RC t_2	-.09***	-.09***	.03	-.02	.11***	.06**	.02	.11***	.19***	.14***	-.27***	-.16***	-.19***	-.11***	.54***	.61***	.57***	.61***		
20. RC t_3	-.07***	-.08***	.01	-.02	.06**	.01	-.02	.12***	.17***	.12***	-.25***	-.21***	-.20***	-.14***	.53***	.53***	.60***	.61***	.63***	
21. Gender	-.04**	.01	-.01	-.10***	.04	.01**	-.03	.07***	.07***	.03	-.13***	-.15***	.10***	.13***	-.12***	-.14***	-.12***	.06***	.10***	.10***

Notes. DA = Days of absence from school, SH = Self-estimated health, SL = Satisfaction with life, SS = Satisfaction with school, HG = Helplessness German, HM = Helplessness Math, MC = Mathematical competence, RC = Reading competence, t_1 = measurement in grade 5, t_2 = measurement in grade 7, t_3 = measurement in grade 9.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Appendix C

In the following you can see the intraclass correlation coefficients (ICC) for the variables we used in our analyses. Sample sizes differed depending on the number of measurement time points used in the respective analysis. Therefore, ICCs are displayed once for variables included in the analysis over three points of measurement (see Table C1) and once for the variables included in the analyses over two points of measurement (see Table C2). As can be seen from the tables the ICC values of the variables mathematical competence and reading comprehension are very high. This is not a surprising finding because the cluster variable contains schools from different types of school and those should vary highly on academic achievement.

Table C1: ICC values of variables included in the analysis over t_1 to t_3

	t_1	t_2	t_3
Satisfaction with life	.04	.05	.03
Satisfaction with school	.06	.03	.03
Mathematical competence	.41	.41	.38
Reading comprehension	.31	.31	.33

Table C2: ICC values of variables included in the analyses over t_2 to t_3

	t_2	t_3
Days of absence from school	.03	.02
Self-estimated health	.03	.02
Helplessness German	.07	.03
Helplessness Math	.06	.05
Mathematical competence	.41	.38
Reading comprehension	.32	.33

Appendix D

Measurement invariance of the helplessness scale had to be tested between different points of measurement, as well as between sexes and types of school. Therefore, we started by testing measurement invariance between different occasions. More precisely, we first checked measurement invariance between points of measurement considering all individuals and afterwards by focusing on different groups of gender and type of school (see Table D1). Subsequently, we tested measurement invariance between different sexes and types of school for single points of measurement (see Table D2). Configural invariance over points of measurement was achieved through excluding items 4 ("When my teacher calls me surprisingly in German I cannot answer even the simplest questions") and 5 ("No matter if I try to do my homework in German, I always make many mistakes") of the subscale *helplessness German* and 1 ("No matter how much I try in Math, my grades won't get better") and 2 ("It's not worth practicing mathematics for a class test, I will be bad again") of the subscale *helplessness Math*. Tables D1 and D2 show that – according to ΔCFI – metric invariance could be assumed for the helplessness scale.

Table D1: Examination of measurement invariance of the helplessness scale over points of measurement

Model	χ^2	*Df*	*p*	CFI/TLI	RMSEA/SRMR	Comparison	ΔCFI	$\Delta\chi^2$	Δ*df*	$p(\Delta\chi^2)$
Overall:										
1. configural	216.66	42	<.001	.989/0.982	.039/.025					
2. metric	237.89	46	<.001	.987/0.982	.039/.027	2 vs. 1	.002	21.23	4	<.001
3. scalar	295.90	52	<.001	.984/0.980	.041/.028	3 vs. 2	.003	62.63	6	<.001
4. residual	302.44	58	<.001	.983/0.981	.040/.028	4 vs. 2	.004	64.23	12	<.001
Gender = male[a]:										
1. configural	114.68	42	<.001	.990/0.984	.036/.025					
2. metric	129.82	46	<.001	.989/0.984	.037/.028	2 vs. 1	.001	15.04	4	<.01
3. scalar	160.80	52	<.001	.985/0.981	.040/.029	3 vs. 2	.004	33.87	6	<.001
4. residual	162.31	58	<.001	.985/0.983	.038/.028	4 vs. 2	.004	32.68	12	<.01
Gender = female[b]:										
1. configural	147.27	42	<.001	.987/0.979	.042/.027					
2. metric	155.09	46	<.001	.986/0.980	.041/.029	2 vs. 1	.001	8.02	4	.091
3. scalar	187.60	52	<.001	.983/0.978	.042/.031	3 vs. 2	.003	34.08	6	<.001
4. residual	193.56	58	<.001	.982/0.979	.041/.032	4 vs. 2	.004	38.75	12	<.001
Type of school = "Hauptschule"[c]:										
1. configural	85.71	42	<.001	.978/0.966	.056/.039					
2. metric	92.93	46	<.001	.977/0.967	.055/.041	2 vs. 1	.001	7.05	4	.134
3. scalar	108.87	52	<.001	.973/0.965	.057/.047	3 vs. 2	.004	16.52	6	<.05
4. residual	118.15	58	<.001	.969/0.965	.057/.046	4 vs. 2	.008	25.09	12	<.05
Type of school = "Realschule"[d]:										
1. configural	105.21	42	<.001	.985/0.977	.044/.029					
2. metric	111.60	46	<.001	.985/0.978	.043/.030	2 vs. 1	.000	6.59	4	.159
3. scalar	127.40	52	<.001	.983/0.978	.043/.030	3 vs. 2	.002	16.01	6	<.05
4. residual	144.96	58	<.001	.979/0.976	.045/.031	4 vs. 2	.006	32.83	12	<.01
Type of school = "Gymnasium"[e]:										
1. configural	134.45	42	<.001	.990/0.984	.036/.025					
2. metric	156.61	46	<.001	.988/0.982	.038/.029	2 vs. 1	.002	21.76	4	<.001
3. scalar	258.28	52	<.001	.978/0.972	.048/.038	3 vs. 2	.010	113.14	6	<.001
4. residual	263.65	58	<.001	.976/0.973	.047/.039	4 vs. 2	.012	97.69	12	<.001

Notes. $N = 4180$. χ^2 = Chi-Square, *df* = degrees of freedom. CFI = Comparative Fit Index. TLI = Tucker-Lewis index. RMSEA = Root mean square error of approximation. SRMR = Standardized root mean square residual. $p(\Delta\chi^2)$-values are calculated based on the Satorra-Bentler scaled chi-square difference test (Satorra & Bentler, 1994).

