

Reciprocal Associations Between Students' Mathematics Anxiety and Achievement: Can Teacher Sensitivity Make a Difference?

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Students' mathematics anxiety is closely related to poor report card grades and low scores on standardized mathematics tests – but what is cause, what is consequence and how can teachers intervene?

Mathematics anxiety is a problem for many secondary school students worldwide, and the accompanying concerns (= worry as cognitive component) and unpleasant affective reactions (= emotionality as affective component) threaten their well-being ([PISA 2015](#)). An extensive body of studies has found a negative correlation between anxiety and concurrent mathematics achievement (for a comprehensive overview, see this [review article](#)). However, the question as to which causes which cannot clearly be answered. Furthermore, the question of how teachers' instructional behavior could reduce anxiety and its negative consequences remains open and was addressed in our study.

How do anxiety and achievement affect each other?

According to the *disruption account*, anxiety leads to lower performance because the rumination and negative thoughts going along with it are supposed to distract attention and expend working memory resources. In contrast, the *reduced competency account* suggests that students with early deficits in basic numerical functions repeatedly experience failures and, hence, perceive themselves as incapable of mastering mathematics-related tasks (a more detailed discussion of theoretical models can be found [here](#)). These ideas are illustrated in Figure 1.

Prior research aiming to provide insights in the longitudinal interplay between mathematics anxiety and achievement in children and adolescents has yielded inconsistent results: Studies using questionnaires of mathematics anxiety that measured the cognitive and the affective components, but did not distinguish between the two, showed reciprocal links. Conversely, investigations focusing only on emotionality found prior achievement to predict this facet of mathematics anxiety, but not the other way around. Drawing on the disruption account, we hypothesized that these contradictory findings were because the worry, rather than the emotionality component, would be associated with lower performance making it

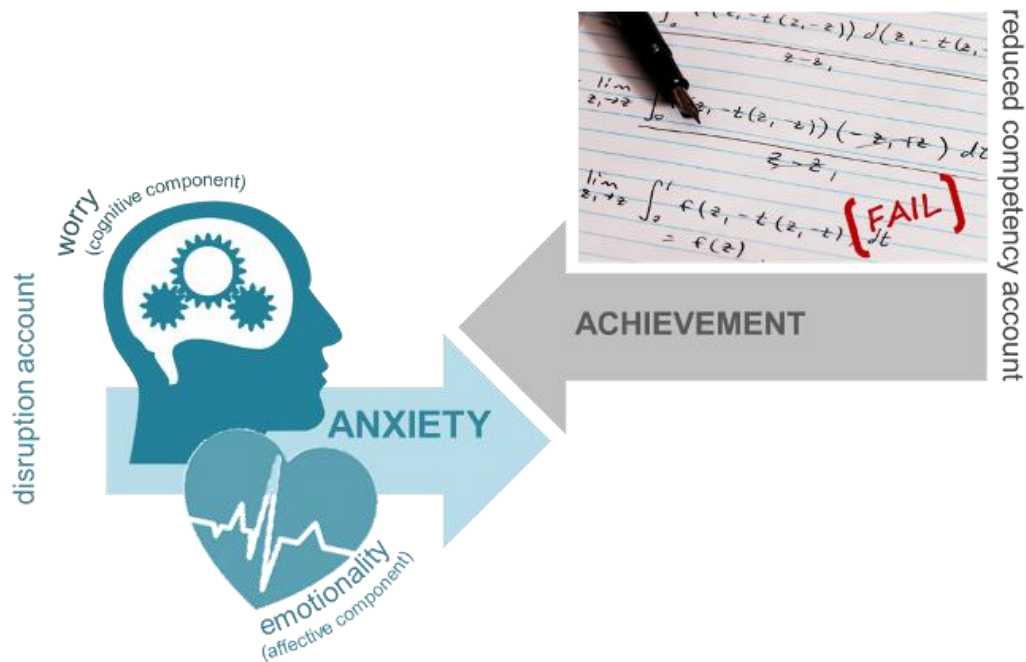


Figure 1: Reciprocal association between students' mathematics anxiety and achievement

worthwhile to simultaneously consider the two facets of mathematics anxiety and their differential relationships with achievement. This knowledge is vital for designing targeted interventions. If worry cognitions predicted lower performance, it would be vital to change dysfunctional cognitions, whereas adopting relaxation techniques would be more helpful if physiological and affective arousal were the reason for reduced mathematics achievement.

What can teachers do?

Considering the negative association between mathematics anxiety and achievement, it is important to intervene in this potential downwards spiral. A prominent theory of students' achievement emotions – the [control-value theory](#) – proposed that students' control and value appraisals are proximal antecedents of students' emotions and that the social context, for example, teachers' instructional quality, is a central predictor of these cognitions. In this regard, especially 'teacher sensitivity' (that is, teachers' awareness of students' academic difficulties and emotional needs) could be a resource. For instance, noticing when students are afraid, frustrated, or sad can allow teachers to show empathy and provide sensitive, encouraging feedback to help students regulate their emotions. Furthermore, realizing when students are struggling with understanding new content, following the classroom discourse, or solving tasks, can enable teachers to adjust their instruction to give students a sense of control and competence.



