Abstract Title Page

Title: To What Extent Does the Responsive Classroom Approach Modify Fifth Grade Students' Efficacy and Anxiety in Mathematics and Science?

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Abstract Body

Background / Context:

American students show declines in mathematics and science achievement between fourth and eighth grade and lag behind peers in other industrialized countries (Gonzales et al., 2008), suggesting a need to better understand factors that might boost achievement in these areas. Students' self-efficacy, or belief in their ability to be successful, has important implications for their perseverance in difficult academic tasks (Bandura, 1986). Research has shown mathematics self-efficacy to be a strong predictor of students' mathematics achievement (Meece, Wigfield, & Eccles, 1990; Pajares & Graham, 1999; Pajares & Kranzler, 1995; Pajares & Miller, 1994) as well as their decisions to enroll in future mathematics coursework (Meece et al., 1990). Some evidence suggests a similar importance of self-efficacy in science to students' engagement and performance (Pintrich & DeGroot, 1990; Simpson & Oliver, 1990); however, this link has been less well-established in science than in mathematics.

Bandura (1986; 1997) suggested that emotional states are important contributing factors to self-efficacy. When students experience negative emotions such as anxiety in the presence of academic tasks, they often interpret the emotional response to mean they will not perform well. This negative relationship between anxiety and self-efficacy has been observed specifically with regard to mathematics and science (Britner & Pajares, 2006; Stevens, Olivarez, & Hamman, 2006; Usher & Pajares, 2008). These findings imply that teachers can enhance self-efficacy in mathematics and science by creating a classroom emotional climate that facilitates students' abilities to manage their negative emotional reactions to these subjects.

Social contexts such as classrooms and schools play an important role in either enhancing or decreasing students' anxiety. Social and Emotional Learning (SEL) interventions have been designed to give teachers skills to both meet students' emotional needs and create classroom environments that are responsive to students' social and emotional needs. Although such interventions have been well-studied in relation to social, emotional, and academic outcomes (Durlak, Weissburg, Dymnicki, Taylor, & Schellinger, 2011), little work has examined how SEL interventions attenuate strong negative feelings about mathematics and science. The present study addresses this issue by examining the impact of the *Responsive Classroom® (RC)* approach on students' self-efficacy and anxiety in relation to mathematics and science, and specifically, the extent to which the presence of this intervention attenuates the link between anxiety and self-efficacy.

The *RC* approach is a Social and Emotional Learning intervention designed to create a classroom environment conducive to learning. Specifically, teachers are taught how to interact with students and facilitate interactions in order to create a comfortable classroom environment so that students can take the risks that are necessary to learn. For example, one of the principles of the *RC* approach is a focus on the process of learning, not only the product. This principle and the way that teachers embody this approach in classroom practices (e.g., showing sensitivity to students even when they make mistakes) may support students' engagement in learning and comfort with taking academic risks and making mistakes. Our hypothesis stems from literature on the important role that teachers play in creating warm and supportive classroom environments. Specifically, we expect that students in schools utilizing the *RC* approach may be better able to manage their anxiety and thereby maintain their self-efficacy in the face of challenging academic subjects such as mathematics and science. In contrast, we expect that

students in schools that do not utilize the *RC* approach may be less capable of reducing their anxiety and feeling self-efficacious in these challenging academic subjects.

Purpose / Objective / Research Question / Focus of Study:

The current analyses address two primary research aims: 1) Does students' anxiety in mathematics and science predict their self-efficacy in each subject area? We hypothesized that students' anxiety in mathematics and science would be negatively associated with their self-efficacy in each area. 2) Does being in an *RC* school moderate the relationship between students' anxiety and self-efficacy in mathematics and science? Our hypothesis was that being in an *RC* school would serve to attenuate the typically negative relationship between students' anxiety and their self-efficacy in mathematics and science.

Setting:

The present findings are situated within a three-year longitudinal cluster randomized control trial, the Responsive Classroom Efficacy Study (RCES). Twenty-four schools were selected for the study and randomized into intervention and control conditions at the school level. From those 24 schools, 20 (12 intervention, 8 control) schools participated in the Mathematics Learning Study (MLS) involving child-level data collection on student perception of mathematics and science, as reported here. All students enrolled in fifth grade mathematics instruction were included in the sample. Comparison schools used "business as usual" approaches to social and emotional learning and classroom management, as described through principal interviews and questionnaires.