[a]$n = 2109$, [b]$n = 2071$, [c]$n = 583$, [d]$n = 1166$, [e]$n = 2431$.

Table D2: Examination of measurement invariance of the helplessness scale over gender and types of school on single occasions

Model	χ^2	*Df*	*p*	CFI/TLI	RMSEA/SRMR	Comparison	ΔCFI	$\Delta\chi^2$	Δ*df*	$p(\Delta\chi^2)$
Over gender on t_2:										
1. configural	121.01	16	<.001	.985/0.971	.070/.030					
2. metric	134.76	20	<.001	.984/0.976	.064/.032	2 vs. 1	.001	8.19	4	.085
3. scalar	277.86	26	<.001	.967/0.962	.081/.059	3 vs. 2	.017	171.49	6	<.001
4. residual	286.95	32	<.001	.963/0.965	.077/.060	4 vs. 2	.021	147.21	12	<.001
Over gender on t_3:										
1. configural	68.59	16	<.001	.993/0.987	.048/.023					
2. metric	76.04	20	<.001	.993/0.989	.044/.026	2 vs. 1	.000	7.48	4	.112
3. scalar	224.53	26	<.001	.975/0.971	.071/.064	3 vs. 2	.018	172.34	6	<.001
4. residual	229.79	32	<.001	.972/0.974	.068/.065	4 vs. 2	.021	143.07	12	<.001
Over types of school on t_2:										
1. configural	111.16	24	<.001	.987/0.976	.063/.029					
2. metric	127.45	32	<.001	.986/0.981	.056/.031	2 vs. 1	.001	13.46	8	.097
3. scalar	289.95	44	<.001	.968/0.967	.074/.074	3 vs. 2	.018	200.59	12	<.001
4. residual	383.42	56	<.001	.952/0.962	.080/.077	4 vs. 2	.034	251.47	24	<.001
Over types of school on t_3:										
1. configural	73.26	24	<.001	.993/0.988	.047/.023					
2. metric	87.51	32	<.001	.993/0.990	.043/.027	2 vs. 1	.000	13.59	8	.093
3. scalar	161.57	44	<.001	.986/0.985	.051/.040	3 vs. 2	.007	82.95	12	<.001
4. residual	175.97	56	<.001	.983/0.986	.049/.044	4 vs. 2	.010	78.45	24	<.001

Notes. $N = 4180$. χ^2 = Chi-Square, *df* = degrees of freedom. CFI = Comparative Fit Index. TLI = Tucker-Lewis index. RMSEA = Root mean square error of approximation. SRMR = Standardized root mean square residual. $p(\Delta\chi^2)$-values are calculated based on the Satorra-Bentler scaled chi-square difference test (Satorra & Bentler, 1994).

Similar to the procedure described above, measurement invariance of the satisfaction scale had to be tested between different points of measurement, as well as between sexes and types of school. Therefore, we started by testing measurement invariance between different occasions. More precisely, we first checked measurement invariance between points of measurement considering all individuals and afterwards by focusing on different groups of gender and type of school (see Table D3). Subsequently, we tested measurement invariance between different sexes and types of school for single points of measurement (see Table D4). Because we were interested in differences between general life satisfaction and satisfaction with school, we excluded one item ("How satisfied are you with your school situation?") and calculated measurement invariance for the remaining 5 items. As can be seen from Tables D3 and D4 – according to ΔCFI – at least configural invariance was given for the satisfaction scale. Furthermore, metric invariance was given for most measurement invariance analyses, as well. Only the measurement invariance analyses of female students over points of measurement and students attending "Hauptschule" over points of measurement represented an exception of this.

Table D3: Examination of measurement invariance of the satisfaction scale over points of measurement

Model	χ^2	*Df*	*p*	CFI/TLI	RMSEA/SRMR	Comparison	ΔCFI	$\Delta\chi^2$	Δ*df*	$p(\Delta\chi^2)$
Overall:										
1. configural	151.58	72	<.001	.991/0.986	.028/.026					
2. metric	204.21	80	<.001	.985/0.980	.033/.039	2 vs. 1	.006	47.27	8	<.001
3. scalar	484.99	90	<.001	.953/0.946	.055/.068	3 vs. 2	.032	355.20	10	<.001
4. residual	602.09	100	<.001	.936/0.933	.061/.073	4 vs. 2	.049	339.37	20	<.001
Gender = male[a]:										
1. configural	89.07	72	<.001	.996/0.994	.018/.028					
2. metric	98.89	80	<.001	.996/0.994	.018/.033	2 vs. 1	.000	9.82	8	.278
3. scalar	216.67	90	<.001	.971/0.967	.044/.056	3 vs. 2	.025	152.49	10	<.001
4. residual	288.24	100	<.001	.954/0.952	.052/.061	4 vs. 2	.042	164.12	20	<.001
Gender = female[b]:										
1. configural	132.99	72	<.001	.986/0.980	.034/.031					
2. metric	205.88	80	<.001	.970/0.961	.047/.055	2 vs. 1	.016	60.74	8	<.001
3. scalar	401.39	90	<.001	.928/0.916	.069/.088	3 vs. 2	.042	231.15	10	<.001
4. residual	511.66	100	<.001	.895/0.890	.079/.096	4 vs. 2	.075	252.25	20	<.001
Type of school = "Hauptschule"[c]:										
1. configural	80.16	72	<.001	.992/0.989	.024/.049					
2. metric	100.66	80	<.001	.981/0.975	.037/.065	2 vs. 1	.011	20.61	8	<.01
3. scalar	125.96	90	<.001	.968/0.962	.045/.065	3 vs. 2	.013	27.87	10	<.01
4. residual	170.53	100	<.001	.931/0.928	.063/.076	4 vs. 2	.050	61.86	20	<.001
Type of school = "Realschule"[d]:										
1. configural	96.38	72	<.001	.991/0.986	.028/.032					
2. metric	125.22	80	<.001	.982/0.977	.037/.049	2 vs. 1	.009	27.36	8	<.001
3. scalar	187.96	90	<.001	.963/0.957	.051/.061	3 vs. 2	.019	78.09	10	<.001
4. residual	252.07	100	<.001	.937/0.934	.063/.069	4 vs. 2	.045	112.81	20	<.001
Type of school = "Gymnasium"[e]:										
1. configural	123.11	72	<.001	.990/0.985	.028/.031					
2. metric	153.34	80	<.001	.985/0.980	.033/.042	2 vs. 1	.005	26.04	8	<.01
3. scalar	452.76	90	<.001	.925/0.913	.068/.097	3 vs. 2	.060	356.85	10	<.001
4. residual	569.01	100	<.001	.895/0.890	.076/.105	4 vs. 2	.090	343.28	20	<.001

