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Perceived Teacher Unfairness and Student Motivation in Math and German: An Application of the Generalized Internal/External Frame of Reference Model

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Abstract

The Generalized Internal/External Frame of Reference Model offers a framework according to which the perception of teacher characteristics might impact on students' motivation within and between subjects. In the present study, relations between perceived teacher unfairness and student motivation in math and German were examined. In a sample of *N*=1685 German secondary school students, perceived teacher unfairness was found to be negatively related with student self-concept, interest, and importance of doing well on the task within the subjects of math and German, while being positively related with the three aspects of student motivation between subjects. Mediation analyses revealed partial mediation through academic self-concept within, and complete mediation between subjects. The results imply that students' motivation in one subject is not only related to perceived teacher characteristics in the corresponding subject, but also to the experiences that these students make with teachers in another subject.

Keywords: motivation; self-concept; teacher unfairness; GI/E model

1. Introduction

This study links research on the association between perceived teacher unfairness as a component of the student-teacher relationship and different aspects of student motivation (e.g., Roorda, Koomen, Spilt, & Oort, 2011; Wentzel, 2009) to the Generalized Internal/External Frame of Reference Model (Möller, Müller-Kalthoff, Helm, Nagy, & Marsh, 2016). Negative relations are thus expected between perceived teacher unfairness in math (German) and self-concept, interest, and importance of the same subject, whereas positive relations are anticipated between perceived teacher unfairness in math (German) and self-concept, interest, and importance of the other subject. Moreover, we tested whether the within- and between-subject relations between perceived teacher unfairness and interest respectively importance are mediated through subject-specific academic self-concept.

1.1 Perceived Teacher Unfairness and Student Motivation

Student motivation is largely affected by the quality of the student-teacher relationship (e.g., Wentzel, 2009). A central attribute of students' perceived student-teacher relationship is teachers' fairness towards their students or the felt unfairness (Hofer, Pekrun, & Zielinski, 1986). Chory-Assad and Paulsel (2004) define teacher fairness as " (…) perceptions of fairness regarding outcomes or processes that occur in the instructional context" (p. 254). Thus, perceived unfairness encompasses perceptions of unjust outcomes of evaluation (e.g., school grades), unjust teacher behavior in instruction processes (e.g., assistance offered to the students) or unjust processes in the classroom (e.g., the teacher's feedback during lessons). For example, a student might feel that the teacher takes the student's own oral contributions less seriously than other

students' contributions, cares more about other students' matters of concern than about his or hers, or grades the student unfairly.

Perceived teacher unfairness is negatively related to students' satisfaction with the teacher (Wendorf & Alexander, 2005) and to classroom climate (Peter & Dalbert, 2010). Sanches, Gouveia-Pereira, and Carugati (2012; see also Gouveia-Pereira, Vala, Palmonari, & Rubini, 2003) found that the more students feel they are being treated unfairly by their teachers, the more deviant behavior they show and the less they adjust to school norms and rules. Perceived teacher unfairness in high school is related to bullying behavior (Donat, Umlauft, Dalbert, & Kamble, 2012) and to students' school distress (Peter et al., 2012). It is further negatively related to student achievement (Wang & Holcombe, 2010; see also Dalbert & Stoeber, 2006; Kahileh, Felix, & Dalbert, 2013) and to student motivation including enjoyment, interest and mastery orientation as well as academic self-concept (Berti, Mameli, Speltini, & Molinari, 2016; Kahileh et al., 2013).

In sum, students who perceive a higher level of teacher unfairness seem to suffer in several learning-related aspects including academic motivation. So far, research on the relation between teacher unfairness and student motivation has been conducted on a general level without examining students' perceived teacher unfairness and student motivation related to specific school subjects. Yet, theory and research on the Generalized Internal/External Frame of Reference Model (Möller et al., 2016) suggest that student motivation in a school subject is based on experiences not only in the same subject but also on experiences in other subjects.

1.2 The Generalized Internal/External Frame of Reference Model

The Generalized Internal/External Frame of Reference (GI/E) model originates from the Internal/External Frame of Reference Model (I/E model; Marsh, 1986) that explains the

formation of subject-specific academic self-concepts, that is, a person's perceptions of his or her abilities in academic subjects (Shavelson, Hubner, & Stanton, 1976). The I/E model is based on the finding that math and verbal self-concepts (typically referring to the subjects math and the language of instruction) are far less correlated than math and verbal achievements are. This finding is explained by the interplay of two comparison processes: On the one hand, students are assumed to compare their own achievement in one domain with their classmates' achievements in the same domain (social comparison), thus, to use an external frame of reference. On the other hand, students are assumed to compare their achievements in the math domain with their achievements in the verbal domain, using an internal frame of reference, this process being called "dimensional comparison" (Möller & Köller, 2001).

Since Marsh (1986) firstly proposed the I/E model, researchers on the I/E model continue assuming that social comparisons lead to the positive paths from achievement to self-concept in the corresponding subject depicted in the I/E model: Students performing better than their classmates develop a relatively high academic self-concept in the corresponding subject. Dimensional comparisons are assumed to invoke the negative paths between achievement in one subject and self-concept in the other subject: Students performing better in the math (verbal) subject form a poorer verbal (math) self-concept. For example, two students with identical verbal achievements are likely to form differential levels of verbal self-concepts if their math achievements differ. A student with a higher level of math achievement is assumed to establish a poorer verbal self-concept than a student with a lower level of math achievement. The same assumption holds for two students with identical math, but differential levels of verbal achievements. The assumptions of the I/E model have been found to be generalizable across students from different countries and age groups (for meta-analytic findings see Möller, Pohlmann, Köller, and Marsh, 2009) and were validated by experimental and introspective studies

(e.g., Helm, Mueller-Kalthoff, Nagy, & Möller, 2016; Möller & Husemann, 2006; Möller & Savyon, 2003; Müller-Kalthoff et al., 2017).

Dimensional Comparison Theory (DCT; Möller & Marsh, 2013) focuses on psychological processes of dimensional comparisons and their field of application. DCT paves the way for the GI/E model as a generalization of the classic I/E model. The GI/E model assumes that students draw social and dimensional comparisons between additional characteristics of different subjects beyond subject-specific achievements and that social and dimensional comparisons impact on more variables than academic self-concepts (see Appendix, Figure 1).

In line with the latter assumption, path-analytic studies showed hints on effects of social and dimensional achievement comparisons on, for example, self-regulated learning (Miller, 2000), students' perceptions of instructional quality and student-teacher relations (Arens & Möller, 2016), and interest (e.g., Arens & Preckel, 2018). Two studies found that the effect of achievement on student interest was mediated by self-concept. First, Goetz, Frenzel, Hall, and Pekrun (2008) demonstrated a mediation of the within- and between-subject relations between students' math and verbal achievements and math and verbal enjoyment through students' math and verbal self-concepts. Second, Schurtz, Pfost, Nagengast, and Artelt (2014) found the within-subject relations between students' grades and interest in math and English to be mediated by subject-specific academic self-concepts.

To our knowledge, so far, only one study has applied the GI/E model to other predictor variables in the academic area except achievements: Dietrich, Dicke, Kracke, and Noack (2015) analysed within-subject and cross-subject effects of perceived teacher support in math and German on student motivation (i.e., intrinsic value and effort). As Dietrich et al. (2015) measured

perceived teacher support as a climate variable (e.g., “Our teacher takes care of our problems”, p. 48), they analysed the relations between perceived support and the outcome variables on both student and classroom levels. They found positive within-subject effects (on both levels) and negative cross-subject effects (on the classroom level), corresponding to the GI/E assumptions. Dietrich et al. (2015) thus showed that, for example, in two classes with the same level of shared classroom perception of the math teacher’s support, the level of shared classroom motivation for math can still differ, when the shared classroom perception of the German teacher’s support differs. In the class with higher levels of shared classroom perception of the German teacher’s support, the level of the shared math motivation is lower compared to the class with lower levels of shared perception of German teacher’s support.

The application of the GI/E model to the relations between a perceived teacher characteristic and different aspects of student motivation can be theoretically linked to Expectancy-Value Theory (EVT; e.g., Eccles & Wigfield, 1995, 2002; Wigfield & Eccles, 2000, 2002). EVT conceptualizes an expectancy and a value component as distinguishable but interacting facets of student motivation. The expectancy component is often operationalized by academic self-concept in the regarding area which is itself defined as students’ self-perception of competence (e.g., Guo et al., 2017; Guo, Marsh, Morin et al., 2015; Guo, Marsh, Parker et al., 2015). The subjective task value is composed of several subfacets: intrinsic value (“enjoyment the individual gets from performing the activity or the subjective interest the individual has in the subject”; Eccles & Wigfield, 2002, p. 120), attainment value (“personal importance of doing well on the task”; Eccles & Wigfield, 2002, p. 119), utility value (the extent to “how well a task relates to current and future goals”; Eccles & Wigfield, 2002, p. 120), and cost. In modern EVT (e.g., Wigfield & Eccles, 2000), students’ academic self-concept and the value attached to a task are assumed to be affected by socializers’ (e.g., teachers’) behaviors. More precisely, socializers’

beliefs and behaviors are supposed to influence a student's self-concept, which in turn is assumed to influence inter alia student interest and subjective importance of the respective task.

As described above, Dietrich et al. (2015) showed that teacher behavior might affect student motivation within and between subjects, supporting the assumptions of the GI/E model. The assumption that teacher behavior might take an effect on student self-concept, interest and subjective importance of the regarding school subject is also in line with predictions of the EVT. The studies by Goetz et al. (2008) and Schurtz et al. (2014) moreover underline the assumption that self-concept plays a mediating role in the relation between teacher feedback and student interest, the results obtained by Goetz et al. (2008) even indicate that this might be the case for the relations between subjects, as well.

