How Can We Motivate Autistic Students In High School Math?

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Introduction

• The path to higher education and careers after high school is difficult for autistic students, even for those with strong skills

• Mathematics is an area of higher interest for autistic students, but they are less likely to have academic results that reflect their abilities and are less inclined to pursue math after high school

• **Understanding the motivation behind autistic students' math success, especially given prevalent math stereotypes for this group, may help inform interventions to improve these outcomes**

• Expectancy-value theory of motivation has been used to predict students' outcomes and understand their choices in education, including high school mathematics

• While a variety of populations have been examined through this lens, it has not yet been used for autistic students. In light of the characteristics of these students, we may expect these variables to work differently for them

• **Since it is well known that some autistic students are high achievers in subjects involving math, we expect a wider math score distributions when compared to other disabilities, and we believe it important to separate analysis into two groups based on score**

Methods

Data
• High School Longitudinal Study of 2009, nationally representative data on high school students who graduated in 2013, n=11,000

Model & Variables
• The Eccles Expectancy-Value Model of Activity Choices (EVT) was used as the theory to develop a path diagram for predicting mathematics success (operationalized as final Math GPA)
• Motivation factors of expectancies and subjective task value were operationalized via standardized composite scores of math self-efficacy and math identity (which combine to approximate the expectancy factor) and math utility and math interest (which combine to approximate the subjective task value factor)

Analysis
• Distribution of 9th grade math scores for autistic students first analyzed to find potential grouping
• We computed the mean and SD for the full sample of students [n=11,000], used these to create z-scores, and examined the distribution of these scores among autistic students. The median was -0.5 SD. We divided the sample into two groups, those below and above this value.
• Separate multivariate linear regressions were run for each group.
• Resulting coefficients were compared and tested with Chow F-Tests and interacted models were tested using Fisher F-Tests of nested models
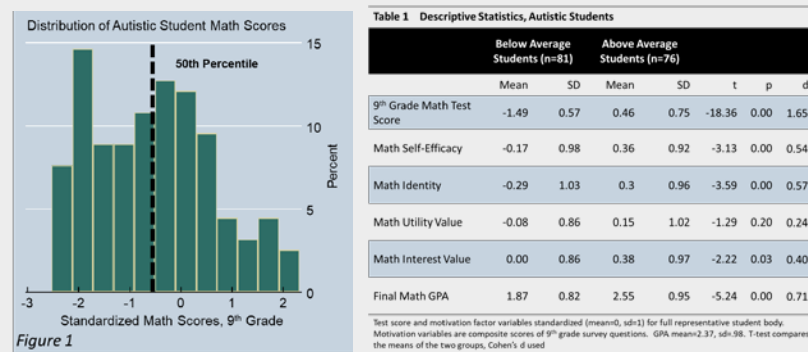
Figure 1

Table 1 Descriptive Statistics, Autistic Students

	Below Average Students (n=81)		Above Average Students (n=76)				
	Mean	SD	Mean	SD	t	p	d
9th Grade Math Test Score	-1.49	0.57	0.46	0.75	-18.36	0.00	1.65
Math Self-Efficacy	-0.17	0.98	0.36	0.92	-3.13	0.00	0.54
Math Identity	-0.29	1.03	0.3	0.96	-3.59	0.00	0.57
Math Utility Value	-0.08	0.86	0.15	1.02	-1.29	0.20	0.24
Math Interest Value	0.00	0.86	0.38	0.97	-2.22	0.03	0.40
Final Math GPA	1.87	0.82	2.55	0.95	-5.24	0.00	0.71

Test score and motivation factor variables standardized (mean=0, sd=1) for full representative student body. Motivation variables are composite scores of 9th grade survey questions. GPA mean=2.37, sd=.98. T-test compares the means of the two groups, Cohen's d used