Notes. $N = 2902$. χ^2 = Chi-Square, *df* = degrees of freedom. CFI = Comparative Fit Index. TLI = Tucker-Lewis index. RMSEA = Root mean square error of approximation. SRMR = Standardized root mean square residual. $p(\Delta\chi^2)$-values are calculated based on the Satorra-Bentler scaled chi-square difference test (Satorra & Bentler, 1994).

[a]$n = 2109$, [b]$n = 2071$, [c]$n = 583$, [d]$n = 1166$, [e]$n = 2431$.

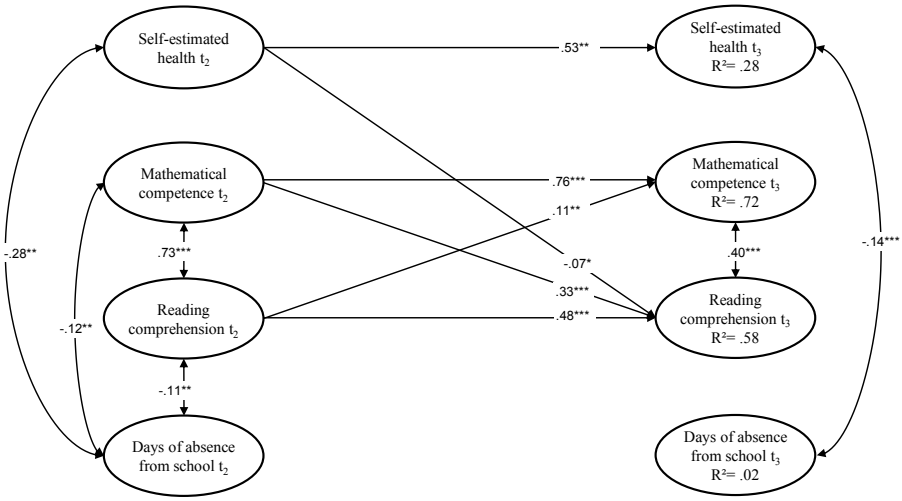
Table D4: Examination of measurement invariance of the satisfaction scale over gender and types of school on single occasions

Model	χ^2	*Df*	*p*	CFI/TLI	RMSEA/SRMR	Comparison	ΔCFI	$\Delta\chi^2$	Δ*df*	$p(\Delta\chi^2)$
Over gender on t_1:										
1. configural	30.05	10	<.001	.991/0.982	.056/.018					
2. metric	34.71	14	<.001	.991/0.987	.048/.025	2 vs. 1	.000	4.16	4	.385
3. scalar	46.33	19	<.001	.989/0.989	.044/.030	3 vs. 2	.002	11.07	5	.050
4. residual	66.78	24	<.001	.978/0.982	.055/.043	4 vs. 2	.013	31.07	10	<.001
Over gender on t_2:										
1. configural	22.47	10	<.001	.993/0.986	.041/.016					
2. metric	41.56	14	<.001	.985/0.979	.051/.037	2 vs. 1	.008	19.55	4	<.001
3. scalar	72.77	19	<.001	.974/0.973	.058/.042	3 vs. 2	.011	41.53	5	<.001
4. residual	79.09	24	<.001	.971/0.976	.054/.049	4 vs. 2	.014	38.04	10	<.001
Over gender on t_3:										
1. configural	22.19	10	<.001	.995/0.990	.045/.014					
2. metric	28.77	14	<.001	.994/0.992	.041/.024	2 vs. 1	.001	6.19	4	.186
3. scalar	68.45	19	<.001	.984/0.983	.059/.035	3 vs. 2	.010	62.28	5	<.001
4. residual	84.50	24	<.001	.979/0.982	.061/.040	4 vs. 2	.015	59.79	10	<.001
Over types of school on t_1:										
1. configural	31.32	15	<.001	.993/0.985	.048/.015					
2. metric	53.21	23	<.001	.987/0.983	.051/.035	2 vs. 1	.006	22.34	8	<.01
3. scalar	113.52	33	<.001	.971/0.974	.064/.065	3 vs. 2	.016	89.17	10	<.001
4. residual	278.24	43	<.001	.842/0.890	.131/.098	4 vs. 2	.145	298.12	20	<.001
Over types of school on t_2:										
1. configural	26.50	15	<.001	.994/0.988	.039/.017					
2. metric	34.44	23	<.001	.994/0.992	.031/.025	2 vs. 1	.000	7.88	8	.445
3. scalar	54.27	33	<.001	.990/0.991	.033/.032	3 vs. 2	.004	22.62	10	<.05
4. residual	117.66	43	<.001	.963/0.974	.056/.046	4 vs. 2	.031	87.79	20	<.001
Over types of school on t_3:										
1. configural	25.08	15	<.001	.996/0.992	.040/.014					
2. metric	33.02	23	<.001	.997/0.995	.031/.022	2 vs. 1	-.001	6.84	8	.554
3. scalar	55.92	33	<.001	.993/0.994	.036/.030	3 vs. 2	.004	28.18	10	<.01
4. residual	80.01	43	<.001	.988/0.991	.042/.039	4 vs. 2	.109	47.90	20	<.001