2. The Present Study

Perceived teacher unfairness is a central factor of student-teacher relations and is linked to motivational variables like students' academic self-concept, interest, and subjective importance of a learning task (e.g., Berti et al., 2016). Drawing on the outlined empirical findings and on the assumptions of the GI/E model, we suggest that when examining the association between student motivation and perceived teacher unfairness in one specific school subject, one should consider student experiences in other school subjects as well.

We thus tested the applicability of the GI/E model to the relations between perceived teacher unfairness and different aspects of student motivation in the subjects of math and German, which represent the two central academic subjects for German students. According to the assumptions of the GI/E model, perceived teacher unfairness in different subjects might negatively relate to student motivation in the same subject (due to social comparisons), but might positively relate to student motivation between different subjects (due to dimensional

comparisons). We examined three central aspects of student motivation: academic self-concept, interest, and subjective importance of the subject, considered as central aspects of student motivation, see for example EVT (e.g., Wigfield & Eccles, 2000, 2002). We further drew on the findings by Goetz et al. (2008) and Schurtz et al. (2014) and on the assumptions of EVT, and examined the mediating role of subject-specific self-concept in the relation between perceived teacher unfairness and student interest respectively importance (see Appendix, Figure 2).

Students' achievement is assumed to correlate with all variables examined in our study, that is, with academic self-concept and value facets (e.g., Abu-Hilal, 2000; Möller, Retelsdorf, Köller, & Marsh, 2011; Schurtz et al., 2014) and with perceived teacher unfairness (e.g., Dalbert & Stoeber, 2005). Ignoring these relations could bias the relations between perceived teacher unfairness and self-concept, interest and importance of the subject. Thus, our hypotheses are tested while controlling for students' math and verbal achievements operationalized by school grades. School grades can be easily compared between students (social comparisons) and across school subjects (dimensional comparisons), as students are informed about their school grades frequently during the school year. In sum, we tested the following hypotheses:

1) We assumed negative relations between students' perceived teacher unfairness in math and German and students' self-concept, interest, and importance in the matching subject (horizontal path hypothesis).
2) We assumed positive relations between students' perceived teacher unfairness in math and German and students' self-concept, interest and importance in the non-matching subject (cross-path hypothesis).
3) The relations between perceived teacher unfairness and interest and importance in matching subjects were assumed to be mediated through students' academic self-concept in the matching subject (mediation hypothesis 1).

4) The relations between perceived teacher unfairness and interest and importance in non-matching subjects were assumed to be mediated through students' self-concept in the non-matching subject (mediation hypothesis 2).

3. Method

3.1 Sample

The data of the present study originate from the large-scale longitudinal study "Bildungsprozesse, Kompetenzentwicklung und Selektionsentscheidungen im Vorschul- und Schulalter" (BiKS, *Educational processes, competence development and selection decisions in pre- and primary school* age; Faust, 2013; Lorenz, Schmitt, Lehrl, Mudiappa, & Rossbach, 2013), funded by the German Research Foundation (DFG). The study was approved by the Ministries of Culture of the German federal states of Hesse and Bavaria. The data were made publically available by the Research Data Centre (FDZ) at the Institute for Educational Quality Improvement (IQB, Berlin). Inter alia, the study aimed to investigate the development of competence and motivation across school. BiKS 8-14 (Artelt, Blossfeld, Faust, Roßbach, & Weinert, 2013; Zielonka et al., 2013), which this study relies on, investigated students across grade levels 3 to 9. Starting in spring 2006, a sample of approximately $N = 2{,}400$ elementary school students was longitudinally surveyed with measurement waves taking place from third grade on until the end of grade 9. The surveys were conducted approximately every six months when the students attended grades 3 and 4, but only once a year when students attended grades 5 to 9. All surveys were administered in German.

We considered data of students in grade 6 (measurement wave 5). The respective sample consisted of *N*=1685 students (*M* age=12.47 (*SD*=0.57); 52.90% girls) from Bavaria (71.00%) and Hesse (29.00%). 56.20% of the students attended the high-ability track of German secondary schooling ("Gymnasium"), 17.30% the intermediate track ("Realschule"), 14.40% the low-ability track ("Hauptschule"), 10.20% attended the comprehensive track ("Gesamtschule"), and 1.80% attended schools for special education. The highest rating on the International Socio-Economic-Index of Occupational Status (ISEI; Ganzeboom, De Graaf, & Treiman, 1992) for the household in which a student lives (HISEI) provided information about students' socioeconomic background. HISEI values range from 16, indicating low SES, to 90, indicating high SES (this range of values is covered in the present study). Information on the HISEI was available for *n*=1472 (87.40%) of the students. The average value of the HISEI was 53.60 (*SD*=16.00), ranging from 16 to 90. For *n*=257 (15.30%), one or two parents had an immigrant background; information on immigrant background was available for *n*=1479 (87.80%) students.

3.2 Measures

3.2.1 Perceived teacher unfairness. Two scales, developed by the authors of the BIKS 8-14 study (see Faust, 2013), were used to assess students' perceived unfairness of their math and German teachers. The scales consisted of three items each, which had parallel wordings for the math and German teachers: "The math/German teacher marks my exams more strictly than those of my classmates; the math/German teacher takes my contributions in class less seriously than those of my classmates; the math/German teacher cares more about other students than about me" (English translations). The students rated on a 5-point Likert-type scale whether these items do not at all apply (1), rather do not apply (2), partly apply and partly do not apply (3), rather apply (4), or fully apply (5) to them. The scales demonstrated good coefficient alpha reliability

estimates: Perceived unfairness of the math teacher: α = .86; perceived unfairness of the German teacher: α = .85.

3.2.2 Academic self-concept. Three parallel-worded items were used to measure students' math and German self-concepts. The items were derived from academic self-concept scales used in the study "Bildungsverläufe und psychosoziale Entwicklung im Jugendalter" [Learning Processes, Educational Careers and Psychosocial Development in Adolescence and Young Adulthood] (BIJU; Baumert et al., 1997): "I learn things quickly in math/German; I am good at math/German; Work in math/German is easy for me" (English translations). The students indicated their consent to the items on a 5-point-Likert scale ranging from "not at all" to "very much". The scales demonstrated good coefficient alpha reliability estimates: : Math self-concept: α = .94; German self-concept: α = .88.

3.2.3 Interest. Students' interest in math and German was assessed by two items each which have been developed in the BIJU study (Baumert et al., 1997) and which had parallel wordings across domains/subjects: "How much are you looking forward to a math/German lesson?; How much would you like to have more lessons in math/German than you have now?" (English translations). The students responded to these items on the same 5-point Likert scale as applied for the academic self-concept scales. The coefficient alpha reliability estimates of the scales were good: -Math interest: α = .87; German interest: α = .86.

3.3.4 Importance. Using two parallel-worded items, students were asked to rate the importance they attributed to their learning in math and German. The items were also developed in the BIJU study (Baumert et al., 1997): "How important is it to you to remember the subject matter of math/German?; How important is it to you to know much about math/German?" (English translations). The same 5-point Likert scale was used as for the academic self-concept

and interest scales. Both scales showed good coefficient alpha reliability estimates:: Math importance: $\alpha = .90$; German importance: $\alpha = .89$.

3.2.5 Academic achievement. Students' school grades received in math and German in the latest school report were used to operationalize students' math and verbal achievements. In Germany, school grades range from 1 to 6 with 1 indicating the highest, and 6 indicating the poorest achievement. Grades were reverse-coded for the analyses, thus high values reflect high achievement levels. At the time of the surveys, the latest school reports dated four to six months back.

3.3 Statistical Analyses

All analyses were conducted within the framework of structural equation modelling (SEM; Kline, 2005) using Mplus Version 7.4 (Muthén & Muthén, 1998-2015). Hence, the items used to measure students' perceived teacher unfairness, self-concept, interest, and importance in math and German were defined as separate factors using the corresponding items. We modelled math and German achievement factors by students' grades in math and German as single-item indicators and integrated them as covariates. Hence, in the model, math and German achievements were related to self-concept, interest, and importance, and teacher unfairness related to the two domains.

To test the GI/E model assumptions (Hypotheses 1 and 2), these factors were integrated in a series of latent regression models which all used perceived teacher unfairness in math and verbal subjects as predictor variables, but considered different outcome variables. Model 1 (Table 2) used math and German self-concepts as outcome variables, Model 2 integrated math and German interest as outcome variables, and Model 3 considered importance of math and German as outcome variables (Table 2). Model 4 is a mediation model in which math and German self-

concepts were assumed to mediate the relation between math (German) teacher unfairness and math (German) interest (see Appendix, Table 3). Model 5 tested whether math and German self-concepts mediated the relation between perceived teacher unfairness and subjective importance in math and German (Table 3). To specify the indirect relations in the mediation models (Models 4 and 5), we used the Mplus "model indirect" option. Academic achievement was included as a control variable in all models by assuming math and German achievements to be predictors of all other variables considered in the respective models.

All models were conducted using the robust maximum likelihood estimator (MLR) which is robust against non-normality of the observed variables and allows to account for the treatment of items responded on a Likert-type scale as continuous variables (Beauducel & Herzberg, 2006). We used the Full Information Maximum Likelihood (FIML) implemented in Mplus to estimate missing values on all levels. The FIML approach is known to be reliable in handling missing data, leading to trustworthy, unbiased estimates for missing values (Enders, 2010; Graham, 2009). All models included correlated uniquenesses between items with parallel wordings across the math and German subjects to account for potential shared method variance (Marsh, Lüdtke, Nagengast, Morin, & Von Davier, 2013). Finally, all analyses were conducted using the Mplus option "type = complex" with students' classes treated as clustering variables. This option corrects for possible biased standard errors resulting from the hierarchical nature of data (students clustered within classes; Muthén & Satorra, 1995).

As researchers are advised to consider a wide range of descriptive goodness-of-fit indices to evaluate model fit (e.g., Marsh, Hau, & Wen, 2004), we reported the comparative fit index (*CFI*), the Tucker-Lewis index (*TLI*), the root mean square error of approximation (*RMSEA*), and the standardized root mean square residual (*SRMR*). For the *CFI* and *TLI*, values above .90 and .95 represent an adequate respectively good model fit (Hu & Bentler, 1999). For the *RMSEA*,

values should be below .05 for a close fit, or between .05 and .08 for a reasonable fit (Browne & Cudeck, 1992). Regarding the *SRMR*, Hu and Bentler (1999) propose values below .08 as indicative of a good model fit.

