Exploring the Correlations Among Creativity, Grit, and Mathematics Achievement in Socioeconomically Diverse Schools

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Introduction and Purpose

Mathematics achievement is typically measured by tests of analytical thinking. Within the theoretical framework of triarchic thinking/successful intelligence, creative and practical thinking are also likely correlates of student achievement (Sternberg, 2006, 2009; Sternberg & Rainbow Project, 2006).

Successful mathematical thinkers need more than rote knowledge and memorization; they must also possess the creative and practical skills necessary to solve real world problems (Schommer-Aikins et al., 2005; Sternberg, 2007).

The purpose of this study was to investigate the predictive relationship between grit, general creativity, mathematical creativity, and mathematics achievement—each representing an area of Sternberg's (1984) triarchic model. We also sought to determine whether students' reports of their own grit and creativity differed as a function of gender and ethnicity.

Method

Participants and Data Sources

Participants were 2,421 students (49% girls) in Grades 4-8 from three elementary schools and four middle schools in an eastern central U.S. city. Two of the elementary schools and one of the middle schools have greater than 50% of the student population who qualify for free or reduced lunch (from 54% to 89%). The remaining schools were socioeconomically diverse with between 30% and 46% of the students qualifying. School records identified the students as 56% White, 27% Black/African-American, 10% Hispanic/Latino, 3% Asian, and 4% other. Participants completed a survey of mathematics and reading attitudes, which included the measures described below.

- **Grit** was assessed students' perceptions of their ability to persevere in spite of obstacles. Ten items were adapted from an existing measure of grit (Duckworth & Quinn, 2009). Sample item: "Once I make a commitment, I keep it."
- **General creativity** was assessed with two subscales based on Sternberg's (2000) conceptualization of general creativity. The Creative Self-Concept subscale consists of 4 items (e.g., "I often do creative work"). The Divergent Thinking subscale consists of 9 items (e.g., "I am able to see problems in new ways").
- **Mathematical creativity** was assessed with 6 items adapted from Renzulli et al. (2009). Sample item: "I enjoy challenging math puzzles, games, or logic problems."
- **Mathematics achievement** was measured in two ways: teacher assessment of competence in mathematics and mathematics report card grade.

Analyses

We used zero-order correlations to examine bivariate relationships among the variables. Two multiple linear regression models were used to test the predictive relationship of grit, general creativity, and mathematical creativity on teacher rating of competence in math (Model 1) and on math report card grade (Model 2). Analysis of variance was used to test for mean differences in the independent variables as a function of gender and ethnicity. By examining these variables among diverse students, we hope to identify areas of intervention for students at risk of academic disengagement.

Results

Table 1
Means, Standard Deviations, and Reliability for Study Variables

Variable	*N*	*Mean*	*SD*	*α*	Possible Range	Observed Range
Grit	2418	4.62	.89	.85	1-6	1-6
Creative Self-Concept	2421	4.79	1.15	.87	1-6	1-6
Divergent Thinking	2420	4.56	.94	.82	1-6	1-6
Mathematical Creativity	2418	4.38	1.07	.84	1-6	1-6
Teacher Rating of Competence	2570	4.36	1.37	---	1-6	1-6
Math Report Card Grade	2671	85.28	10.72	---	0-100	19-100

Key Findings: Relationships

- All variables were significantly related to one another (see Table 2). Self-reported grit and creativity were strongly related.
- Results of the first and second regression models showed that grit and mathematical creativity were positively related to teachers' ratings of their students' math competence. Divergent thinking was negatively related to both outcomes (see Table 3).
- Students' creative self-concept was unrelated to achievement in math.

Table 2
Zero-Order Correlations for the Variables in the Study

Measure	*1*	*2*	*3*	*4*	*5*
1. Grit	--				
2. Creative Self-Concept	.49*	--			
3. Divergent Thinking	.68*	.61*	--		
4. Mathematical Creativity	.45*	.30*	.47*	--	
5. Teacher Rating	.15*	.06*	.09*	.25*	--
6. Math Report Card Grade	.23*	.07*	.09*	.24*	.52*

*$p < .01$

Table 3
Regression Results for the Prediction of Math Achievement

	Model 1 Teacher Rating of Competence in Math		**Model 2** Math Report Card Grade	
Variable	*B*	95% CI	*B*	95% CI
Grit	.11*	[.08,.25]	.29*	[2.76,4.10]
Creative Self- Concept	-.01	[-.07,.05]	.00	[-.45,.47]
Divergent Thinking	-.10*	[-.23,-.05]	-.21*	[-3.09,-1.7]
Mathematical Creativity	.26*	[.26,.38]	.21*	[1.61,2.52]
R^2	.07		.10	
F	42.92*		60.71*	

*$p < .01$, *B* = standardized beta

Key Findings: Mean Differences

- Girls were significantly higher in grit and creative self-concept than were boys, and girls earned higher grades in math than did boys. There were no gender differences in divergent thinking or mathematical creativity (see Table 4 for ANOVA results).
- Students from different ethnic groups differed in creative self-concept and mathematical creativity, but not in grit or divergent thinking. Asian students were highest in mathematical creativity (4.52), followed by Black/African-American (4.48), White (4.39), other (4.29), and Hispanic/Latino (4.10) students. The highest mean scores for creative self-concept were among students in the "other" ethnicity category (4.95) followed by White (4.87), Black/African-American (4.77), Asian (4.62), Hispanic/Latino (4.58) students.
- The largest mean differences were observed in student achievement in math. In terms of their report card grades, Asian students had the highest grades (89.37) followed by White (86.01), Hispanic/Latino (85.88), African American (83.83), and other-ethnicity (81.09) students.

Table 4
Analysis of Variance by Gender and Race/Ethnicity

Variable	Gender	Ethnicity
Grit	$F(1,2400) = 13.44$ $p < .001$	$F(4,1719) = 1.97$ $p = .10$
Creative Self-Concept	$F(1,2399) = 37.97$ $p < .001$	$F(4,1718) = 3.01$ $p = .02$
Divergent Thinking	$F(1,2400) = .57$ $p = .45$	$F(4,1719) = 1.6$ $p = .17$
Mathematical Creativity	$F(1,2395) = 2.23$ $p = .14$	$F(4,1719) = 4.06$ $p < .01$
Teacher Rating	$F(1,2541) = 2.04$ $p = .15$	$F(4,1719) = 11.92$ $p < .001$
Math Report Card Grade	$F(1,2662) = 63.94$ $p < .001$	$F(4,1943) = 8.70$ $p < .001$

Conclusion

- Grit and creativity are both correlates of mathematics achievement that have implications for teaching practice. The ability to persevere in spite of obstacles may be a character trait or a skill that can be nurtured through educational intervention. Creative problem-based mathematics teaching strategies may engage students at a deeper level and lead to higher math achievement. African Americans, for example, trail significantly in actual mathematics achievement, but express high levels of mathematical creativity. Promoting both grit and mathematical creativity would be of benefit to all students.
- Divergent thinking is often touted as a 21st century skill. However, in schools, divergent thinkers are less likely to be perceived as competent by their math teachers and receive significantly lower grades. It may be that creative thinkers have a tendency towards nonconformity, which is not rewarded in large public school systems. Future research should empirically address this disconnect between divergent thinking and academic achievement.
- Research to benefit at-risk students might focus on interventions that target creativity and promote grit as variables that may be related to the achievement gap in mathematics.

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