Notes. $N = 2902$. χ^2 = Chi-Square, *df* = degrees of freedom. CFI = Comparative Fit Index. TLI = Tucker-Lewis index. RMSEA = Root mean square error of approximation. SRMR = Standardized root mean square residual. $p(\Delta\chi^2)$-values are calculated based on the Satorra-Bentler scaled chi-square difference test (Satorra & Bentler, 1994).

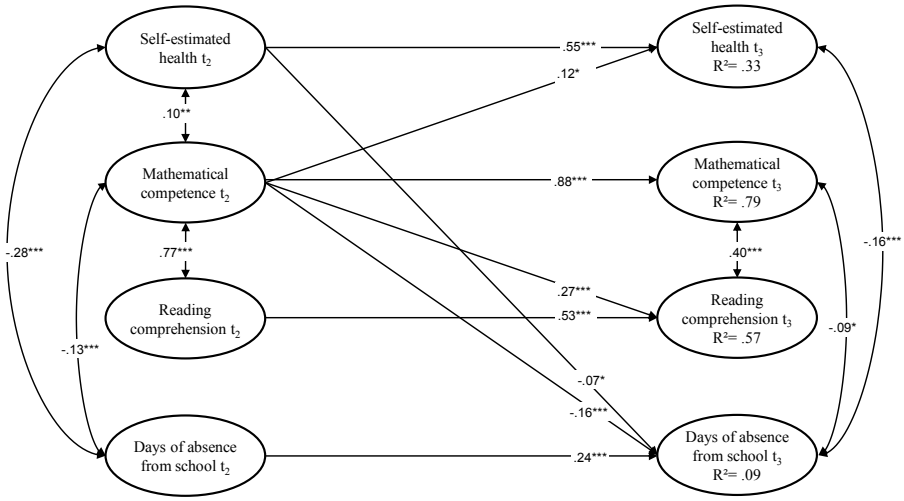
Appendix E

Figure E1: Reciprocal relations between physical well-being (measured by self-estimated health and days of absence from school) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. Sex = male. N = 2100. Fit measures are not reported because the model is saturated. All latent variables are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

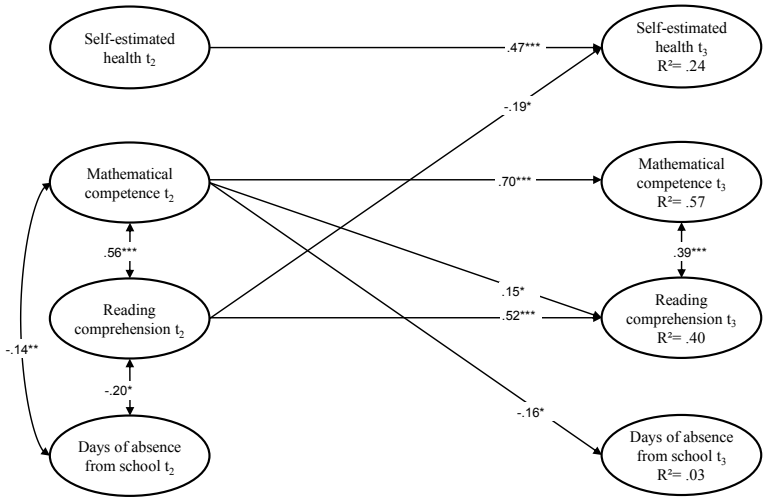
Figure E2: Reciprocal relations between physical well-being (measured by self-estimated health and days of absence from school) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. Sex = female. N = 2059. Fit measures are not reported because the model is saturated. All latent variables are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

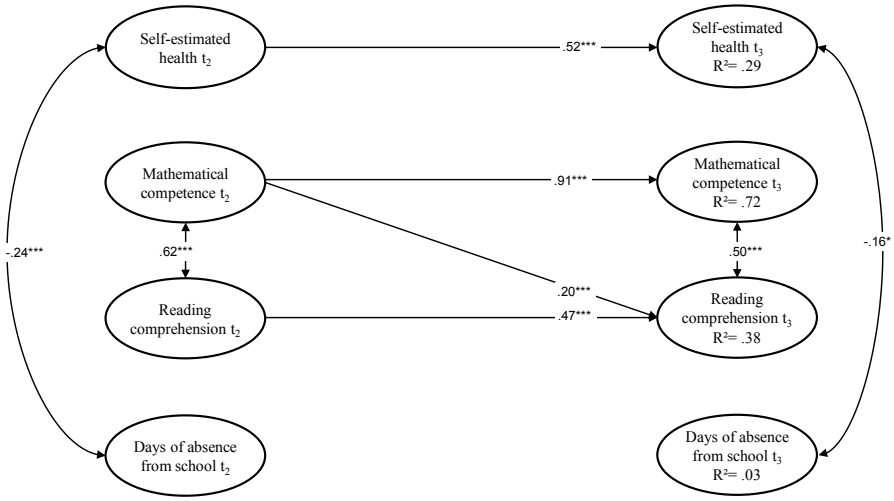
Appendix F

Figure F1: Reciprocal relations between physical well-being (measured by self-estimated health and days of absence from school) and academic achievement (MC and RC) from grade 7 to grade 9.