4. Results

5.1 Descriptives and Measurement Model

Table 1 (see Appendix) shows the factor correlations between the examined variables. A positive correlation emerged between perceived teacher unfairness in math and German. Moreover, the findings demonstrated significantly negative relations between perceived teacher unfairness and all motivational variables (self-concept, interest, importance) within the subjects of math and German. Correlations between perceived teacher unfairness in one subject and motivational variables of non-corresponding subjects were lower and mostly non-significant.

Before testing our hypotheses, we tested the integrity of our measurement model (Model 0). We examined a confirmatory factor analytic model in which we assumed separate factors for teacher unfairness, self-concept, interest, and importance related to math and German. The fit of this model was good (see Appendix, Table 2). The items had high positive and statistically significant loadings on their corresponding factors (range: .74 – .94), which indicated a high integrity of the used measures.

5.2 Testing the GI/E Model (Hypotheses 1 and 2)

Table 2 contains the fit indices for all latent regression models conducted in this study (Models 1 to 5). The path coefficients for the GI/E model with perceived teacher unfairness in math and German as predictor variables and students' motivation (i.e., self-concept, interest, and importance) as outcome criteria are depicted in Table 3 (see Appendix; for the confidence intervals of the path- coefficients, see Table 1 in the online supplementary material). Firstly, significant negative relations were found between teacher unfairness on the one hand and self-concept, interest, and importance on the other hand within corresponding subjects. Secondly, teacher unfairness was positively related to self-concept, interest, and importance of the non-corresponding subject. Only the path leading from perceived unfairness by the math teacher to importance in German was

non-significant, although positive and thus corresponding to the expected direction. Hence, students' perceptions of being treated unfairly by their German (math) teacher showed a negative relation with students' German (math) self-concept, interest, and importance, but a positive relation with students' math (German) self-concept, interest, and importance (with the above stated exception). Hypotheses 1 and 2 were thus almost fully confirmed when using self-concept (Model 1), interest (Model 2), and importance (Model 3) as outcome variables.

5.3 Mediation Analyses (Hypotheses 3 and 4)

Model 4 tested the assumption of indirect relations between students' perceptions of teacher unfairness and interest mediated through students' academic self-concept. As can be seen in Table 4 (see Appendix; for the confidence intervals of the path-coefficients, see Table 2 in the online supplementary material), the direct paths between perceived teacher unfairness and interest

within the matching subjects of German and math remained significant (German: β=-.23; math: β=-.18, both $p<.05$), but were also partly mediated through the subject-specific academic self-concepts (German: β=-.08, $p<.001$; math: β=-.17, $p<.001$). Across subjects, however, the direct relations between perceived teacher unfairness and interest dropped to non-significance and thus seemed to be fully mediated through academic self-concept given the significant indirect effects. The indirect effect of perceived unfairness by the German teacher on math interest showed a mediation through math self-concept (β=.07, $p<.01$); the indirect effect of perceived unfairness by the math teacher on German interest indicated a mediation through German self-concept (β=.04, $p<.05$). Hypothesis 3, assuming a mediation of the relations between perceived teacher unfairness and interest through self-concept within subjects, thus received support, as does Hypothesis 4, assuming a mediation of the relations between perceived teacher unfairness and interest by self-concept between subjects.

Model 5 tested whether the relations between perceived teacher unfairness and importance in math and German were mediated through math and German self-concepts (Table 4). The direct relations between perceived teacher unfairness and importance within subjects were still negative and significant (German: β=-.20; math: β=-.18, both $p<.05$). Since the within-subject indirect effects were also significant (German: β=-.08; math: β=-.13, both $p<.05$), the results indicated partial mediation. Both direct cross-paths leading from perceived teacher unfairness to importance of the non-corresponding subject were non-significant. Given the significant indirect path coefficients for cross-subject relations (effect of perceived German teacher unfairness on math importance mediated through math self-concept: β=.05, $p<.01$; perceived math teacher unfairness on German importance mediated through German self-concept: β=.04, $p<.01$), the cross-subject relations between perceived teacher fairness and

importance were fully mediated through academic self-concept. Thus again, Hypothesis 3 and Hypothesis 4 were supported for importance as an outcome variable.

5. Discussion

The present study connected two research areas, that is, research on student-teacher relations, and research on the GI/E model. We examined the relations between perceived teacher unfairness and student motivation in math and German within and between the two subjects. Perceived teacher unfairness showed negative relations with student self-concept, interest, and subjective importance within subjects (Hypothesis 1). Thus, our study replicated results from previous studies (e.g., Berti et al., 2016; Kahileh et al., 2013), showing perceived teacher unfairness to be related with different aspects of student motivation within subjects. Yet, across subjects, students' perceived teacher unfairness was negatively related to the three aspects of student motivation (self-concept, interest, and importance). This result matches the assumptions of the GI/E model, predicting relations between various kinds of subject-related variables and student motivation not only within but also between subjects. Thus, the assumptions of the GI/E model were supported for another predictor variable than achievement and for other outcome variables than self-concept, namely for interest and importance in this study.

Beyond testing the direct relations as assumed by the GI/E model, we aimed to clarify whether subject-specific self-concepts mediated the relations between perceived teacher unfairness and student interest and importance. For both interest and importance, we found partial mediation within math and German (Hypothesis 3) and complete mediation between both subjects (Hypothesis 4). Hence, our results were in line with the findings by Goetz et al. (2008)

and Schurtz et al. (2014). They might be interpreted in the way that self-concept in a certain subject was affected by a student's perception of the teacher's unfairness towards this student, and self-concept in turn affected interest and importance of a subject. Yet, as our data are cross-sectional, causal conclusions cannot be drawn (see below for further explanation).

Keeping the cross-sectional nature of our data in mind, we can deduce assumptions regarding the psychological mechanism underlying the found relations: The negative relations between perceived teacher unfairness and student self-concept within subjects might be due to students' attributing the teacher's perceived unfair behavior to their own accomplishments in the subject. Hence, students might assume that the teacher treats them unfairly because of students' inferior accomplishments. This may cause students to establish a rather low subject-specific self-concept and subsequently low levels of value facets (interest and importance). Moreover, interest and importance in the same subject might be lowered by the perceived teacher unfairness directly (as the partial mediation indicated): A student feeling treated unfairly in lessons of a certain subject might associate negative feelings with the subject and accordingly de-value the subject per se.

The mechanism of teacher behavior influencing student self-concept, which then influences students' value facets, is in accordance with the EVT's assumption that a student's perception of socializers' (e.g., teachers') beliefs and behaviors inter alia affects the student's academic self-concept (see for example Cole, 1991; Gest, Domitrovich, & Welsh, 2005), and that students' academic self-concept in turn affects students' interest and importance. The latter process likely occurs because students attach more value to activities and domains in which they perceive themselves as successful and competent (see for example Eccles, Wigfield, & Schiefele, 1998; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Lauermann, Tsai, & Eccles, 2017; Wigfield, 1997). Regarding the positive cross-subject relations between perceived teacher

unfairness and students' self-concept, interest, and importance as found in the present study, students might naturally draw dimensional comparisons between their perceptions of teachers in different subjects, for example, how likable they find them, how supporting (see Dietrich et al., 2015), or how fairly or unfairly they feel treated. Dietrich et al. (2015) argued that a student's perception of a teacher as more favorable regarding central characteristics might set a high standard " (…) which, if not met by teachers in other subjects, has the potential to lower motivation and effort in the other subjects" (p. 52). Alternatively, the perception of a teacher as acting rather unfairly could set a low standard, leading to higher self-concept and subsequently higher motivation in other subjects. Nevertheless, the correlation between the perceptions of unfairness for math teachers and German teachers was high in our study (as was the correlation of perceived support for math and German teachers in Dietrich et al.'s study). Thus, when a student perceives the math teacher to behave rather fairly towards him or her, the student is likely to perceive the German teacher to behave rather fairly, as well. Hence, for most students, the comparison between teachers with regard to their unfairness does not seem to lead to a marked contrast in students' perceptions of both teachers. This might be due to students' general tendencies to feel treated rather fairly or rather unfairly (see below).

6.1 Theoretical and Practical Implications

The results bear important implications for DCT and the GI/E model as we showed that the assumptions of the GI/E model hold for the relations between perceived teacher unfairness and student self-concept, interest, and subjective importance in math and German. This confirmation of the GI/E model with regard to a teacher characteristic as a predictor variable and different aspects of student motivation as outcome variables adds to the findings by Dietrich et al. (2015) for teacher support. Hence, two teacher variables - low perceived teacher unfairness and

teacher support - seem to relate to different aspects of student motivation - positively within subjects, but negatively between subjects. Yet, recalling the results of the mediation model, it may be hypothesized that social and especially dimensional comparisons between perceived teacher unfairness in math and German primarily affect academic self-concept, and that self-concept influences interest and importance in the same subject. Thus, the positive effect of perceived unfairness on interest and importance in the non-corresponding subject seems to be due completely to the fact that perceived teacher unfairness and self-concept in non-corresponding domains are positively related to each other, and that self-concept is positively related to interest and importance. The negative effect within subjects might be only partly due to such spill-over effects. For research on the student-teacher relationship, our findings indicate that it might be worthwhile to consider not only within-subject relations between teacher variables and student motivation, but also between-subject relations. A corresponding approach might enrich teaching research and contribute to disentangling the complexity of the formation of students' motivation and self-perceptions regarding school.