Population / Participants / Subjects:

Participants included 1561 fifth graders (50% boys; $n = 1440$ reporting gender) representing 62 classrooms. Approximately half of the students were at schools implementing the *RC* approach ($n = 797$; 51%). Schools were sociodemographically diverse, with percent free and reduced lunch ranging from 2% to 83% ($M = 31\%$), and percent English Language Learners ranging from 6% to 76% ($M = 32\%$) during the 2009-2010 academic year, one year prior to the data collection year for the present study.

Intervention / Program / Practice:

RC was designed as an approach to elementary teaching that integrates social and academic learning in order to create classroom learning environments that enhance students' abilities to learn effectively (Northeast Foundation for Children (NEFC), 2010). There are seven guiding principles of *RC* that together emphasize the importance of the classroom social context for learning, the processes of learning as opposed to solely the products, and positive relationships between teachers and their students, students' families, and other adult school-based professionals. *RC* aims to improve students' outcomes by way of teachers' implementation of certain practices, including (but not limited to): regular, structured class meetings designed to be fun and intellectually engaging; an established proactive approach to handling rules and consequences for behavior; procedures that offer academic choice to children; a focus on children's attention on the process of learning, problem-solving, and reflecting on their work; and specific methods for introducing new materials to students

Training for teachers implementing *RC* involves two weeklong institutes, *Responsive Classroom I* and *Responsive Classroom II*, run by NEFC staff (consulting teachers). Following

the *Responsive Classroom I* institute, NEFC staff offer ongoing coaching and one-day workshops to implementing teachers.

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Research Design:

Data for the present study were taken from the third year of data collection of the 3-year longitudinal cluster randomized trial of the *RC* approach.

Data Collection and Analysis:

All students in participating fifth grade classrooms (20 of the 24 RCES study schools that agreed to participate in this phase of data collection) were administered questionnaires in the fall of 2010. Using instructions provided by our study team, teachers administered the Self-efficacy and Anxiety Questionnaire to their classes at a time that was convenient for them, typically before the start of math class. Students typically took five minutes to complete the questionnaire.

Measures

Self-efficacy and Anxiety Questionnaire. Students were administered a set of 20 items pertaining to their self-efficacy and anxiety in mathematics and science. To assess students' self-efficacy beliefs, five items were adapted from the Academic Efficacy subscale of the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000). Wording was modified slightly to make the items specific to both mathematics and science, yielding a total of 10 items (example item: "I know I can learn the skills taught in math this year"). Scores on each set of 5 items were averaged to create a self-efficacy mean score for mathematics and science, with α=.82 for mathematics and α=.84 for science in the current sample. To measure students' feelings of anxiety, five items were adapted from the Student Beliefs about Mathematics Survey (Kaya, 2008; Owens et al., 2007). Wording was again modified to reflect mathematics and science, yielding 10 total items (example item: "I feel nervous when I do math because I think it's too hard"). Scores were averaged to create a mean mathematics anxiety and mean science anxiety score, with α=.61 for mathematics and α=.62 for science in the current sample. The original response scales also were modified so that all of the current items were on a uniform 4-point scale (*1=almost never, 2=sometimes, 3=most of the time, 4=almost all of the time*).

Data Analytic Plan

Descriptive statistics and bivariate correlations were used to examine model assumptions and associations among study variables. Analyses were conducted using Hierarchical Linear Modeling (HLM; Raudenbush & Bryk, 2002) given that the data were structured such that students were nested within schools. Multi-level modeling in HLM serves to account for shared variance at the school level when estimating effects. Intraclass correlations (ICCs) were 1% and 5% for science and mathematics self-efficacy, respectively.

To answer our first research question, we analyzed two multi-level models. Students' self-reported self-efficacy in either science or served as the dependent variable. Students' anxiety in either mathematics or science was entered as a predictor at Level 1. Gender also was entered here as a covariate. No predictors were entered at Level 2; this level was only included to account for shared variance at the school level.

Models for the second research question were identical to those for the first, except both school *RC* treatment assignment (dichotomously-coded) and a covariate for the percentage of students received free/reduced price lunch (FRPL) at that school during the preceding school year (i.e. when the participating students were in fourth grade) were entered at Level 2. To test the significance of *RC* in moderating the relationship between students' anxiety and self-efficacy,

RC treatment assignment also was entered at Level 2 as a predictor of the slope of the relationship between anxiety and self-efficacy.

Analyses were conducted in HLM 6.06 software (Raudenbush, Bryk, & Congdon, 2004) using full maximum likelihood estimation. All continuous predictors were grand mean centered.