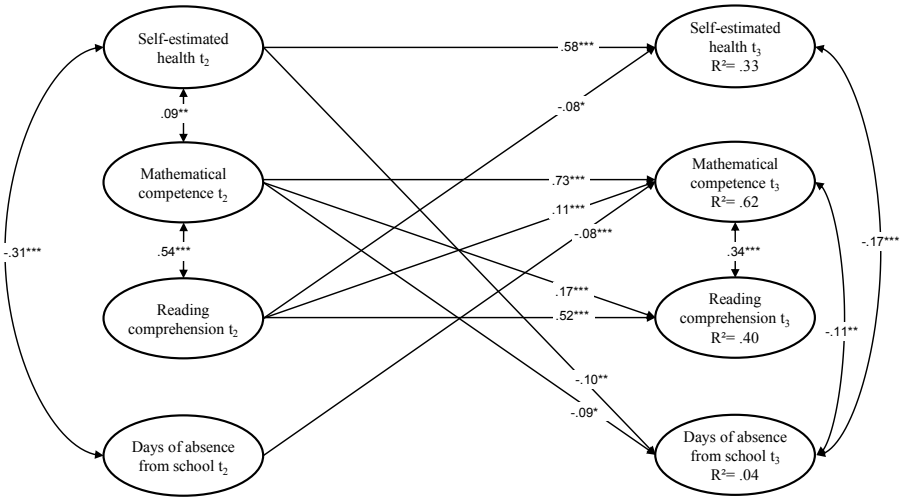
Notes. Type of School = "Hauptschule" (lowest track of German secondary school system). N = 577. Fit measures are not reported because the model is saturated. All latent variables are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown. $^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Figure F2: Reciprocal relations between physical well-being (measured by self-estimated health and days of absence from school) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. Type of School = "Realschule" (intermediate track of German secondary school system). N = 1162. Fit measures are not reported because the model is saturated. All latent variables are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

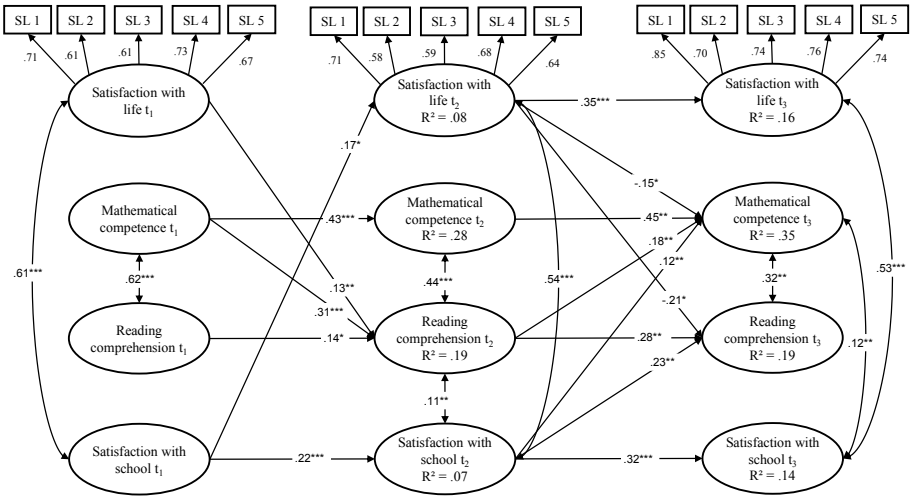
Figure F3: Reciprocal relations between physical well-being (measured by self-estimated health and days of absence from school) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. Type of School = "Gymnasium" (highest track of German secondary school system). N = 2420. Fit measures are not reported because the model is saturated. All latent variables are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

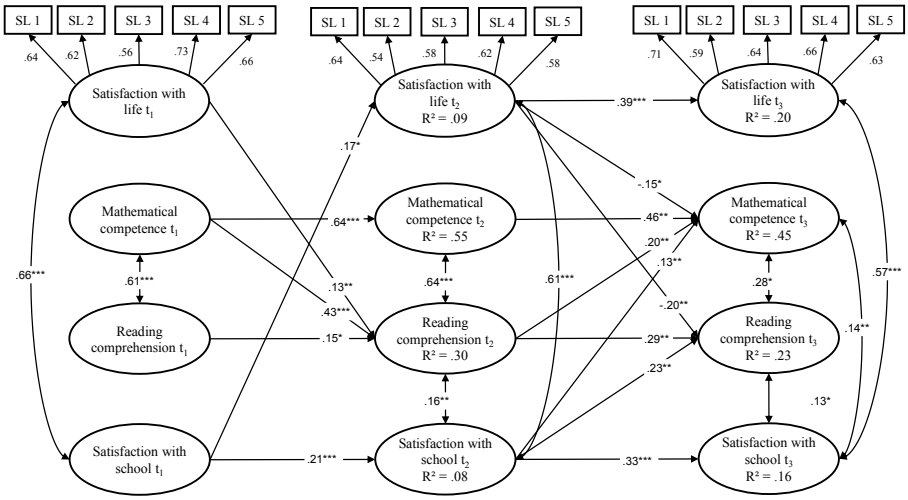
Appendix G

Figure G1: Reciprocal relations between cognitive well-being (measured by satisfaction with life and satisfaction with school) and academic achievement (MC and RC) from grade 5 to grade 9.



