The Effectiveness of a Utility-Value Intervention in Math Classrooms: A Cluster-Randomized Trial

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Abstract

Background

Many adolescents do not see the relevance of mathematics for their lives, and on average, their perceived value of mathematics decreases throughout secondary school (e.g., Watt, 2004). Drawing on expectancy-value theory of achievement motivation (Eccles et al., 1983), utility-value interventions aim at fostering the perceived relevance of the course material to students' lives. These interventions have shown a high potential to foster students' motivation and achievement (Lazowski & Hulleman, 2016).

Objective

Yet, further research is warranted to test how such interventions can be successfully implemented in the classroom setting. In this study, we therefore tested the effectiveness of a utility-value intervention in ninth-grade mathematics classroom. This intervention was previously shown to promote students' value beliefs, competence beliefs, effort, and achievement when implemented by researchers (Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015). We therefore wanted to test whether the positive effects of the intervention can be replicated when the intervention is implemented by master's students or by the regular math teachers.

Setting, Participants, & Research Design

Data for the study were collected in 78 ninth grade classrooms out of 28 academic track schools in Baden-Württemberg in Germany. The sample size was based on a power analysis for a multisite cluster-randomized trial. Within each school, the participating teachers (N = 70) and their

classrooms were randomly attributed to one of the two intervention conditions or a waiting control condition. Students' participation was voluntary. A total of 1,744 students (53.8% female) participated in the study. Students' mean age was 14.63 years (*SD* = 0.48) at the beginning of the study. The study design and the analyses were preregistered (see https://osf.io/d4vp9/?view_only=bcf08d5118f449d49ae2b0572089ddd5).

Intervention

The intervention consisted of a 90-min lesson on the relevance of mathematics, which was implemented during regular math class. It included a psychoeducational presentation for the whole class (about 45 minutes) and relevance-inducing tasks for individual students (about 40 minutes). In this task, students were given six interview quotations of young adults related to the relevance of mathematics and were asked to evaluate and rank these quotations. Intervention materials were based on the efficacy study and subsequently optimized. The intervention materials were identical for both intervention conditions.

The six master's students (five female, one male) who delivered the intervention were trained as part of a two-semester course on motivation interventions. They received intensive practical training on how to deliver the intervention in the classroom, a script with detailed notes for the presentation and got feedback on their presentation in individual training sessions.

Teachers assigned to the intervention by teacher condition were asked to participate in a three-hour workshop in small groups. They were provided with all necessary intervention materials including a script with detailed notes for the presentation. One teacher assigned to this condition declined to participate in the workshop and thus did not deliver the intervention. However, we included this classroom in our analyses to estimate intention-to-treat effects.

Data Collection and Analysis

The study consisted of three waves of data collection (see Table 1). Student questionnaires at pretest, posttest and follow-up assessed students' value beliefs (i.e., intrinsic value, attainment value, utility value, cost), competence beliefs (i.e., self-concept, self-efficacy), and effort in math. All scales were validated in prior studies (e.g., Gaspard, Dicke, Flunger, Schreier, et al., 2015; Guo et al., 2016) and consistent (α = .72-.93). At the pretest and the follow-up, students worked on a standardized speed test, which is a good proxy for students' achievement in longer assessments (Ennemoser, Krajewski, & Schmidt, 2011; Schmidt, Ennemoser, & Krajewski, 2013). Finally, the teachers rated the individual students' effort on two items at each time point (α = .75-.80; Guo et al., 2016).

Two observers attended each intervention and rated the implementation fidelity of the intervention. Overall, the intervention was implemented as planned in both conditions, with the observers noting only very few deviations from the standardized procedure. Regarding adherence, the observers reported that teachers as well as master's students followed the script closely (teachers: *M* = 7.29, *SD* = 1.34; master's students: *M* = 9.05, *SD* = 0.55, on a scale from 1 = *the instructor did not follow the script at all* to 10 = *the instructor followed the script almost word for word*).

To evaluate the effects of the intervention on different outcomes, we conducted two-level regression analyses with the students at Level 1 and classrooms at Level 2 in Mplus 7.31. The clustering of classrooms within schools was accounted for using the design-based correction of standard errors. To estimate the effects of the intervention, we used two dummy variables indicating the two intervention conditions as compared to the control condition. In line with our power analysis, we included the pretest score for the respective variable as a covariate in these analyses. As preregistered, we additionally included those variables (i.e., intrinsic value, cost, self-concept, self-efficacy, effort, math speed test, previous math grades, gender, teacher-rated effort) as covariates for which we found differences between the experimental conditions before the intervention ($\delta > 0.05$).

Results

For utility value, we found positive effects of both intervention conditions at the posttest and the follow-up, although the effects at the follow-up were smaller and only significant when using one-tailed testing as preregistered. No effects on attainment value were observed. For intrinsic value, against our hypotheses, we found a negative effect of the master's student condition at the follow-up. Additionally, students in both intervention conditions reported higher cost at both the posttest and the follow-up as compared to the control condition. No effects of the two intervention conditions on self-concept, self-efficacy, and self-reported effort were observed. Teachers in classes in which they delivered the intervention rated their students' effort as higher at the posttest (using one-tailed testing) as compared to the control condition, but not at the follow-up. Finally, we found that students in the master's student condition showed higher performance on the math speed test at the follow-up as compared to the control condition (using one-tailed testing as preregistered). The effect of the teacher's condition, however, was not significant.

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Table 1

Overview of the Measurement Waves and their Time Points

Pretest (T_1)	Intervention	Posttest (T_2)	Follow-Up (T_3)
October 2017	November 2017	December 2017	February/March 2018
Student questionnaires Math test Teacher ratings	Implementation fidelity (assessed by observers)	Student questionnaires Teacher ratings	Student questionnaires Math test Teacher ratings