NATIONAL MATH + SCIENCE INITIATIVE

RESEARCH REPORT 2016-002

Student Math Self Perceptions: Summary of Survey Responses from the Laying the Foundation Program

Julia Phelan
University of California, Los Angeles

Marsha Ing
University of California, Riverside

July 2016

TABLE OF CONTENTS

ABSTRACT

Long-term persistence in STEM fields depends on students acquiring a solid foundation in math and science. Math and science achievement alone, however, does not fully account for the low persistence often seen in STEM fields. Research suggests that other factors such as students' self-perceptions can influence persistence in STEM fields. This study explored math self-perceptions of eighth and tenth graders enrolled in Algebra I or Algebra II. Teachers of these students participated in the Laying the Foundation (LTF) professional development program. Findings are consistent with other research which suggests that there is a relationship between student self-perceptions and interest in math.

INTRODUCTION

The underlying goals of this project were to continue the collaboration between the Alabama State Department of Education (ALSDE), the National Math + Science Initiative (NMSI) and A+ College Ready to assess the impact of Laying The Foundation-infused courses on student achievement as measured by ACT's ASPIRE assessments. The study focused on student outcomes in mathematics and ELA in grades 8 and 10, and science in grade 8 in the 51 schools.

In 2015-2016 a new cohort of teachers (Cohort VIII) joined 118 Alabama high schools in the ALSDE/A+ College Ready Program (using the Laying the Foundation lessons). The LTF initiative includes comprehensive teacher training and student support to boost enrollment and success in Advanced Placement (AP®) courses in mathematics, science and English, and the rigorous courses that lead up to AP. The overarching study (of which one component will be described here) was designed to explore student outcomes in the Cohort VIII schools (including feeder schools) of the LTF initiative in mathematics, English and science.

Schools invited to become ALSDE/A+ College Ready Cohort VIII Schools agreed to embrace an ambitious plan to train teachers, implement rigorous CCRS-aligned courses, establish vertical team meetings, change policies and procedures and share data to better prepare students and teachers for success in a college readiness and the AP program.

In order to gather data on implementation of the LTF curriculum we developed a set of surveys, online teacher logs as well as observation protocols. Included in these measures were a student survey designed to measure students' self-perceptions and interests. Specific versions of the surveys were created to focus on English, science and math and in this report we present descriptive analyses of the student self-perception surveys focused on perceptions about math.

The design of the self-perception survey was grounded in the expectancy-value theory of achievement motivation. This theory incorporates people's beliefs about how well they will do on the task and the extent to which they value the task (Atkinson, 1957; Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983; Wigfield, 1994; Wigfield & Eccles, 1992, 2000). The theory includes three interrelated constructs: ability belief, expectancy, and value. Ability belief and expectancy are both related to an individual's perceptions of how they do on a task or in a particular subject area currently (ability) or in future (expectancy). Value includes "attainment value or importance, intrinsic value, utility value or usefulness of the task and cost" (Wigfield & Eccles, 2000, p. 72). Variation in children's ability-expectancy beliefs is domain specific (Eccles et al., 1983; Wigfield et al., 1991). For example, positive beliefs about ability beliefs and values in mathematics are different from ability beliefs and values in art.

In studies specific to math and science, research indicates a positive association between perceived values/ability and achievement in mathematics and science (Wigfield et al., 1991), as well as participation in out-of-school mathematics and science activities (Simpkins, Davis-Kean, & Eccles, 2006), and intention to enroll in mathematics and science courses (Atwater, Wiggins, & Gardner, 1995). In other words, those students who see themselves as being good at math, or expect to do well and continue studying math, tend to have higher achievement and participation in math-related activities than those who do not see themselves so.

This particular theory of achievement-motivation informs our work through its emphasis on student beliefs about whether they can and want to learn math and whether they see themselves as having a job in the future which utilizes math-specific learning. This framework is particularly applicable to middle school students' perceptions as this is a critical time for making decisions such as which high school science courses to enroll in and in which extracurricular activities they participate (Wigfield et al., 1997).

Self-perceptions about math ability and value will also likely impact students' persistence at learning math and their choices related to career interests. Identifying and better understanding these perceptions may in turn help us successfully invite more students to learn math and consider math-related careers.