Notes. Sex = male. N = 1458. $\chi^2(187) = 279.73$, AIC = 117852.80, BIC = 118576.82, CFI = .991, TLI = 0.987, RMSEA = .022 SRMR = .024. Variables "Mathematical competence", "Reading comprehension" and "Satisfaction with school" are measured by single indicators which have not been included in the figure. Latent variables that model random intercepts have not been included in the figure for clarity purposes. Only statistically significant paths are shown.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

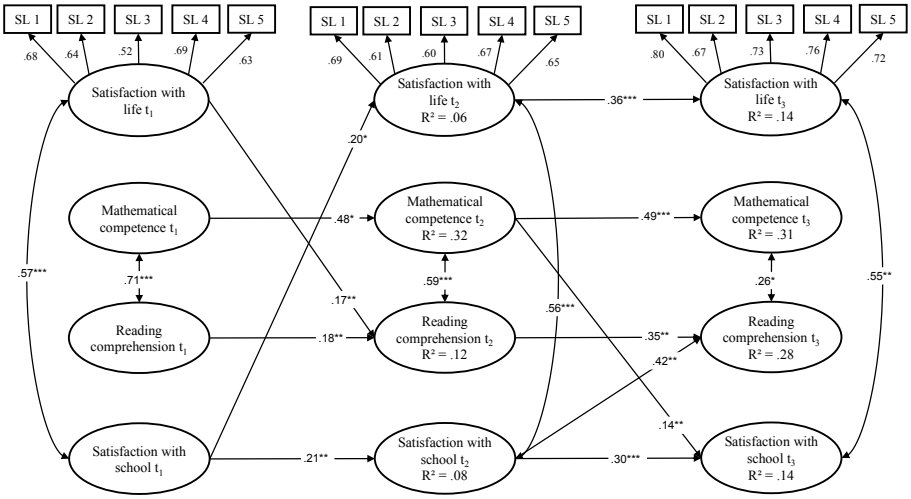
Figure G2: Reciprocal relations between cognitive well-being (measured by satisfaction with life and satisfaction with school) and academic achievement (M C and RC) from grade 5 to grade 9.



Notes. Sex = female. N = 1441. $\chi^2(187)$ = 429.22, AIC = 113682.45, BIC = 114404.87, CFI = .977, TLI = 0.967, RMSEA = .035 SRMR = .035. Variables "Mathematical competence", "Reading comprehension" and "Satisfaction with school" are measured by single indicators which have not been included in the figure. Latent variables that model random intercepts have not been included in the figure for clarity purposes. Only statistically significant paths are shown.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

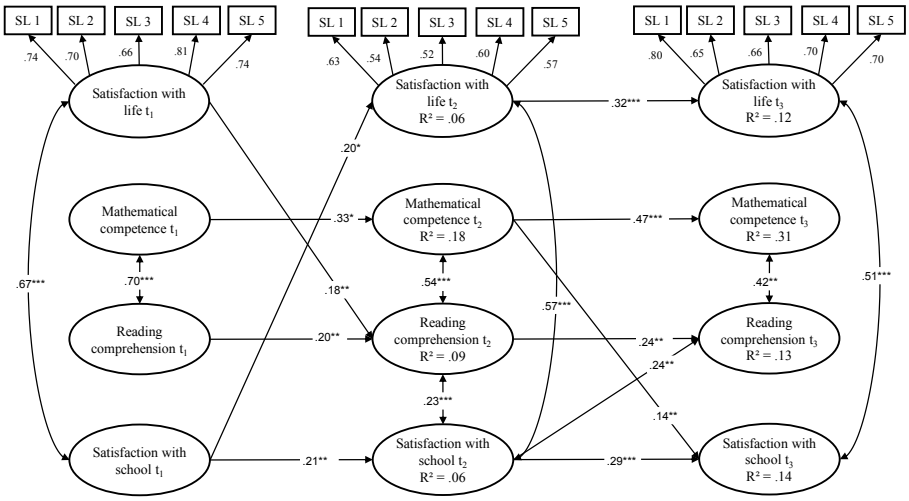
Appendix H

Figure H1: Reciprocal relations between cognitive well-being (measured by satisfaction with life and satisfaction with school) and academic achievement (MC and RC) from grade 5 to grade 9.



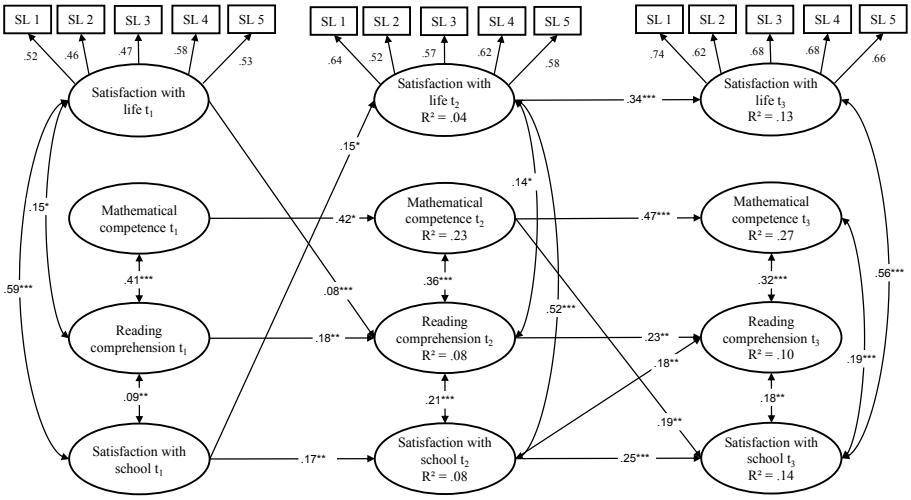
Notes. Type of school = "Hauptschule" (lowest track of German secondary school system). N = 363. $\chi^2(187)$ = 235.65, AIC = 29320.07, BIC = 29853.60, CFI = .981, TLI = 0.971, RMSEA = .029 SRMR = .038. Variables "Mathematical competence", "Reading comprehension" and "Satisfaction with school" are measured by single indicators which have not been included in the figure. Latent variables that model random intercepts have not been included in the figure for clarity purposes. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

Figure H2: Reciprocal relations between cognitive well-being (measured by satisfaction with life and satisfaction with school) and academic achievement (MC and RC) from grade 5 to grade 9.