Findings / Results:

Correlations and descriptive statistics for all study variables can be found in Table 1.

RQ1: In support of our first hypothesis, students' anxiety in math negatively predicted their self-efficacy in math (β = -.48, $p < .001$), when controlling for gender. A similar relationship was observed between students' anxiety and self-efficacy in science (β = -.53, $p < .001$; gender controlled). Model 1 shows that gender and anxiety explain 22% of the total variance in math self-efficacy, and 27% of the variance in science self-efficacy. See Table 2.

RQ2: Consistent with our second hypothesis, a significant cross-level interaction emerged between school *RC* treatment assignment and students' mathematics anxiety in predicting students' mathematics self-efficacy. Probing of the interaction indicated that the negative relationship between anxiety and self-efficacy was weakened in *RC* schools relative to control schools. A graphical depiction of this interaction can be seen in Figure 1. A significant cross-level interaction also emerged between school *RC* treatment assignment and students' science anxiety in predicting students' self-efficacy in science. Probing suggested a similar pattern for science, and a graphical representation of this interaction is found in Figure 2.

Conclusions:

As expected, fifth graders who reported being more anxious about science or mathematics also reported less self-efficacy in each subject. Our results corroborate existing evidence linking the experience of subject-specific anxiety to reduced efficacy in that subject area (Usher & Pajares, 2008), and extend these findings to elementary students. Findings also shed light on the relationship between anxiety and self-efficacy specific to science, an association that has been underexamined in science compared to mathematics.

Critically, *RC* moderated the relationship between anxiety and self-efficacy such that for students in an *RC* school, the typically strong, negative association between anxiety and self-efficacy was attenuated. These results suggest that *RC* teacher practices are effective in creating safe and supportive classrooms contexts where students can better maintain feelings of efficacy despite experiencing anxiety in mathematics and science. Being in an *RC* classroom has been associated with students' enhanced positive perceptions of their classroom environment (Brock, Nishida, Chiong, Grimm, & Rimm-Kaufman, 2008); thus, the current findings suggest the role of the *RC* approach in encouraging students' emotional adjustment in mathematics and science, both challenging content areas garnering national attention.

Two limitations require mention. First, current findings involve reliance on child self-report, particularly with regard to anxiety where reliability is moderate. However, student perceptions have been linked with social and academic outcomes, suggesting their usefulness as a lens on school experience (Battistich, Schaps, & Wilson, 2004). Second, current findings involve inferences about the mechanism involved in attenuating anxiety. Additional work (perhaps using mixed methods approaches) is needed to further examine the mechanism by which *RC* weakens the link between anxiety and self-efficacy in science and mathematics. Nonetheless, the current findings suggest that the *RC* approach holds promise in promoting positive emotional adjustment for students in academic areas often linked to anxiety.

Appendices

Appendix A. References

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Appendix B. Tables and Figures

Table 1

Descriptive Statistics and Correlations for Study Variables

Variable	1	2	3	4	5	6	7
School-level Predictors and Covariates							
1. Treatment assignment (0=control)	--						
2. Percent Free/Reduced Price Lunch	0.22**	--					
Child-level Predictors and Covariates							
3. Gender (0=boys)	0.07**	0.05	--				
4. Math Anxiety	0.09**	0.14**	0.10**	--			
5. Science Anxiety	0.10**	0.19**	0.14**	0.50**	--		
Outcomes							
6. Math Self-efficacy	-0.04	-0.07**	-0.04	-0.46**	-0.22**	--	
7. Science Self-efficacy	-0.04	-0.14**	-0.06*	-0.22**	-0.51**	0.53**	--
N	20[+]	20[+]	1440	1528	1539	1531	1543
M	0.51	30.45	0.50	1.74	1.73	3.28	3.30
SD	0.50	24.43	0.50	0.57	0.57	0.59	0.60
Min	0	2.29	0	1.00	1.00	1.20	1.00
Max	1	83.27	1	4.00	4.00	4.00	4.00