The major practical implication is that perceived teacher unfairness is connected to different central aspects of student motivation – the less fair a student perceives a teacher to be, the less self-confidence and the less motivation the student shows in this subject. For teachers, our results may indicate that trying to treat all their students as fairly as possible is likely to help motivate the students (even if this notion is not new). Treating students fairly includes grading according to a criterion-based reference standard (Dalbert, Schneidewind, & Saalbach, 2007), and individual task-related feedback and encouragement. It further encompasses rewarding of great effort instead of rewarding for excellent achievements (Thorkildsen, Nolen, & Fournier, 1994), interpersonal justice, and justice in disciplinary action (Fan & Chan, 1999).

The relatively high correlation between perceived teacher unfairness in math and German as found in the present study indicates that perceived teacher unfairness might also depend on student characteristics to some degree. A student perceiving his or her math teacher as behaving unfairly against himself or herself is likely to perceive the German teacher not as very fair either. It is thus likely that, despite teachers' efforts to treat their students as fairly as possible, not all the students may feel they are being treated fairly. This might be due not only to real differences in the teacher's behavior towards them but also due to the students' own "fairness biases", that is, their idiosyncratic perceptions of teacher behavior. Students tending to perceive their teachers generally as rather unfair might possess a weak "belief in a just world" (Dalbert & Stoeber, 2005, 2006). To strengthen a student's belief in a just world, the joint effort of main socializers including teachers, parents, and peers is probably needed. On the teachers' side, the above mentioned evaluation practices and teacher behavior (e.g., grading according to a criterion-based reference standard) are likely to strengthen students' beliefs in a just world (e.g., Dalbert, 2011). In addition, characteristics of the school environment and perceptions of additional teacher characteristics (e.g., the teacher's ability to support students emotionally) may affect students' perception of teachers' fairness.

A further interesting result is that a high degree of perceived teacher unfairness in one subject positively relates to self-concept, interest, and importance in the other subject, at least for math and German. Of course, no one would recommend treating students unfairly in one subject to improve motivation in another subject. Rather, teachers might be advised to communicate with each other about how to achieve treating students as fairly as possible. In addition, teachers should discuss with students, which teacher behavior students perceive as fair and unfair. As Thorkildsen et al. (1994) showed, at least in elementary school, adequate and fair teacher behavior might differ for individual students – for example, some students perceive rewarding

effort as fair, other students understand rewarding superior performance as fair, whereas other students perceive rewarding task-focused learning as fair teacher behavior, and other students again prefer extrinsic rewards. The results by Thorkildsen et al. further imply that teachers are well advised to reflect with their students on the reasons for perceiving a certain teacher behaviour as fair or unfair, and to try to work out some aspects of fairness on which all students of a class can agree.

6.2 Limitations and Future Research

Despite the longitudinal nature of the main study, we could not work on our research question longitudinally. We examined students' subjective perceptions of teacher unfairness in relation to a particular teacher. Thus, a corresponding longitudinal study design would require the same math and German teachers to teach students across at least two measurement waves. However, students' math or German teachers changed across measurement waves. Accordingly, we cannot draw any causal conclusions – hence, we could not examine whether perceived teacher unfairness affects self-concept, interest, and importance or vice versa. As such, a teacher could treat those students more unfairly whom he/she perceives to be less motivated in the subject. This again would lead the respective student to feel treated unfairly invoking a self-maintaining circle of student and teacher behavior. In addition, the results regarding our mediation test should be interpreted with caution because other causal ordering in the mediation process is possible and longitudinal data are needed to clarify the mediation process (e.g., Maxwell, Cole, & Mitchell, 2011). Still, we based our assumptions regarding mediation on previous theoretical insights and empirical findings according to which academic self-concept acts as a mediator in the relation between student achievement or socializers' behavior on the one hand and student value facets on the other hand (e.g., Goetz et al., 2008; Schurtz et al., 2014; Wigfield & Eccles, 2000, 2002).

Moreover, the assumption that the relations found in the (G)I/E model are caused by the operation of social and dimensional comparisons is rather speculative. This might be particularly important in our study, since perceived teacher unfairness, that is, a perceived teacher characteristic, was used as a predictor variable. Students might know less about their classmates' perceptions of teacher characteristics than about classmates' achievement, and especially school grades, the latter being used as predictor variables in the classic I/E model. Students are informed about their achievements in the different school subjects quite frequently and often talk about their grades, when, for example, a test is returned. If students do not know about their classmates' perceptions of their teachers, they cannot compare their own perception to the perceptions of their classmates, and thus cannot perform social comparisons. Yet, it is probable that students in a class talk about their teachers and their opinions about their teachers quite frequently. Thus, students might have a more or less accurate view about what their classmates think about their teachers – especially, when it comes to perceived teacher unfairness, which is particularly important for the student-teacher relationship. Students' view about their classmates' perceived teacher unfairness might not be as accurate as students' knowledge about their classmates' achievements. Still, it can be assumed that in many cases, and especially for students who are friends, the view about one's classmate's perceived teacher unfairness is fairly correct. Accordingly, it seems plausible that students compare their own feeling of being treated fairly or unfairly with the feelings of being treated fairly or unfairly by the same teacher they assume that their classmates hold. This kind of social comparison then might influence students' motivation including academic self-concept and value facets. In the future, experimental, introspective and longitudinal studies might confirm the assumption that perceived teacher unfairness causally affects student motivation within and between school subjects. In experimental and introspective studies, participating students could be asked to take the view of the (un)fairly treated student and

then to report on the fictive student's assumed self-concept and value facets in the same and in the other subject. Such studies might confirm that social and dimensional comparisons represent the underlying mechanisms for possible negative effects of perceived teacher unfairness on student self-concept, interest, and importance within subjects and possible positive effects between subjects. The direction of mediating effects between perceived teacher unfairness, student self-concept, and interest as well as importance should be examined in longitudinal studies.

We could have reported results on our research question from multilevel models because teacher unfairness can also be conceptualized as a construct that is shared across students attending the same class / taught by the same teacher. We therefore inspected the intraclass correlations (ICCs) for the perceived teacher unfairness variables. Quite different ICCs for perceived unfairness by the teachers of the two school subjects emerged (German: ICC = .08, math: ICC = .51), the ICC for perceived math teacher unfairness arguing for multilevel models. In the multilevel models, a coherent picture resulted according to which the complete pattern of relations as assumed in the GI/E model only emerged on the student level, but not on the classroom level (for a detailed depiction of the results, see Tables 3, 4, and 5 in the online supplementary material). This result seems plausible in light of the fact that our research question addressed a process on the individual student level: The unfairness of a teacher as perceived by an individual student, who then feels treated differently than other students in the class, should influence the individual's self-concept and motivation. This is reflected in our items assessed with a strong reference to an individual student rather than to the classroom (e.g., "The math/German teacher takes my contributions in class less seriously than those of my classmates"). Based on our considerations that were supported by the results of the multilevel

models, we decided to report our analyses on the individual student level, correcting for possible biased standard errors due to the hierarchical structure of our data.

Our sample comprised only students in the sixth grade of the German federal states of Hesse and Bavaria, of which a majority attended the high-ability track of German secondary schools. This calls into question the generalizability of our results to other age groups, school systems, and school tracks. For example, it is possible that students of higher age are more sensitive to teacher unfairness and thus show stronger relations between perceived teacher unfairness and motivation. Alternatively, younger students might depend more strongly on teacher feedback, leading to a stronger relation between perceived teacher unfairness and motivation for these students. The meta-analytic results by Roorda et al. (2011) showed stronger associations between positive affective qualities of the teacher–student relationship (e.g., closeness) and students' school engagement as well as achievement in secondary school, and stronger associations between negative affective qualities of the teacher–student relationship (e.g., conflict) and school engagement as well as achievement in primary school. These findings thus point to potential differential relations between perceived teacher unfairness as an aspect of the teacher–student relationship and student motivation for students of different age groups.

Further research on the GI/E model should address relations between perceptions of additional teacher characteristics on the one hand and a wide range of student motivation and behavior on the other hand. Regarding the latter, based on EVT (e.g., Wigfield & Eccles, 2000, 2002), additional value facets such as utility value and cost should be included as outcome variables. Regarding the former, for instance, mutual respect, caring, and warmth (Rudasill, Reio, Stipanovic, & Taylor, 2010) as indicators of a positive perceived student-teacher relationship should be taken into account. An interesting research question would be whether certain teacher characteristics are differentially related to different constructs of student motivation. In our study,

the cross-domain relations between perceived teacher unfairness and student self-concept as well as student interest were higher in size than the relation between perceived teacher unfairness and subjective importance. This possibility should be further examined in future studies.

6.3 Conclusion

The present study supported central assumptions of DCT and the GI/E model. Students' perceptions of their learning experiences, like perceived unfairness by their teachers as examined in our study, were related to their motivation. This was the case not only within but also between the subjects of math and German. With regard to student motivation as the outcome, subject-specific self-concept was found to be the central variable: It was related to perceived teacher unfairness within and between subjects. Self-concept, moreover, mediated the relation between teacher unfairness and interest and importance. Hence, research on the GI/E model benefits from our study as we applied the GI/E model to perceptions of teacher characteristics as predictor variables. Our study also enriches theory and research on student-teacher relations and on student motivation, because it is the first to show relations between perceived teacher unfairness and different aspects of student motivation not only within subjects but also between subjects. The study thereby indicates a way for future research on the relations between perceived teacher characteristics and student motivation and behavior - within and between subjects.