Notes. Type of school = "Realschule" (intermediate track of German secondary school system).
N = 788. $\chi^2(187)$ = 279.53, AIC = 63884.19, BIC = 64523.92, CFI = .984, TLI = 0.976, RMSEA = .028 SRMR = .032. Variables "Mathematical competence", "Reading comprehension" and "Satisfaction with school" are measured by single indicators which have not been included in the figure. Latent variables that model random intercepts have not been included in the figure for clarity purposes. Only statistically significant paths are shown.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

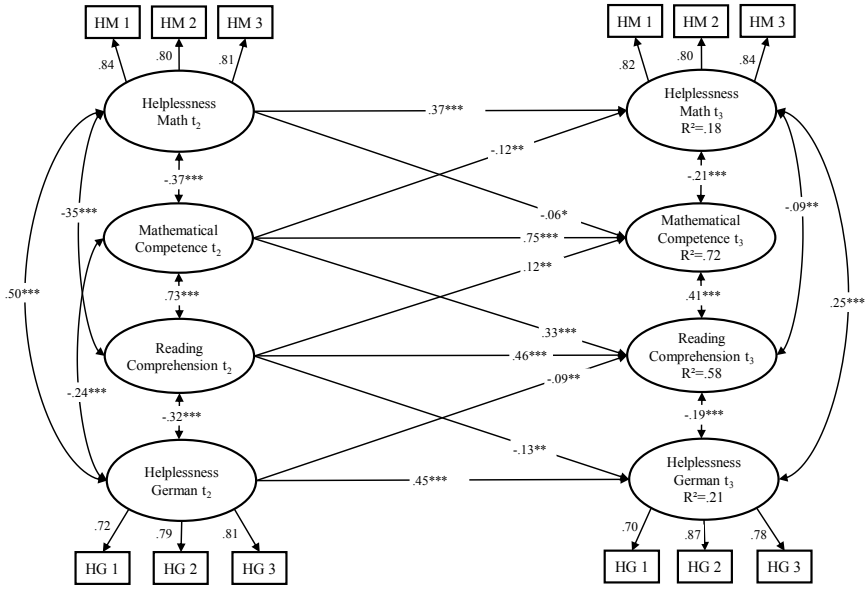
Figure H3: Reciprocal relations between cognitive well-being (measured by satisfaction with life and satisfaction with school) and academic achievement (MC and RC) from grade 5 to grade 9.



Notes. Type of school = "Gymnasium" (highest track of German secondary school system). N = 1748. $\chi^2(187)$ = 382.40, AIC = 135958.52, BIC = 136707.40, CFI = .980, TLI = 0.972, RMSEA = .029 SRMR = .030. Variables "Mathematical competence", "Reading comprehension" and "Satisfaction with school" are measured by single indicators which have not been included in the figure. Latent variables that model random intercepts have not been included in the figure for clarity purposes. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

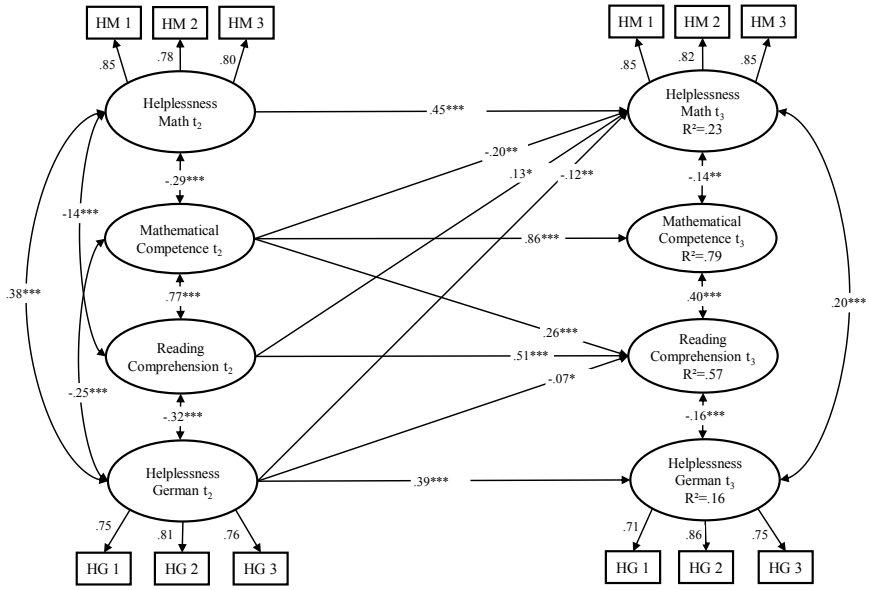
Appendix I

Figure I1: Reciprocal relations between emotional well-being (measured by helplessness German and helplessness Math, respectively) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. Sex = male. N = 2100. $\chi^2(80) = 223.86$, AIC = 66547.67, BIC = 66954.46, CFI = .988, TLI = 0.983, RMSEA = .032, SRMR = .026. Variables "Mathematical competence" and "Reading comprehension" are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

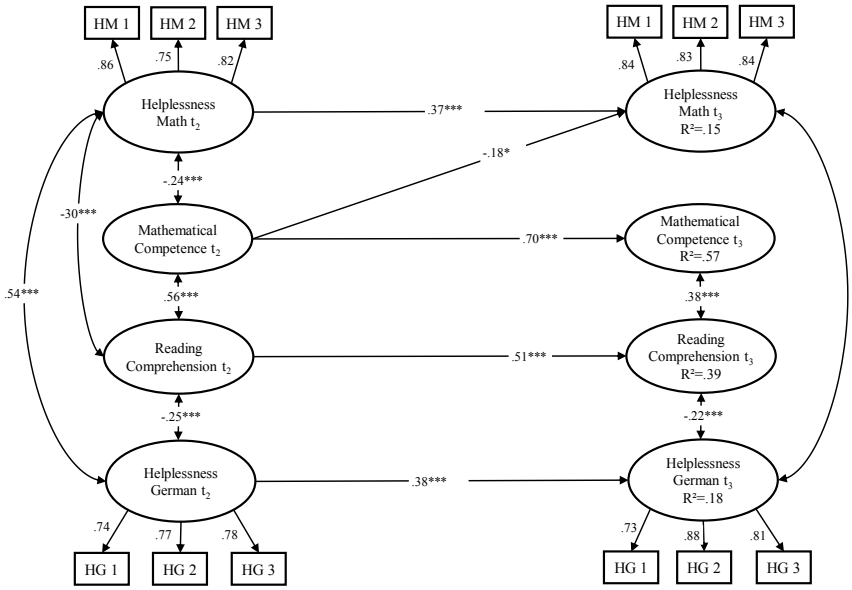
Figure I2: Reciprocal relations between emotional well-being (measured by helplessness German and helplessness Math, respectively) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. Sex = female. N = 2059. $\chi^2(80)$ = 228.23, AIC = 63460.65, BIC = 63866.00, CFI = .988, TLI = 0.983, RMSEA = .031, SRMR = .022. Variables "Mathematical competence" and "Reading comprehension" are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
$p < .05$. $^{**}p < .01$. $^{***}p < .001$.

