Reciprocal effects between self-efficacy and achievement in mathematics and reading

Christian Schöber[a,*], Kerstin Schütte[a], Olaf Köller[a], Nele McElvany[b], Miriam M. Gebauer[b]

[a] Leibniz Institute for Science and Mathematics Education (IPN), Olshausenstraße 62, 24098 Kiel, Germany
[b] Center for Research on Education and School Development, TU Dortmund University, Vogelpothsweg 78, 44227 Dortmund, Germany

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ABSTRACT

Academic self-efficacy is widely accepted as being both the cause and effect of academic achievement. However, empirical research using longitudinal data and domain-specific assessments is scarce and seems to be completely absent in domains other than mathematics. We drew on a sample of $N = 1597$ secondary school students in Germany and 2 measurement occasions within 1 school year to test for reciprocal effects between self-efficacy and achievement in the domains of mathematics and reading. Despite high stabilities of achievement and self-efficacy, structural equation modeling revealed positive effects of mathematics self-efficacy on later mathematics achievement and of reading achievement on later reading self-efficacy. Evidence for reciprocal effects resulted in the domain of reading from separately considering students with and without a migration background in multiple group models. The findings highlight the necessity of early interventions and a domain-specific approach.

1. Introduction

As students our job is to learn and acquire new skills and knowledge. But does it matter whether or not students are confident dealing with requirements made in school? Originally introduced by Albert Bandura as part of the social cognitive theory (Bandura, 1977, 1986, 1997), academic self-efficacy is defined as "personal judgments of one's capabilities to organize and execute courses of action to attain designated types of educational performances" (Zimmerman, 1995, p. 203). It is hypothesized that academic self-efficacy influences students' level of effort, persistence, and their choice of activities (Bandura, 1977)—as a consequence, higher academic achievement can be expected from students with higher self-efficacy than from students with lower self-efficacy.

At the same time, enactive mastery experience is considered to be the strongest source of self-efficacy (Bandura, 1997), that is, high academic achievement strengthens students' judgments of their capability to deal with future performance requirements. Academic self-efficacy is thus considered both the cause and effect of academic achievement. However, the validity of this reciprocal relationship has not yet been rigorously tested because existing research either employed cross-sectional data (e.g., Diseth, Danielsen, & Samdal, 2012; Høigaard, Kovač, Øverby, & Haugen, 2015; Skaalvik, Federici, & Klassen, 2015) or lagged non-repeated measures of self-efficacy and

achievement, respectively (e.g. Caprara, Vecchione, Alessandri, Gerbino, & Barbaranelli, 2011; Ferla, Valcke, & Cai, 2009; Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2014; also see the meta-analyses of Valentine & Dubois, 2005; Valentine, Dubois, & Cooper, 2004). Furthermore, results were not unequivocally in support of a reciprocal relationship. In the absence of longitudinal studies (i.e., repeated concurrent measurement of both constructs), empirical support for the hypothesized reciprocal relationship is still deficient. Moreover, existing research often comprised investigations on a domain-general level (e.g., Galla et al., 2014) or in a single academic domain, namely mathematics (e.g., Hannula, Bofah, Tuohilampi, & Metsämuuronen, 2014). Whether or not the specific academic domain moderates the postulated relationship between self-efficacy and achievement is thus an unresolved question. Consequently, the literature on the widely shared belief in reciprocal relations between self-efficacy and achievement is inconclusive.

In a similar vein, research is scarce regarding a potentially moderating role of student characteristics. Educational research has raised awareness of the students with a migration background who mostly lag behind their peers without a migration background (Organisation for Economic Co-operation and Development [OECD], 2013). In addition to assessing these groups' characteristics, investigating the processes possibly underlying divergent outcomes is warranted. It is unclear whether a migration background (and associated differences to students

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without a migration background like, for example, a mother tongue other than the language of instruction) affects self-efficacy's relationship to achievement in the respective academic domain. It is conceivable that a migration background differentially impacts relations across domains (i.e., it might be especially significant in the domain of reading). Establishing the role of self-efficacy beliefs for achievement in the respective academic domains is a necessary step to incorporate them in supporting these students' educational outcomes.

The goal of this article is to contribute empirical evidence on the hypothesized reciprocal relationship between self-efficacy and achievement in different domains. To this end, we conducted an investigation of the relationship between self-efficacy and achievement in the domains of mathematics and reading as assessed at the beginning and towards the end of a school year in early secondary school. We drew on a sample that comprised a large number of students with a migration background to test whether students' migration background moderated how self-efficacy and achievement were related in both domains. Thus, we add to existing research by being, to the best of our knowledge, the first to investigate the relationship between self-efficacy and achievement in the domain of reading in a repeated measurement design. Moreover, we contribute results on this relationship across domains—that might be differentially affected by students' migration background—from the same sample.

In the remainder of this introduction we briefly delineate competing models regarding the relationship between self-beliefs and achievement. We then review empirical results on this relationship before contemplating possible differences between students with and without a migration background regarding this relationship.