References

Abu-Hilal, M. M. (2000). A structural model of attitudes towards school subjects, academic aspiration and achievement, *Educational Psychology*, *20*, 75–84. doi:10.1080/014434100110399

Arens, A. K., & Möller, J. (2016). Dimensional comparisons in students' perceptions of the learning environment. *Learning and Instruction*, *42*, 22–30. doi:10.1016/j.learninstruc.2015.11.001

Arens, A.K., & Preckel, F. (2018). Testing the internal/external frame of reference model with elementary school children: Extension to physical ability and intrinsic value. *Contemporary Educational Psychology, 54,* 199–211. doi:10.1016/j.cedpsych.2018.06.003

Artelt, C., Blossfeld, H.-P., Faust, G., Roßbach, H.-G., & Weinert, S. (2013). Bildungsprozesse, Kompetenzentwicklung und Selektionsentscheidungen im Vorschul- und Schulalter (BiKS-8-14) (Version 2) [Datensatz]. *[Educational processes, competence development, and selection decisions in pre-school and school-age (BiKS 8-14). Datafile.].* Berlin: IQB – Institut zur Qualitätsentwicklung im Bildungswesen. doi:10.5159/IQB_BIKS_8_14_v2

Baumert, J., Gruehn, S., Heyn, S., Köller, O., Schnabel, K. U., Leven, I. et al. (1997). Bildungsverläufe und psychosoziale Entwicklung im Jugendalter (BIJU) [Learning Processes, Educational Careers and Psychosocial Development in Adolescence and Young Adulthood]: Dokumentation-Band 1.[Dokumentation Volume 1].

Beauducel, A., & Herzberg, P. Y. (2006). On the performance of maximum likelihood versus means and variance adjusted weighted least squares estimation in CFA. *Structural Equation Modeling: A Multidisciplinary Journal*, *13*, 186–203. doi:10.1207/s15328007sem1302_2

Berti, C., Mameli, C., Speltini, G., & Molinari, L. (2016). Teacher justice and parent support as predictors of learning motivation and visions of a just world. *Issues in Educational Research*, *26*, 543–560.

Browne, M. W., & Cudeck, R. (1992). Alternative Ways of Assessing Model Fit. *Sociological Methods & Research*, *21*, 230–258. doi:10.1177/0049124192021002005

Byrne, B. M. (1996). Measures of self-concept for adolescents. In B. M. Byrne (Ed.), *Measurement and instrumentation in psychology. Measuring self-concept across the life span. Issues and instrumentation* (1st ed., pp. 125–168). Washington, DC: American Psychological Association. doi:10.1037/10197-006

Chory-Assad, R. M., & Paulsel, M. L. (2004). Classroom justice: Student aggression and resistance as reactions to perceived unfairness. *Communication Education*, *53*, 253–273. doi:10.1080/0363452042000265189

Cole, D.A. (1990). Change in Self-Perceived Competence as a Function of Peer and Teacher Evaluation. Developmental Psychology, 27, 682–688. doi:10.1037/0012-1649.27.4.682

Dalbert, C. (2011). Warum die durch die Schüler und Schülerinnen individuell und subjektiv erlebte Gerechtigkeit des Lehrerhandelns wichtig ist [Why subjective experience of teacher justice is important]. *Zeitschrift für Pädagogische Psychologie [German Journal of Educational Psychology]*, *25*, 5–18. doi:10.1024/1010-0652/a000031

Dalbert, C., Schneidewind, U., & Saalbach, A. (2007). Justice judgments concerning grading in school. *Contemporary Educational Psychology*, *32*, 420–433. doi:10.1016/j.cedpsych.2006.05.003

Dalbert, C., & Stoeber, J. (2005). The belief in a just world and distress at school. *Social Psychology of Education*, *8*, 123–135. doi:10.1007/s11218-005-1835-2

Dalbert, C., & Stoeber, J. (2006). The personal belief in a just world and subject-specific beliefs about justice at school and in the family: A longitudinal study with adolescents. *International Journal of Behavioral Development*, *30*, 200–207. doi:10.1177/0165025406063638

Dietrich, J., Dicke, A.-L., Kracke, B., & Noack, P. (2015). Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. *Learning and Instruction*, *39*, 45–54. doi:10.1016/j.learninstruc.2015.05.007

Donat, M., Umlauft, S., Dalbert, C., & Kamble, S. V. (2012). Belief in a just world, teacher justice, and bullying behavior. *Aggressive Behavior*, *38*, 185–193. doi:10.1002/ab.21421

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and social psychology bulletin*, *21*, 215–225. doi:10.1177/0146167295213003

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual review of psychology*, *53*, 109–132. doi:10.1146/annurev.psych.53.100901.135153

Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In W. Damon, & N. Eisenberg (Ed.), *Handbook of child psychology: Social, emotional, and personality development* (pp. 1017–1095). John Wiley & Sons Inc.

Enders, C.K. (2010). *Applied missing data analysis*: Guilford Press.

Fan, R. M., & Chan, S. C. N. (1999). Students' perceptions of just and unjust experiences in school. *Educational and Child Psychology*, *16*, 32–50.

Faust, G. (Ed.). (2013). Einschulung: Ergebnisse aus der Studie "Bildungsprozesse, Kompetenzentwicklung und Selektionsentscheidungen im Vorschul-und Schulalter (BiKS)". [Results of the study "Educational processes, skills development, and selection decisions in preschool and school age"]. Waxmann Verlag.

Feldman, K. A. (1989). The association between student ratings of specific instructional dimensions and student achievement: Refining and extending the synthesis from multisection validity studies. *Research in Higher Education*, *30*, 583–645. doi:10.1007/BF00992392

Ganzeboom, H. B., De Graaf, P. M., & Treiman, D. J. (1992). A standard international socio-economic index of occupational status. *Social science research*, *21*, 1–56. doi:10.1016/0049-089X(92)90017-B

Gest, S. D., Domitrovich, C. E., & Welsh, J. A. (2005). Peer academic reputation in elementary school: Associations with changes in self-concept and academic skills. *Journal of Educational Psychology*, *97*, 337–346. doi:10.1037/0022-0663.97.3.337

Goetz, T., Frenzel, A. C., Hall, N. C., & Pekrun, R. (2008). Antecedents of academic emotions: Testing the internal/external frame of reference model for academic enjoyment. *Contemporary Educational Psychology*, *33*, 9–33. doi:10.1016/j.cedpsych.2006.12.002

Gouveia-Pereira, M., Vala, J., Palmonari, A., & Rubini, M. (2003). School experience, relational justice and legitimation of institutional. *European Journal of Psychology of Education*, *18*, 309–325. doi:10.1007/BF03173251

Graham, J. W. (2009). Missing data analysis: making it work in the real world. *Annual Review of Psychology*, *60*, 549–576. doi:10.1146/annurev.psych.58.110405.085530

Guo, J., Marsh, H. W., Morin, A. J., Parker, P. D., & Kaur, G. (2015). Directionality of the associations of high school expectancy-value, aspirations, and attainment: A longitudinal study. *American Educational Research Journal*, *52*, 371–402. doi:10.3102/0002831214565786

Guo, J., Marsh, H. W., Parker, P. D., Morin, A. J., & Dicke, T. (2017). Extending expectancy-value theory predictions of achievement and aspirations in science: Dimensional

comparison processes and expectancy-by-value interactions. *Learning and Instruction*, *49*, 81–91. doi:10.1016/j.learninstruc.2016.12.007

Guo, J., Marsh, H. W., Parker, P. D., Morin, A. J., & Yeung, A. S. (2015). Expectancy-value in mathematics, gender and socioeconomic background as predictors of achievement and aspirations: A multi-cohort study. *Learning and individual differences*, *37*, 161–168. doi:10.1016/j.lindif.2015.01.008

Helm, F., Mueller-Kalthoff, H., Nagy, N., & Möller, J. (2016). Dimensional comparison theory. Perceived subject similarity impacts on students' self-concepts. *AERA Open*, *2*. doi:10.1177/2332858416650624

Hofer, M., Pekrun, R., & Zielinski, W. (1986). Die Psychologie des Lernens. [Psychology of learning]. In W. B. Weidenmann, A. Krapp, M. Hofer, G. L. Huber, & H. Mandl (Eds.), *Pädagogische Psychologie* (pp. 219–275). München: Urban & Schwarzenberg.

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

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*, 509–527. doi:10.1111/1467-8624.00421

Kahileh, R., Felix, P., & Dalbert, C. (2013). Gerechte-Welt-Glaube, Gerechtigkeitserleben und Schulerfolg. In C. Dalbert (Ed.), *Gerechtigkeit in der Schule* (pp. 55–71). Wiesbaden: Springer. doi:10.1007/978-3-531-93128-9_3

Kline, T. (2005). *Psychological testing: A practical approach to design and evaluation*. Thousand Oaks, CA: Sage.

Lauermann, F., Tsai, Y.-M., & Eccles, J. S. (2017). Math-related career aspirations and choices within Eccles et al.'s expectancy-value theory of achievement-related behaviors. *Developmental Psychology*, *53*, 1540–1559. doi:10.1037/dev0000367

Lorenz, C., Schmitt, M., Lehrl, S., Mudiappa, M., & Rossbach, H.-G. (2013). The Bamberg BiKS research group. In M. Pfost, C. Artelt, & S. Weinert (Eds.), *The development of reading literacy from early childhood to adolescence. Empirical findings from the Bamberg BiKS longitudinal studies* (pp. 15–33). Bamberg, Germany: University of Bamberg Press.

Marsh, H. W. (1986). Verbal and math self-concepts: An internal/external frame of reference model. *American Educational Research Journal*, *23*, 129–149. doi:10.3102/00028312023001129

Marsh, H. W. (2007). Students' evaluations of university teaching: Dimensionality, reliability, validity, potential biases and usefulness. In R. P. Perry & J. C. Smart (Eds.), *The scholarship of teaching and learning in higher education: An evidence-based perspective* (pp. 319–383). Dordrecht: Springer. doi:10.1007/1-4020-5742-3_9

Marsh, H. W., Lüdtke, O., Nagengast, B., Morin, A. J., & Von Davier, M. (2013). Why item parcels are (almost) never appropriate: Two wrongs do not make a right—Camouflaging misspecification with item parcels in CFA models. *Psychological Methods*, *18*, 257–284. doi:10.1037/a0032773

Marsh, H. W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling: A Multidisciplinary Journal*, *11*, 320–341. doi:10.1207/s15328007sem1103_2

Maxwell, S. E., Cole, D. A., & Mitchell, M. A. (2011). Bias in cross-sectional analyses of longitudinal mediation: Partial and complete mediation under an autoregressive

model. *Multivariate Behavioral Research*, *46*, 816-841. doi: 10.1080/00273171.2011.606716

Miller, J. W. (2000). Exploring the source of self-regulated learning: The influence of internal and external comparisons. *Journal of Instructional Psychology, 27*, 47–52.