METHODOLOGY

Packages with 40 paper copies of the student surveys were mailed to participating mathematics teachers in the fall (2015) and spring (2016). Teachers administered and returned the surveys once complete. Of the 49 teachers with signed letters of agreement, 36 teacher returned their student surveys in the fall (73%, n = 889 student surveys) and 14 teachers returned student surveys in the spring (29%, n = 310 student surveys). The number of student surveys returned per teacher ranged from 7 to 89. On average, approximately 25 surveys per teacher were returned. Thirty-six teachers requested feedback on their fall student surveys and were sent a two-page summary (Appendix A) in February 2016.

The student surveys included questions about students' math self-perceptions (such as how much they like doing math), opportunities to learn math (such has whether they solve problems in different ways) and aspirations in math (such as whether they want to take more math courses in high school). What we report in this technical report does not include all of the items that were included in the survey or in the two-page summary given to teachers. Instead the data included in this technical report are based on the items that were selected after initial analyses. We excluded, for example, items that did not show much variation in responses or did not correlate highly with the other variables.

Self-Perceptions: The first 10 items focused on students' mathematics self-perceptions (Table 1). Survey items were based on the expectancy-value achievement motivation theory framework (described above) which suggests that student performance and persistence are influenced by students' beliefs in their abilities and the extent to which they value the activities in which they (Atwater et al., 1995; Simpkins et al., 2006; Wigfield et al., 1991). The original items included four response options (strongly disagree, disagree, agree, strongly agree). However, due to skewed distributions, with most students selecting disagree or agree across most items (rather than the more extreme response options), we collapsed the response options from four to two. The two response options are agree (1) which included agree and strongly agree and disagree (0) which included disagree and strongly disagree. A composite score to indicate math self-perceptions was created by summing scores on these ten dichotomous items (maximum score is 10; fall: M = 5.35, SD = 2.45; spring: M = 5.59, SD = 2.59).

Opportunity to Learn: In addition to the self-perception items, the survey included items focused on students' perceived opportunities to learn (OTL) mathematics. The OTL mathematics items were from the PISA student questionnaire (Table 2). Similar to the rationale for dichotomizing the self-perception items, these OTL items were also collapsed to dichotomous response options (disagree, agree). A composite score which summed the dichotomous items was used to represent student-perceived opportunities to learn mathematics (maximum score is 10; fall: M = 6.16, SD = 2.17; spring: M = 6.62, SD = 2.24).

Student Interest in Math: The three items related to students' interest in mathematics were:

- I would like to work in a career involving mathematics
- I would like to take more mathematics courses in high school
- I would like to study mathematics after high school

Similar to the rationale for dichotomizing the self-perception and OTL items, these items were collapsed to dichotomous response options (disagree, agree). A composite score to indicate interest in mathematics was created by adding scores for these three items.

Linear regression analyses were conducted to explore the relationship between perceived opportunities to learn math, math self-perceptions and interest in math.

Student self-perceptions were similar in the fall and spring (Table 1). Based on the composite score for student self-perceptions, there were no gender differences in the fall, $t(887) = 1.26$, $p = .21$, or spring, $t(308) = 0.98$, $p = .33$. There were also no differences based on ethnicity for either the fall, $t(887) = 1.63$, $p = .10$, or spring, $t(308) = 0.69$, $p = .49$.

Table 1. Descriptive statistics for math self-perception items.

	Fall		Spring	
	M	SD	M	SD
I am good at math.	0.85	0.36	0.79	0.41
Compared to other students in my class, I am one of the best in math.	0.48	0.50	0.48	0.50
Compared to my other school subjects, I am better at math.	0.47	0.50	0.44	0.50
I expect to do well in math this year	0.93	0.26	0.88	0.32
I am good at learning new things in math.	0.76	0.43	0.75	0.43
What I learn in math is useful outside of math class.	0.54	0.50	0.55	0.50
For me, being good at math is very important.	0.85	0.36	0.85	0.36
Working on math assignments is very interesting.	0.42	0.49	0.37	0.48
I really like doing math.	0.50	0.50	0.49	0.50

Student perceived opportunities to learn were similar in the fall and spring (Table 2). There were no gender or ethnicity-based differences in perceived opportunities to learn.

Table 2. Descriptive statistics for math OTL items.