1.1. Relationship between academic self-beliefs and achievement

Academic achievement has often been related to self-beliefs, with self-concepts and self-efficacy being the most important self-beliefs. Self-concepts include cognitive and affective appraisals of the self in contrast to self-efficacy, which only includes cognitive appraisals. Self-concepts are past-oriented and relatively stable, whereas self-efficacy is future-oriented and relatively malleable (see Bong & Clark, 1999; Bong & Skaalvik, 2003, for comparisons). Both should be assessed on a domain-specific level (Bong, Cho, Ahn, & Kim, 2012; Pajares, 1996) in order to obtain valid results. In a meta-analysis, both constructs showed discriminant validity as predictors of achievement, but self-efficacy had a higher incremental validity than self-concept (Huang, 2011). Due to self-efficacy's malleability, educators might have a notable influence on the development of students' academic self-efficacy (see Pajares, 1996; Schunk & Pajares, 2009, for overviews).

Three models that assume causal relationships between self-beliefs and achievement have been discussed in the literature (Calsyn & Kenny, 1977). The *skill development model* implies that students' self-efficacy in a specific domain will become higher, the higher their achievement in the same domain is. Enactive mastery experience is considered the most powerful source of self-efficacy: One's own success or failure is assumed to have a longer-lasting influence than vicarious experience, verbal persuasion, or physiological and affective states (Bandura, 1997; Usher & Pajares, 2008) and can even abrogate these other sources of information (Bandura, 1997). For example, verbal persuasion may be useless if it is followed by contradictory enactive mastery experience. The primacy of enactive mastery experience supports the idea of a causal influence of achievement on future self-efficacy because successful behavior should lead to an improvement in the corresponding self-efficacy whereas failure should diminish it. Thus, the skill development model represents the influence of enactive mastery experience on self-efficacy. According to this model, self-efficacy does not have a causal effect on later achievement.

In contrast, the *self-enhancement model* signifies that students' high self-efficacy in a specific domain enhances their achievement in that domain, but that achievement level does not influence the development

of self-efficacy. Galla et al. (2014) confirmed Bandura's (1977) claim that academic self-efficacy has a positive influence on the effort students make and, thereby, on their achievement. They found that students' scores in standardized reading and mathematics tests were higher the higher their self-reported academic self-efficacy was; this effect was mediated by the students' level of effortful engagement in academic situations, as rated by their teachers. Thus, academic self-efficacy is one important precursor of engagement; engaging in effortful learning behavior, in turn, leads to higher academic achievement.

The *reciprocal effects model* (REM) of causal relationships, which was promoted by Marsh (1990), integrates the causal relationships proposed by the aforementioned models; it hypothesizes that self-beliefs and achievement mutually reinforce each other. This view is consistent with Bandura's (1997) assertion that self-efficacy is both a cause and an effect of achievement.

1.2. Empirical results regarding the relationship between self-beliefs and achievement

Evidence for prospective relationships was shown in meta-analyses controlling for prior levels of self-beliefs or prior achievement (Valentine et al., 2004; Valentine & Dubois, 2005). The path coefficient from achievement to later self-beliefs ($\beta = .15$)—the positive causal relationship proposed by the skill development model—was about twice as high as the path coefficient from self-beliefs to later achievement ($\beta = .08$)—the causal relationship proposed by the self-enhancement model (Valentine & Dubois, 2005). However, in these meta-analyses, various constructs were included as measures for self-beliefs (self-esteem, self-concept, and self-efficacy) and achievement (grades, standardized test scores, and attainment). In addition, academic domains were not examined separately, so that these meta-analyses do not speak to their results' validity within any particular domain or across domains.

Mittag, Kleine, and Jerusalem (2002) tracked the development of domain-general academic self-efficacy and achievement in the three main subjects in German secondary school from Grade 7 to Grade 10 with annual measurements. They did not find support for a reciprocal relationship between a general measure of academic self-efficacy and an aggregated measure of academic achievement, but they found evidence to support the self-enhancement model (i.e., positive path coefficients from academic self-efficacy to later academic achievement) from Grade 7 to Grade 8 and from Grade 9 to Grade 10.

Likewise, Hwang, Choi, Lee, Culver, and Hutchison (2016) tracked students in Korea from Grade 8 to Grade 12 and investigated their academic self-efficacy and achievement with 1-year intervals. They revealed consistent reciprocal effects between achievement and later academic self-efficacy (βs from .36 to .44) and between academic self-efficacy and later achievement (βs from .13 to .14). As was the case with the meta-analytical results, because these studies investigated self-efficacy on a domain-general level and the achievement measures comprised several domains, the reported effects cannot be applied to any specific domain.

Williams and Williams (2010) tested the reciprocal relationship between mathematics self-efficacy and mathematics achievement in 33 countries and found supporting evidence in 24 of those countries. However, due to the cross-sectional nature of their data set, cross-lagged effects between self-efficacy and achievement could not be modeled.

First evidence based on longitudinal data within the mathematics domain corroborated reciprocal effects between self-efficacy and achievement (Hannula et al., 2014). Hannula et al. (2014) surveyed students over 7 years until the end of Grade 9, with intervals of at least 3 years between the measurements. In their study, the self-enhancement path from self-efficacy to achievement was stronger when students were older ($\beta = .16$ between Grade 3 and Grade 6, and $\beta = .26$ between Grade 6 and Grade 9), whereas the skill development path