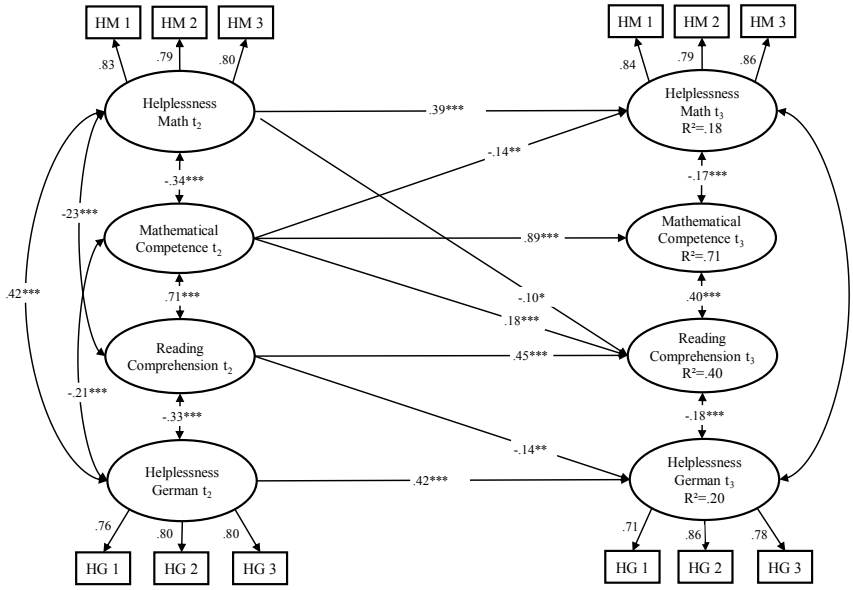
Appendix J

Figure J1: Reciprocal relations between emotional well-being (measured by helplessness German and helplessness Math, respectively) and academic achievement (MC and RC) from grade 7 to grade 9.



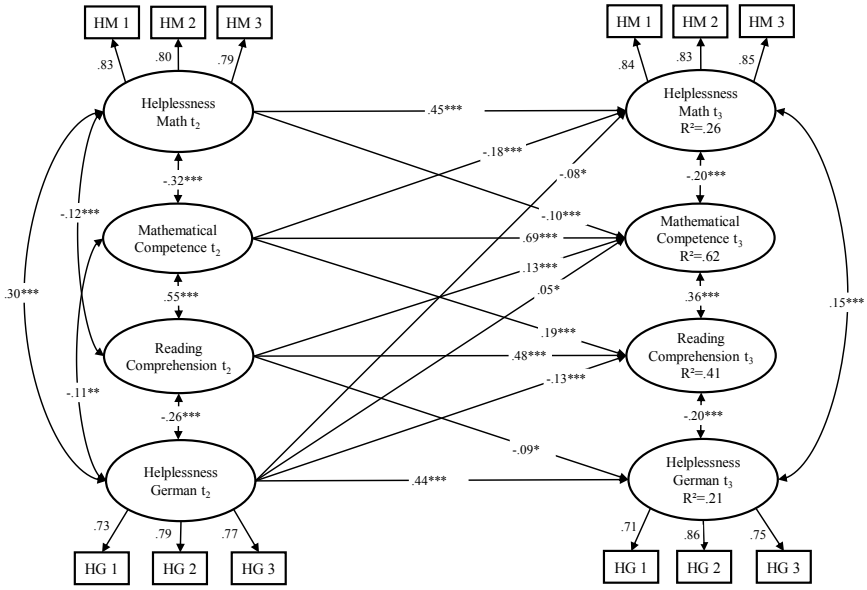
Notes. Type of school = "Hauptschule" (lowest track of German secondary school system). N = 577. $\chi^2(80)$ = 104.68, AIC = 17665.57, BIC = 17979.33, CFI = .991, TLI = 0.987, RMSEA = .024, SRMR = .030. Variables "Mathematical competence" and "Reading comprehension" are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

Figure J2: Reciprocal relations between emotional well-being (measured by helplessness German and helplessness Math, respectively) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. Type of school = "Realschule" (intermediate track of German secondary school system). N = 1162. $\chi^2(80)$ = 159.17, AIC = 36065.55, BIC = 36429.72, CFI = .988, TLI = 0.981, RMSEA = .031, SRMR = .023. Variables "Mathematical competence" and "Reading comprehension" are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.

Figure J3: Reciprocal relations between emotional well-being (measured by helplessness German and helplessness Math, respectively) and academic achievement (MC and RC) from grade 7 to grade 9.



Notes. Type of school = "Gymnasium" (highest track of German secondary school system). N = 2420. $\chi^2(80)$ = 228.462, AIC = 74479.07, BIC = 63866.00, CFI = .988, TLI = 0.983, RMSEA = .029, SRMR = .022. Variables "Mathematical competence" and "Reading comprehension" are measured by single indicators which have not been included in the figure. Only statistically significant paths are shown.
*p < .05. **p < .01. ***p < .001.