*p<.05; **p<.01

[+] indicates a school-level sample size

Table 2

Hierarchical Linear Modeling Predicting Mathematics and Science Self-Efficacy

Model 1:		Mathematics Self-Efficacy			Science Self-Efficacy		
Fixed Effects	Parameter	Coefficient	SE		Coefficient	SE	
Intercept, β_{0j}	*γ00*	3.28***	0.02		3.30***	0.02	
Slope of Gender, β_{1j}	*γ10*	0.01	0.03		0.01	0.03	
Slope of Anxiety[a], β_{2j}	*γ20*	-0.48***	0.03		-0.53***	0.03	
Random Effects		σ^2	τ	χ^2	σ^2	τ	χ^2
Unconditional Model		.339	.004	37.69	.343	.019	105.05
Conditional Model		.268	.001	28.90	.261	.004	40.17
Model 2:		Mathematics Self-Efficacy			Science Self-Efficacy		
Fixed Effects	Parameter	Coefficient	SE		Coefficient	SE	
Intercept, β_{0j}	*γ00*	3.27***	0.03		3.28***	0.03	
Treatment assignment	*γ01*	0.01	0.03		0.03	0.04	
FRPL	*γ02*	0.00	0.00		0.00	0.00	
Slope of Gender, β_{1j}	*γ10*	0.01	0.03		0.01	0.03	
Slope of Anxiety[a], β_{2j}	*γ20*	-0.53***	0.04		-0.59***	0.04	
Interaction term	*γ21*	0.10*	0.05		0.12*	0.05	
Random Effects		σ^2	τ	χ^2	σ^2	τ	χ^2
Conditional Model		.267	.001	30.16	.260	.003	38.37

*p<.05; **p<.01; ***p<.001

Note: FRPL = Percentage free and reduced price lunch.

[a]Mathematics anxiety was entered when the outcome was mathematics self-efficacy, and science anxiety was entered when the outcome was science self-efficacy.

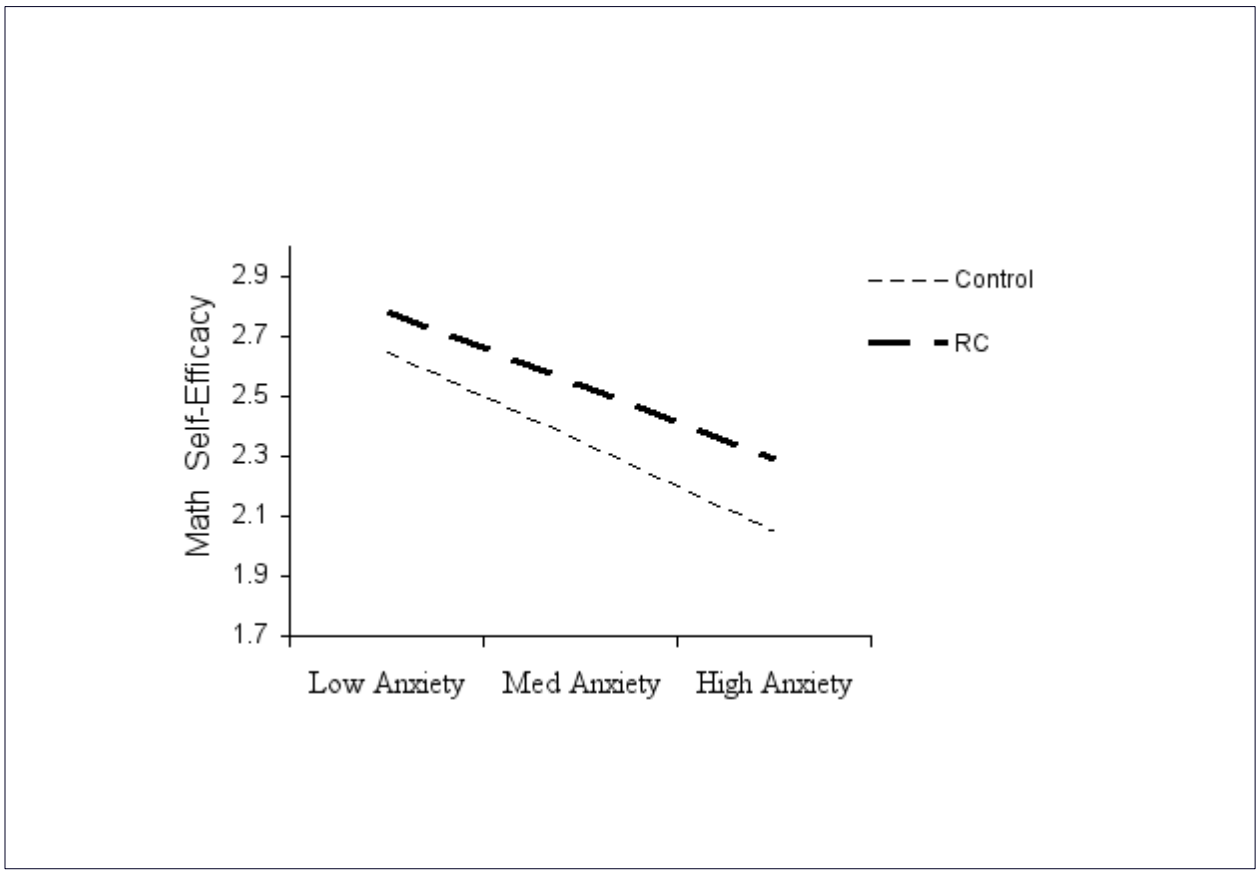

Figure 1. *RC* attenuates the relationship between mathematics anxiety and mathematics self-efficacy.