Research Questions

1. What are the levels of different types of motivation for the two groups? Do they differ?
2. What are the most important motivational predictors, net of prior test score, of math achievement (final GPA) for each group? Do they differ?
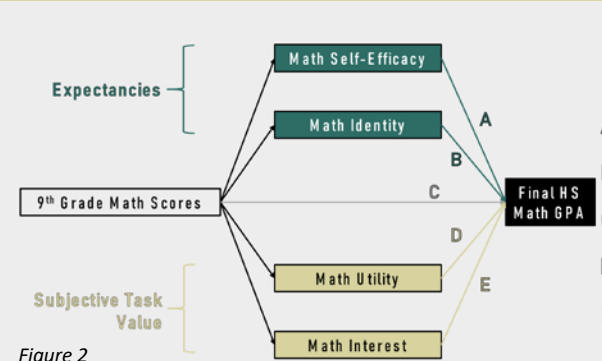3. What are the implications for interventions to assist autistic students to succeed at math?

Figure 2

Table 2 Regression Coefficients
Motivation Predictors of Final High School Math GPA for Autistic Students

	Below Average Students	Average and Above Students	Difference
A	Math Self-Efficacy	0.43**	0.19	0.24
B	Math Identity	-0.04	0.36**	-0.40*
C	9th Grad Math Test Score	0.00	0.16	-0.16
D	Math Utility Value	-0.17	-0.26*	0.09
E	Math Interest Value	-0.21	0.14	-0.35*

Standardized coefficients. Difference column significance determined from Chow F-Test
*p<.05
**p<.01

Results

Group Descriptive Comparison
• The students with above average 9th grade test scores showed higher measures of math self-efficacy, math identity (both a little more than one half of a standard deviation difference), and math interest value (a little less than one half of a standard deviation difference).
• Final math GPA was also higher for the higher test score group
• Of the four motivation factors, the expectancy variables (self-efficacy and identity) showed the largest group differences [Cohen's d].

Test Scores
• With the motivational variables in the equation, math test score relationship with 12th grade GPA was insignificant for both groups. Note that this is in strong contrast to its strong predictive ability for non-autistic students (comparison data not presented here).

This indicates that the motivational variables fully mediate the relationship between prior test scores and final GPA

Expectancy Variables
• Math self-efficacy was the strongest and only statistically significant predictor of final math GPA in the group of autistic students with below average test scores
• However, this variable yielded a positive, but statistically insignificant coefficient for the above average test score group

• Math identity was the strongest and most statistically significant predictor for autistic students with above average test scores
• However, this variable produced only a small, negative, and insignificant coefficient for students with below average scores

• Testing for a significant difference between coefficients across groups using Chow F-tests shows that the coefficients for math identity are significantly different.

Subjective Task Value Variables
• Math interest value was significantly different between the two groups, but did not have a large effect for either
• When comparing models by groups using Chow F-tests, however, we can be confident that the coefficients do differ between groups (note that the most significant model still differs by math identity alone and not math interest)
• Math utility produces a negative coefficient for both groups, with the effect being significant for the above average group

Discussion & Questions

• We have found that elements of EVT have good predictive power for math GPA outcomes, even after controlling for prior math test scores. However, the predictive elements differ between the below average and above average performing students. For the below average performing students, math self-efficacy is the most powerful predictor of final GPA. For the above average students, the most powerful predictor is math identity. Thus, these are important mediating variables between prior math test ability and subsequent math GPA.

• The importance of math self-efficacy for below average performing students may make sense because these students need to feel that math is doable for them in order to put forward the effort to attain a higher GPA. For the above average students, however, math identity may be the most important since these students are higher achievers and the more strongly this becomes a part of their identity, the higher their GPA.

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• Subjective task value measures overall fail to positively predict final high school math outcomes. In fact, utility value may show a negative impact.

How do autistic students value high school mathematics for their futures and in their lives?
Why might utility have no effect, or a negative effect, on their final GPA?
Is this evidence against value-based interventions for autistic students?

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• Expectancy measures, on the other hand, appear to be the most relevant for autistic students in math. Beliefs in their own math ability (self-efficacy) likely have a strong, positive predictive effect on their performance for the lower test score group.

Should we intervene to improve self-efficacy for these students? How?

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• Math identity may have the most interesting interpretation, with a strong predictive effect for the above average students alone, as well as a strong, convincing difference between groups.

Can (or should) positive math identities be fostered in autistic students to improve their academic outcomes?

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