	Fall		Spring	
	M	SD	M	SD
My teacher asks questions that make me reflect on the problem.	0.70	0.46	0.74	0.44
My teacher gives problems that require me to think for an extended time.	0.72	0.45	0.75	0.43
My teacher asks me to decide on my own procedures for solving complex problems.	0.45	0.50	0.54	0.50
My teacher presents problems for which there is no immediately obvious method of solution.	0.52	0.51	0.58	0.50
My teacher presents problems in different contexts so that students know whether they have understood the concepts.	0.79	0.41	0.77	0.43
My teacher helps me to learn from my mistakes.	0.82	0.39	0.81	0.40
My teacher asks me to explain how I solved a problem.	0.75	0.43	0.75	0.43
My teacher presents problems that require me to apply what I have learned to new contexts.	0.88	0.33	0.84	0.37
My teacher gives problems that can be solved in different ways.	0.81	0.39	0.83	0.38

Fewer than half of the students expressed interest in a career that required some math and wanting to take more math classes after high school (Figure 1). Percentages were similar for both surveys (fall and spring). 51% of students expressed interest in wanting to take more math in high school and percentages were similar for the fall and spring survey responses.

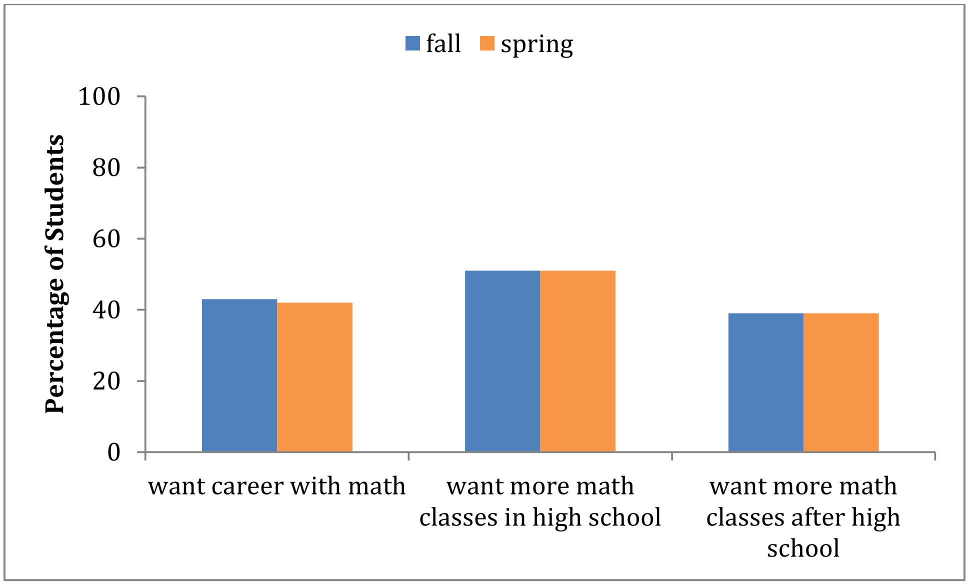


Figure 1. Self-reported student interest in math.

There were positive and significant correlations between student self-perceptions and interest in math for the fall (*r* = .62) and spring (*r* = .63) survey responses.

Regression analyses suggest that self-perceptions and opportunities to learn math relate to student interest in math (Table 3). However, when considering both variables, perceived OTL math was not a significant predictor. Although these analyses do not include classroom or teacher predictors such as teacher implementation of the professional development program, these models cluster standard errors to account for the nested structure of the data.

Table 3. Summary of regression analysis predicting student interest in math based on spring data

	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Perceived opportunities	0.12	0.02	0.21**				0.02	0.02	0.04
Self-perceptions				0.30	0.02	0.63**	0.29	0.02	0.62**
R^2	0.07			0.42			0.42		
	$F(3, 13) = 32.74$**			$F(3, 13) = 138.62$**			$F(4, 13) = 99.28$**		

*$p < .01$. **$p < .001$.

Additional models were run to look at the relationship for teachers with student survey data at both time points. The relationships were similar between self-perceptions and interest in math for the reduced sample of teachers. In addition, controlling for average classroom level of interest seen in the fall surveys, there was still a significant relationship in the spring between self-perceptions and interest in math.