Möller, J., & Husemann, N. (2006). Internal comparisons in everyday life. *Journal of Educational Psychology*, *98*, 342–353. doi:10.1037/0022-0663.98.2.342

Möller, J., & Köller, O. (2001). Dimensional comparisons: An experimental approach to the internal/external frame of reference model. *Journal of Educational Psychology*, *93*, 826–835. doi:10.1037/0022-0663.93.4.826

Möller, J., & Marsh, H. W. (2013). Dimensional comparison theory. *Psychological Review*, *120*, 544–560. doi:10.1037/a0032459

Möller, J., Müller-Kalthoff, H., Helm, F., Nagy, N., & Marsh, H. W. (2016). The generalized internal/external frame of reference model: An extension to dimensional comparison theory. *Frontline Learning Research*, *4*, 1–11. doi:10.14786/flr.v4i2.169

Möller, J., Pohlmann, B., Köller, O., & Marsh, H. W. (2009). A meta-analytic path analysis of the internal/external frame of reference model of academic achievement and academic self-concept. *Review of Educational Research*, *79*, 1129–1167. doi:10.3102/0034654309337522

Möller, J., Retelsdorf, J., Köller, O., & Marsh, H. W. (2011). The reciprocal internal/external frame of reference model an integration of models of relations between academic achievement and self-concept. *American Educational Research Journal*, *48*, 1315–1346. doi:10.3102/0002831211419649

Möller, J., & Savyon, K. (2003). Not very smart, thus moral: Dimensional comparisons between academic self-concept and honesty. *Social Psychology of Education*, *6*, 95–106. doi:10.1023/A:1023247910033

Müller-Kalthoff, H., Jansen, M., Schiefer, I. M., Helm, F., Nagy, N., & Möller, J. (2017). A double-edged sword? On the benefit, detriment, and net effect of dimensional comparison on self-concept. *Journal of Educational Psychology*, *109*, 1029–1047. doi:10.1037/edu0000171

Muthén, B. O., & Satorra, A. (1995). Complex sample data in structural equation modeling. *Sociological Methodology*, *25*, 267–316. doi:10.2307/271070

Muthén, L. K., & Muthén, B. O. (1998-2015). *Mplus. Statistical analysis with latent variables. User's guide* (7th ed.). Los Angeles: Muthén & Muthén.

Nagy, G., Trautwein, U., Baumert, J., Köller, O., & Garrett, J. (2006). Gender and course selection in upper secondary education: Effects of academic self-concept and intrinsic value. *Educational Research and Evaluation*, *12*, 323–345. doi:10.1080/13803610600765687

Peter, F., & Dalbert, C. (2010). Do my teachers treat me justly?: Implications of students' justice experience for class climate experience. *Contemporary Educational Psychology*, *35*, 297–305. doi:10.1016/j.cedpsych.2010.06.001

Peter, F., Kloeckner, N., Dalbert, C., & Radant, M. (2012). Belief in a just world, teacher justice, and student achievement: A multilevel study. *Learning and Individual Differences*, *22*, 55–63. doi:10.1016/j.lindif.2011.09.011

Roorda, D. L., Koomen, H. M. Y., Spilt, J. L., & Oort, F. J. (2011). The influence of affective teacher-student relationships on students' school engagement and achievement: A meta-

analytic approach. *Review of Educational Research, 81*, 493–529. doi:10.3102/0034654311421793

Rudasill, K. M., Reio Jr, T. G., Stipanovic, N., & Taylor, J. E. (2010). A longitudinal study of student–teacher relationship quality, difficult temperament, and risky behavior from childhood to early adolescence. *Journal of school psychology*, *48*(5), 389–412. doi:10.1016/j.jsp.2010.05.001

Sanches, C., Gouveia-Pereira, M., & Carugati, F. (2012). Justice judgements, school failure, and adolescent deviant behavior. *The British Journal of Educational Psychology*, *82*, 606–621. doi:10.1111/j.2044-8279.2011.02048.

Schurtz, I. M., Pfost, M., Nagengast, B., & Artelt, C. (2014). Impact of social and dimensional comparisons on student's mathematical and English subject-interest at the beginning of secondary school. *Learning and Instruction*, *34*, 32–41. doi:10.1016/j.learninstruc.2014.08.001

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research*, *46*, 407–441. doi:10.3102/00346543046003407

Thorkildsen, T. A., Nolen, S. B., & Fournier, J. (1994). What is fair? Children's critiques of practices that influence motivation. *Journal of Educational Psychology*, *86*, 475–486. doi:10.1037/0022-0663.86.4.475

Wang, M. T., & Holcombe, R. (2010). Adolescents' perceptions of school environment, engagement, and academic achievement in middle school. *American Educational Research Journal*, *47*, 633–662. doi:10.3102/0002831209361209

Wendorf, C. A., & Alexander, S. (2005). The influence of individual- and class-level fairness-related perceptions on student satisfaction. *Contemporary Educational Psychology*, *30*, 190–206. doi:10.1016/j.cedpsych.2004.07.003

Wentzel, K. R. (2009). Students' relationships with teachers as motivational contexts. In K. Wentzel & Wigfield A. (Eds.), *Handbook of motivation at school* (pp. 301–322). Mahwah, NJ: LEA. doi:10.4324/9780203879498

Wigfield, A. (1997). Children's motivations for reading and reading engagement. *Reading engagement: Motivating readers through integrated instruction*, *14*, 33.Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68–81. doi:10.1006/ceps.1999.1015

Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 91–120). San Diego: Academic Press. doi:10.1016/B978-012750053-9/50006-1

Zielonka, M., Relikowski, I., Kleine, L., Luplow, N., Yilmaz, E., Schneider, T. et al. (2013). Migrations-und geschlechtsspezifische Disparitäten in der Primar- und Sekundarstufe. Befunde aus der Längsschnittstudie BiKS-8-14. *[Migration and gender specific disparities in primary and secondary school. Findings from the longitudinal survey BiKS 8-14.]*. In A. Hadjar & S. Hupka-Brunner (Hrsg.), Geschlecht, Migrationshintergrund und Bildungserfolg [Gender, migration background and educational success] (pp. 133–158). Weinheim: Beltz Juventa

Appendix

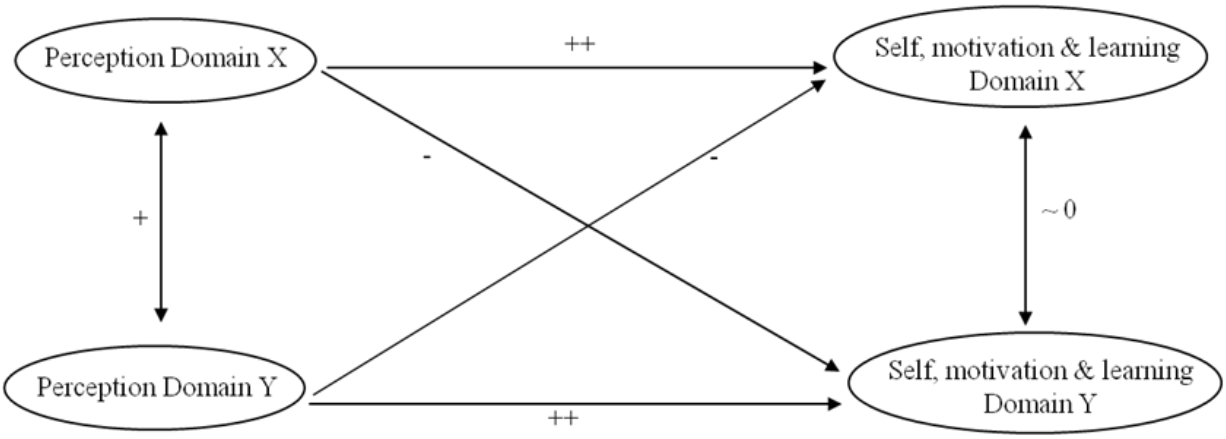

Figure 1. The GI/E model by Möller et al. (2016). ++ = strong positive effect; + = positive effect; - = negative effect.

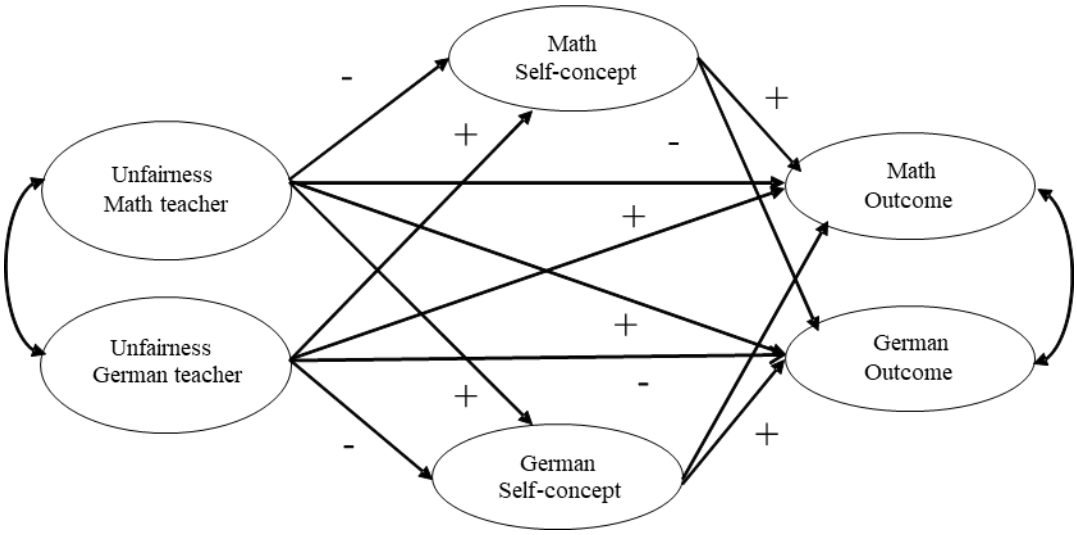

Figure 2. Prototypic representation of the moderated GI/E model tested in this study. + = positive effect; - = negative effect.