Studies that have examined teachers' general instructional quality (e.g., clarity, pacing) and investigations focusing on teachers' sensitivity for *learning difficulties*, more specifically, have suggested that teachers are a source of support for math-anxious students. However, even though it seems plausible that teacher sensitivity – *for emotions* in particular – would help alleviate mathematics anxiety, this aspect of teacher sensitivity has been neglected in prior research. Therefore, there is still limited empirical evidence addressing the question as to whether teachers' sensitivity not only for subject-related issues, but also for their students' emotional lives can make a difference for student development (this article argues for the relevance of [teachers' emotional and social competence](#)). These insights could inform teacher educators about the extent to which learning opportunities should more strongly emphasize emotional aspects.

How did we investigate our research questions?

The [present study](#) drew on longitudinal data from 1,559 secondary school students. In the fifth, sixth, and seventh grades, they reported on their mathematics anxiety in terms of worry (e.g., “Before taking a math test, I am worried about forgetting everything I learned”) and emotionality (e.g., “I get nervous when I ask something in math course”), and on their mathematics teachers' sensitivity (e.g., “My math teacher realizes when there's something I don't understand.”, “My math teacher doesn't notice when I'm afraid”). Furthermore, students completed standardized mathematics tests and report card grades were included as an additional indicator of achievement. Finally, to obtain a comprehensive picture, parents also rated their children's anxiety. This allowed us to investigate, for example, whether the potentially negative consequences of low achievement or of an insensitive teacher were also visible for others – and not only perceived by the students themselves.

What did we find?

Reciprocal associations between anxiety and achievement

In our analyses we used so-called latent cross-lagged panel models to test whether students' worry and emotionality predicted changes in students' test scores and mathematics grades from one school year to the next. At the same time, we also analyzed the reverse paths (i.e., achievement predicting changes in anxiety). Results showed that students reporting more worry and emotionality achieved lower learning gains in the following school year, as measured by standardized achievement tests and grades. Reciprocally, lower achievement predicted subsequent anxiety. Overall, the associations with achievement were more pronounced for worry cognitions than for emotionality. These findings indicate that both the 'disruption' and the 'reduced competency' accounts play a role in secondary school students' mathematics anxiety: Students who worry about mathematics perform worse, perhaps, because these cognitions interfere with their working memory capacities; at the same time, low achievement puts students a risk for experiencing more anxiety.

The role of teacher sensitivity

Regarding the question of how to intervene in this process, we found that students reporting high teacher sensitivity in Grade 6 experienced a decrease in their mathematics anxiety compared to Grade 5. The same was true for teacher sensitivity in Grade 7 and changes in anxiety from Grade 6 to Grade 7. However, students who reported more teacher sensitivity in Grade 5 did not have lower levels of concurrent worry or emotionality. Notably, the results were almost identical when parents reported on anxiety.

In sum, these results show that teachers can help reduce anxiety, but that their role may differ depending on students' developmental stage. After the transition to secondary school, which takes place after Grade 4 in Germany where the study was conducted, other factors may play a role, such as the new peer group and altering achievement standards. The fact that results were similar with parent-reported anxiety is remarkable because it reveals that they are able to notice reductions in worry and emotionality when their children perceive the teacher to respond sensitively to emotional and academic needs.

Finally, we explored whether teacher sensitivity could alleviate the negative relationship between low achievement and anxiety. Put differently, does teacher sensitivity contribute to closing the gap between students at risk and those with more beneficial prerequisites? We did not find evidence for this idea, which means

that low achieving or highly anxious students do not profit more from teacher sensitivity than their peers. Rather, sensitivity is similarly effective for all students.

What does our work imply for teachers and school practice?

Before discussing practical implications from our study, we would like to acknowledge some limitations that should be considered when interpreting our findings. First, relationships between anxiety, achievement, and teacher sensitivity may depend on, for example, students' class level or the school system. Second, causal inferences, in particular regarding the role of teacher sensitivity, should be drawn with caution. Due to our design, we cannot rule out that change in anxiety caused students to perceive their teachers' sensitivity more positively than the other way around.

Regardless of these limitations, this study clearly emphasizes that mathematics anxiety is an important factor for secondary school students' educational pathways: Over time, experiencing worries and negative affective responses in mathematics can reduce achievement and, at the same time, low performance will further increase mathematics anxiety. Considering the substantial number of students experiencing mathematics anxiety, it is highly relevant to find ways for exiting this downwards spiral.

We conclude that it is worthwhile to consider teacher sensitivity as one potential resource for preventing mathematics anxiety. To improve teacher sensitivity, teacher education and professional development may want to put stronger emphasis on knowledge and skills that will enable empathy and the consideration of students' needs, such as teachers' social-emotional competence. Importantly, other school-related outcomes (e.g., student engagement, interest, and self-concept) could profit from this step as well. Yet, it would be exaggerated to say that teacher sensitivity is the sole key for intervening in students' mathematics anxiety. In particular for students with severe symptoms, other strategies, such as individualized learning programs or emotion regulation trainings may be necessary (this article includes an overview of [potential treatments](#)).

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