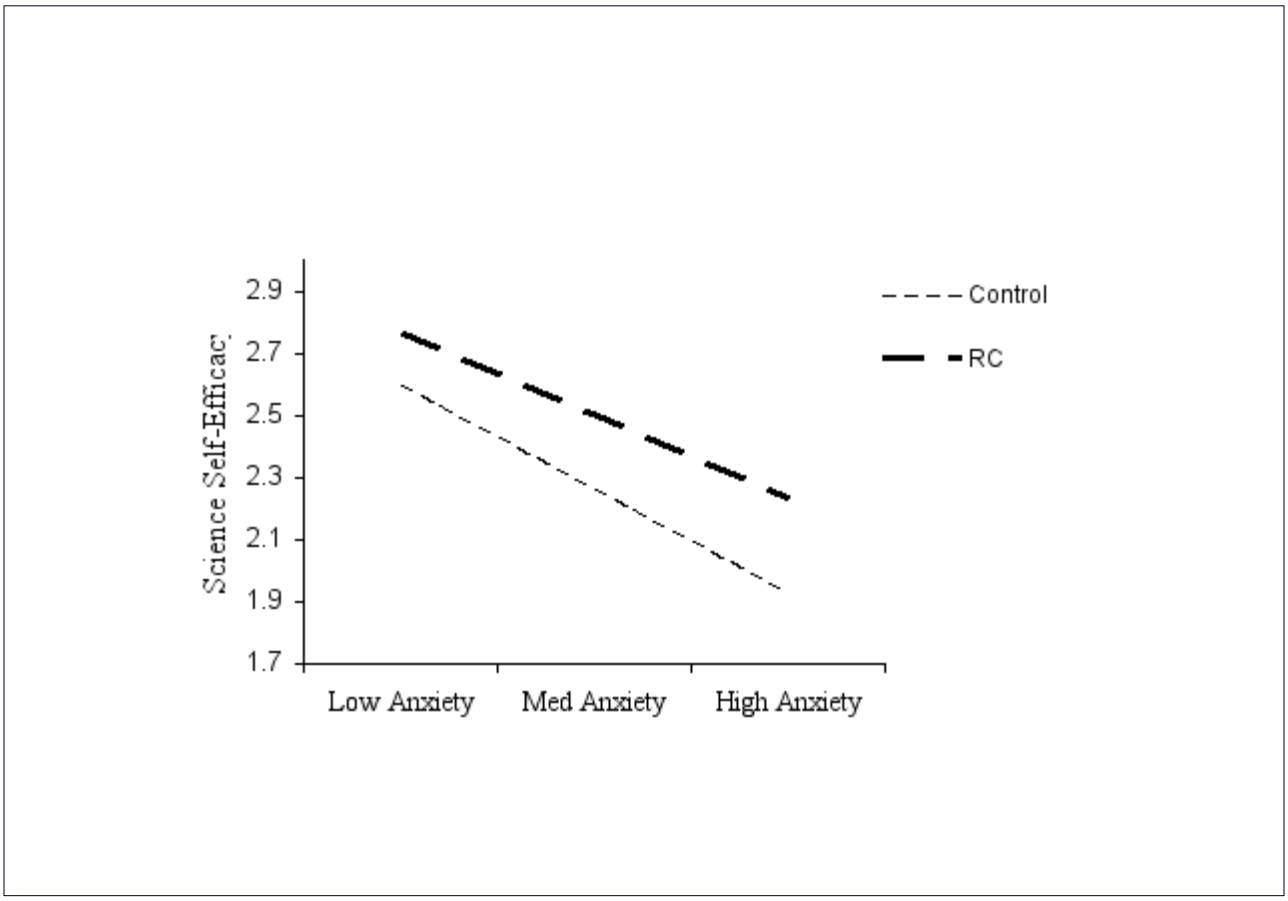

Figure 2. *RC* attenuates the relationship between science anxiety and science self-efficacy.