Table 1

Factor Correlations of the CFA Model with Achievement, Teacher Discrimination, Self-concept, Interest, and Importance in Math and German

	German unfairness	Math unfairness	German self-concept	Math self-concept	German interest	Math interest	German importance	Math importance	German achieve-ment
Math unfairness	.50***								
German self-concept	-.21***	-.01							
Math self-concept	-.05	-.29***	.07*						
German interest	-.27***	-.02	.50***	-.05					
Math interest	-.02	-.31***	-.00	.66***	.19***				
German importance	-.28***	-.10**	.45***	-.02	.76***	.19***			
Math importance	-.10**	-.30***	.12***	.53***	.23***	.70***	.45***		
German achievement	-.23***	-.13***	.34***	.05	.17***	-.02	.14***	.08**	
Math achievement	-.14***	-.21***	.02	.47***	-.09**	.24***	-.07*	.20***	.43***

Note. CFA = confirmatory factor analyses.

N=1685. χ^2 (156) = 370.274, CFA=.988, TLI=.982, RMSEA=.029, SRMR=.022.

* p<.05, ** p<.01, *** p<.001.

Table 2

Goodness-of-fit Indices for the GI/E Model with Perceived Math and German Teacher Unfairness as Predictors and different Criteria Variables

		χ^2	*df*	*CFI*	*TLI*	*RMSEA*	*SRMR*
Model	Criteria/Mediators						
0		308.082	132	.989	.984	.028	.022
1	Math and German self-concept / no mediator	145.117	58	.990	.984	.030	.023
2	Math and German interest / no mediator	113.443	36	.988	.977	.036	.025
3	Math and German importance / no mediator	77.086	36	.994	.988	.026	.018
4	Math and German interest / math and German self-concept as mediators	275.056	102	.986	.979	.032	.034
5	Math and German importance / math and German self-concept as mediators	252.709	102	.988	.982	.030	.032

Notes. All models are estimated with the Robust Maximum Likelihood (MLR) estimator; all χ^2 are significant ($p<.05$). *CFA* = confirmatory factor analyses; *CFI* = comparative fit index; *TLI* = Tucker-Lewis Index; *RMSEA* = root mean square error of approximation; *SRMR* = standardized root mean square residual.

Table 3

Standardized Path Coefficients and Correlations from GI/E Models with Direct Effects

	Outcome		
	Self-concept (Model 1)	Interest (Model 2)	Importance (Model 3)
Achievement as predictor			
German achievement → German outcome	.37*	.21*	.15*
German achievement → math outcome	-.18*	-.11*	.01
Math achievement → German outcome	-.15*	-.19*	-.16*
Math achievement → math outcome	.51*	.21*	.14*
German achievement → German unfairness	-.21*	-.21*	-.22*
German achievement → math unfairness	-.06	-.06	-.06
Math achievement → German unfairness	-.05	-.05	-.04
Math achievement → math unfairness	-.18*	-.18*	-.18*
Unfairness as predictor			
German unfairness → German outcome	-.19*	-.31*	-.28*
German unfairness → math outcome	.10*	.15*	.07*
Math unfairness → German outcome	.10*	.11*	.03
Math unfairness → math outcome	-.26*	-.36*	-.31*
Correlations			
German unfairness ↔ math unfairness	.48*	.48*	.48*
German outcome ↔ math outcome	.18*	.32*	.51*
German achievement ↔ math achievement	.43*	.43*	.42*

Note. *$p < .05$

Table 4

Standardized Path Coefficients and Correlations from GI/E Models with Mediated Effects

	Outcome	
	Interest (Model 4)	Importance (Model 5)
Direct paths		
German unfairness → German outcome	-.23***	-.20***
German unfairness → math outcome	.09	.03
Math unfairness → German outcome	.07	-.01
Math unfairness → math outcome	-.18*	-.18***
German achievement → German outcome	.03	-.01
German achievement → math outcome	-.01	.06
Math achievement → German outcome	-.11**	-.11**
Math achievement → math outcome	-.10*	-.11**
German achievement → German unfairness	-.21***	-.21***
German achievement → math unfairness	-.05	-.05
Math achievement → German unfairness	-.05	-.05
Math achievement → math unfairness	-.18***	-.19***
German achievement → German self-concept	.36*	.36***
German achievement → math self-concept	-.17*	-.17***
Math achievement → German self-concept	-.12*	-.12***
Math achievement → math self-concept	.50*	.50***
German self-concept → German outcome	.44***	.41***
German self-concept → math outcome	-.02	.07*
Math self-concept → German outcome	-.02	.00
Math self-concept → math outcome	.66*	.53***
German unfairness → German self-concept	-.19***	-.19***
German unfairness → math self-concept	.10*	.10**
Math unfairness → math self-concept	-.26*	-.25***
Math unfairness → German self-concept	.10**	.10**
Correlations		
German unfairness ↔ math unfairness	.48***	.48***
German outcome ↔ math outcome	.40***	.56***
German achievement ↔ math achievement	.43***	.43***
Indirect relations		
German unfairness → German self-concept → German outcome	-.08***	-.08***
German unfairness → math self-concept → math outcome	.07**	.05**

(continued)

Math unfairness → math self-concept → math outcome	-.17***	-.13*
Math unfairness → German self-concept → German outcome	.04*	.04**

Notes. *p<.05, **p<.01, ***p<.001

Perceived Teacher Unfairness and Student Motivation in Math and German: An Application of the Generalized Internal/External Frame of Reference Model

Supplementary Files

Table 1
Standardized Path Coefficients and Correlations from GI/E Models with Direct Effects

	Outcome (β-coefficient and 95%-confidence interval in parentheses)		
	Self-concept (Model 1)	Interest (Model 2)	Importance (Model 3)
Achievement as predictor			
German achievement → German outcome	.37* (.30 – .45)	.21* (.13 – .28)	.15* (.08 – .22)
German achievement → math outcome	-.18* (-.24 – -.13)	-.11* (-.17 – -.04)	.01 (-.05 – .08)
Math achievement → German outcome	-.15* (-.21 – -.08)	-.19* (-.26 – -.12)	-.16* (-.23 – -.09)
Math achievement → math outcome	.51* (.46 – .56)	.21* (.13 – .29)	.14* (.07 – .20)
German achievement → German unfairness	-.21* (-.28 – -.14)	-.21* (-.28 – -.15)	-.22* (-.29 – -.15)
German achievement → math unfairness	-.06 (-.13 – .02)	-.06 (-.14 – .02)	-.06 (-.14 – .01)
Math achievement → German unfairness	-.05 (-.11 – .01)	-.05 (-.11 – .02)	-.04 (-.10 – .03)
Math achievement → math unfairness	-.18* (-.25 – -.12)	-.18* (-.25 – -.11)	-.18* (-.25 – -.11)
Unfairness as predictor			
German unfairness → German outcome	-.19* (-.27 – -.11)	-.31* (-.37 – -.24)	-.28* (-.35 – -.20)
German unfairness → math outcome	.10* (.04 – .17)	.15* (.09 – .21)	.07* (.01 – .13)
Math unfairness → German outcome	.10* (.03 –. 17)	.11* (.04 – .18)	.03 (-.05 – .11)
Math unfairness → math outcome	-.26* (-.32 – -.20)	-.36* (-.40 – -.31)	-.31* (-.37 – -.24)

(continued)

Correlations			
German unfairness ↔ math unfairness	.48*	.48*	.48*
	(.39 – .57)	(.40 – .57)	(.40 – .57)
German outcome ↔ math outcome	.18*	.32*	.51*
	(.11 – .25)	(.25 – .39)	(.45 – .57)
German achievement ↔ math achievement	.43*	.43*	.42*
	(.37 – .49)	(.37 – .49)	(.36 – .49)

Notes. GI/E model = Generalized Internal/External Frame of Reference Model.
* $p < .05$.

Table 2

Standardized Path Coefficients and Correlations from GI/E Models with Mediated Effects

	Outcome (β-coefficient and 95%-confidence interval in parentheses)	
	Interest (Model 4)	Importance (Model 5)
Direct paths		
German discrimination → German outcome	-.23*** (-.29 – -.16)	-.20*** (-.28 – -.18)
German discrimination → math outcome	.09 (.03 – .14)	.03 (-.03 – .10)
Math discrimination → German outcome	.07* (-.00 – .14)	-.01 (-.09 – .06)
Math discrimination → math outcome	-.18* (-.24 – -.13)	-.18*** (-.25 – -.11)
German achievement → German outcome	.03 (-.05 – .10)	-.01 (-.08 – .08)
German achievement → math outcome	-.01 (-.07 – .05)	.06 (-.01 – .13)
Math achievement → German outcome	-.11** (-.19 – -.05)	-.11** (-.18 – -.03)
Math achievement → math outcome	-.10* (-.17 – -.04)	-.11** (-.18 – -.04)
German achievement → German discrimination	-.21*** (-.27 – -.14)	-.21*** (-.27 – -.15)
German achievement → math discrimination	-.05 (-.12 – .02)	-.05 (-.12 – .01)
Math achievement → German discrimination	-.05 (-.11 – .02)	-.05 (-.11 – .02)
Math achievement → math discrimination	-.18*** (-.25 – -.12)	-.19*** (-.25 – -.12)
German achievement → German self-concept	.36* (.29 – .43)	.36*** (.29 – .43)
German achievement → math self-concept	-.17* (-.23 – -.11)	-.17*** (-.23 – -.11)
Math achievement → German self-concept	-.12* (-.18 – -.07)	-.12*** (-.19 – -.06)
Math achievement → math self-concept	.50* (.45 – .56)	.50*** (.45 – .56)
German self-concept → German outcome	.44*** (.38 – .50)	.41*** (.34 – .47)
German self-concept → math outcome	-.02 (-.06 – .04)	.07* (.01 – .13)

(continued)

Math self-concept → German outcome	-.02 (-.08 – .05)	.00 (-.06 – .07)
Math self-concept → math outcome	.66* (.61 – .71)	.53*** (.46 – .59)
German discrimination → German self-concept	-.19*** (-.26 – -.12)	-.19*** (-.26 – -.12)
German discrimination → math self-concept	.10* (.03 – .17)	.10** (.03 – .17)
Math discrimination → math self-concept	-.26* (-.32 – -.19)	-.25*** (-.32 – -.19)
Math discrimination → German self-concept	.10** (.02 – .17)	.10** (.02 – .17)
Correlations		
German discrimination ↔ math discrimination	.48*** (.41 – .55)	.48*** (.41 – .55)
German outcome ↔ math outcome	.40*** (.34 – .47)	.56*** (.51 – .62)
German achievement ↔ math achievement	.43*** (.38 – .49)	.43*** (.37 – .48)
Indirect relations		
German discrimination → German self-concept → German outcome	-.08*** (-.12 – -.05)	-.08*** (-.11 – -.05)
German discrimination → math self-concept → math outcome	.07** (.02 – .11)	.05** (.02 – .09)
Math discrimination → math self-concept → math outcome	-.17*** (-.22 – -.13)	-.13* (-.18 – -.10)
Math discrimination → German self-concept → German outcome	.04* (.01 – .08)	.04** (.01 – .07)

Notes. GI/E model = Generalized Internal/External Frame of Reference Model.
Confidence intervals were computed using estimator = ML and type = general.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 3

Goodness-of-fit Indices for the Multilevel GI/E Models with Perceived Math and German Teacher Unfairness as Predictors and Different Criteria Variables

		χ^2	*df*	*CFI*	*TLI*	*RMSEA*
Model	Criteria/Mediators					
1	CFA Self-concept German, math Unfairness German, math Free loadings across levels	196.138*	84	.989	.983	.028
2	CFA Self-concept German, math Unfairness German, math Invariant loadings across levels	204.410*	92	.989	.985	.027
3	GI/E model German, math self-concept on Unfairness German, math / no mediator Invariant loadings across levels Achievement not controlled	204.297*	92	.989	.985	.027
4	GI/E model Self-concept German, math on unfairness German, math / no mediator Invariant loadings across levels Achievement controlled	266.648*	124	.988	.982	.026
5	CFA Interest German, math Unfairness German, math Free loadings across levels	145.886*	48	.987	.975	.035
6	CFA Interest German, math Unfairness German, math Invariant loadings across levels	156.160*	54	.986	.977	.034
7	GI/E model Interest German, math on unfairness German, math / no mediator Invariant loadings across levels Achievement controlled	237.849*	78	.981	.968	.035

(continued)

8	GI/E model Interest German, math on unfairness German, math Invariant loadings across levels Achievement controlled Mediation by self-concept	553.045*	214	.981	.972	.031
9	CFA Importance German, math Unfairness German, math Free loadings across levels	121.333*	48	.991	.983	.030
10	CFA Importance German, math Unfairness German, math Invariant loadings across levels	128.426*	54	.991	.984	.029
11	GI/E model Importance German, math on unfairness German, math / no mediator Invariant loadings across levels Achievement controlled	175.498*	78	.989	.982	.027
12	GI/E model Importance German, math on unfairness German, math Invariant loadings across levels Achievement controlled Mediation by self-concept	497.515*	214	.984	.977	.028

Notes. All models are estimated with the Robust Maximum Likelihood (MLR) estimator; all χ^2 are significant ($p<.05$). *CFA* = confirmatory factor analyses; GI/E model = Generalized Internal/External Frame of Reference Model; *CFI* = comparative fit index; *TLI* = Tucker-Lewis Index; *RMSEA* = root mean square error of approximation; *SRMR* = standardized root mean square residual.

* $p < .05$.

Table 4

Unstandardized Path Coefficients and Correlations from Multilevel GI/E Models with Direct Effects

	Outcome		
	Self-concept	Interest	Importance
Within: student level (L1)			
Achievement as control variable			
German achievement → German outcome	.32*	.22*	.15*
German achievement → Math outcome	-.15*	-.12*	.01
Math achievement → German outcome	-.16*	-.19*	-.12*
Math achievement → Math outcome	.49*	.22*	.17*
German achievement → German Unfairness	-.17*	-.18*	-.19*
German achievement → Math unfairness	-.08*	-.08*	-.08*
Math achievement → German Unfairness	-.06*	-.05*	-.03
Math achievement → Math unfairness	-.14*	-.14*	-.13*
Unfairness as predictor			
German unfairness → German outcome	-.20*	-.31*	-.24*
German unfairness → Math outcome	.14*	.12*	.08
Math unfairness → German outcome	.08*	.12*	.04
Math unfairness → Math outcome	-.27*	-.26*	-.27*
Correlations			
German unfairness ↔ Math unfairness	.24*	.24*	.24*
German outcome ↔ Math outcome	.11*	.20*	.31*
German achievement ↔ Math achievement	.39*	.39*	.39*
Between: classroom level (L2)			
Achievement as control variable			
German achievement → German outcome	.18	.43	.21
German achievement → Math outcome	-.15	.11	.18

(continued)

Math achievement → German outcome	.22	.01	-.36
Math achievement → Math outcome	.16	-.24*	-.34
German achievement → German Unfairness	.07	.10	.11
German achievement → Math unfairness	.31	.27	.29
Math achievement → German Unfairness	.08	.07	.03
Math achievement → Math unfairness	-.20	-.11	-.18
Unfairness as predictor			
German unfairness → German outcome	-.41*	-1.26*	-.89*
German unfairness → Math outcome	.10	.37	.06
Math unfairness → German outcome	.29	-.20	-.28
Math unfairness → Math outcome	-.51*	-1.05*	-.96*
Correlations			
German unfairness ↔ Math unfairness	.01	.01	.01
German outcome ↔ Math outcome	.01	.02	.02
German achievement ↔ Math achievement	.05*	.04	.04

Notes. GI/E model = Generalized Internal/External Frame of Reference Model.
* $p < .05$.

Table 5

Standardized Path Coefficients and Correlations from Multilevel GI/E Models with Mediated Effects

	Outcome	
	Interest	Importance
Within: student level (L1)		
Direct paths		
German unfairness → German outcome	-.19***	-.15**
German unfairness → Math outcome	.06	.03
Math unfairness → German outcome	.07	-.00
Math unfairness → Math outcome	-.12*	-.16***
German achievement → German outcome	.04	.01
German achievement → Math outcome	-.03	.05
Math achievement → German outcome	-.07	-.03
Math achievement → Math outcome	-.03	-.05
German achievement → German unfairness	-.17***	-.17***
German achievement → Math unfairness	-.05	-.07*
Math achievement → German unfairness	-.08*	-.05**
Math achievement → Math unfairness	-.14***	-.15***
German achievement → German self-concept	.31***	.31***
German achievement → Math self-concept	-.14***	-.14***
Math achievement → German self-concept	-.13***	-.12***
Math achievement → Math self-concept	.48***	.48***
German self-concept → German outcome	.51***	.42***
German self-concept → Math outcome	.01	.09**
Math self-concept → German outcome	-.05	-.03
Math self-concept → Math outcome	.57***	.52***
German unfairness → German self-concept	-.19***	-.19***
German unfairness → Math self-concept	.14**	.14**
Math unfairness → Math self-concept	-.26***	-.26***
Math unfairness → German self-concept	.08*	.09*
Correlations		
German unfairness ↔ Math unfairness	.24***	.24***
German outcome ↔ Math outcome	.18***	.29***
German achievement ↔ Math achievement	.39***	.39***
Indirect relations		
German unfairness → German self-concept → German outcome	-.10***	-.08***

(continued)

German unfairness → Math self-concept → Math outcome	.08**	.07**
Math unfairness → Math self-concept → Math outcome	-.15***	-.14***
Math unfairness → German self-concept → German outcome	.04*	.04*
Between: classroom level (L2)		
Direct paths		
German unfairness → German outcome	-1.04**	-.61*
German unfairness → Math outcome	.24	.17
Math unfairness → German outcome	-.32	-.40
Math unfairness → Math outcome	-.39	-.76**
German achievement → German outcome	.58	.08
German achievement → Math outcome	-.16	.21
Math achievement → German outcome	-.02	-.48*
Math achievement → Math outcome	1.32**	-.53**
German achievement → German unfairness	.09	.06
German achievement → Math unfairness	.33*	.31
Math achievement → German unfairness	.06	.03
Math achievement → Math unfairness	-.19	-.23
German achievement → German self-concept	.16	.16
German achievement → Math self-concept	-.16	-.19
Math achievement → German self-concept	.19	.17
Math achievement → Math self-concept	.20	.21
German self-concept → German outcome	.58	.58
German self-concept → Math outcome	-.16	.33
Math self-concept → German outcome	-.02	.05
Math self-concept → Math outcome	1.32**	.66
German unfairness → German self-concept	-.41	-.38*
German unfairness → Math self-concept	.07	.08
Math unfairness → Math self-concept	-.50**	-.47**
Math unfairness → German self-concept	.24	.23
Correlations		
German unfairness ↔ Math unfairness	.01	.01
German outcome ↔ Math outcome	.01	.01
German achievement ↔ Math achievement	.05*	.06*

(continued)

Indirect Relations		
German unfairness → German self-concept → German outcome	-.24	-.22
German unfairness → Math self-concept → Math outcome	.09	.05
Math unfairness → Math self-concept → Math outcome	-.65*	-.31
Math unfairness → German self-concept → German outcome	.14	.13

Notes. GI/E model = Generalized Internal/External Frame of Reference Model.
* $p < .05$, ** $p < .01$, *** $p < .001$.