DISCUSSION & CONCLUSIONS

Findings suggest a positive relationship between students' math self-perceptions and interest in math. Students' perceptions of themselves in math may influence whether they want to learn more math in the future and ultimately pursue careers in math. These findings also suggest that although perceived opportunities to learn math are important for students wanting to learn more math, the relationship between these variables is influenced by student self-perceptions. In other words, students might report positive experiences in learning math but if they do not perceive math to be useful and valuable to their lives, they are not likely to show interest in math.

There are several limitations of these findings. First, we were not able to link student responses in the fall and spring. Thus, while the fall and spring samples come from the same population of Alabama teachers who participate in the professional development program, the students of those teachers might change from the fall to the spring. This limits our ability to discuss growth or change between the fall and spring. To attempt to address this limitation, we ran analyses for teachers with student responses in both the fall and spring (and found similar relationships between the variables) but we do not have student-level information to compare how the same students responded in the fall and spring.

Second, we were also not able to link student responses to administrative and student outcome data. Without this information, we could not validate student reports of gender, ethnicity, or student math achievement. We were not able to confirm whether students who reported a particular ethnicity are also categorized similarly in the district administrative records. We were also not able to confirm whether students who reported that they were good at math were actually the same students who received high grades in math or who had high scores on standardized math achievement measures. In addition, we were not able to confirm how students interpreted the survey items (for example, through cognitive interviews or classroom observations). Without being able to validate the data, the self-report nature of the study data is limiting.

Finally, although we statistically adjusted for differences between classrooms, these analyses do not include classroom or teacher-level characteristics that might help explain the variation between classrooms. This is due in part to the low completion rates compared to other classroom measures (such as teacher surveys, logs, observations). This limits our ability to attribute differences in student interests to specific teacher characteristics (such as how well the teacher implemented the professional development program).

Despite these limitations, self-perceptions should be considered when trying to understand the context in which the professional development is implemented. For example, teachers who are teaching math in a classroom where a greater proportion of students report high self-perceptions in math might have a different classroom environment than teachers who are teaching math in a classroom where a larger proportion of students report low self-perceptions. Self-perceptions might have indirect relationships with important student outcomes such as achievement and persistence in STEM careers. Since teachers have influence on both learning activities and students' sense of self as a math learner, these results underscore the importance of preparing teachers to foster student desire to learn more math in the future.

REFERENCES

1. Atkinson, J. W. (1957). Motivational determinants of risk taking behavior. *Psychological Review*, *64*, 359-372.
2. Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 74-146). San Francisco, CA: W. H. Freeman.
3. Wigfield, A. (1994). Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review*, *6*(1), 49-78.
4. Wigfield, A., & Eccles, J. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review*, *12*(3), 265-310.
5. Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, *25*(1), 68-81.
6. Wigfield, A., Eccles, J., Mac Iver, D., Reuman, D., & Midgley, C. (1991). Transitions at early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school. *Developmental Psychology*, *27*(4), 552-565.
7. Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivations: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology*, *42*(1), 70-83.
8. Atwater, M. M., Wiggins, J., & Gardner, C. M. (1995). A study of urban middle school student with high and low attitudes toward science. *Journal of Research in Science Teaching*, *32*(6), 665-677.
9. Wigfield, A., Eccles, J. S., Yoon, K. S., Harold, R. D., Arbreton, A., Freedman-Doan, K., & Blumenfeld, P. C. (1997). Changes in children's competence beliefs and subjective task values across the elementary school years: A three year study. *Journal of Educational Psychology*, *89*(3), 451-469.

February 11, 2016

Dear Amanda,

Thank you for your participation in the study conducted by the Alabama State Department of Education (ALSDE), A+ College Ready and the National Math + Science Initiative (NMSI) to assess the impact of the Laying the Foundation lessons in your classroom.

As part of the study, you administered surveys to students in your math courses in the fall. The surveys included questions about your students' math self-perceptions (such as how much they like doing math), their opportunities to learn math (such has the frequency of working on problems that can be solved in multiple ways) and their aspirations in math (such as whether they want to take more math courses in high school). We are in the process of analyzing data collected in the fall but wanted to provide you with brief, initial results for your students.

We averaged scores from your students' responses across items for each of the three areas (math self-perceptions, opportunities to learn math, math aspirations). For the eleven items related to math self-perceptions, students provided responses that indicated whether they strongly agree (4), agree (3), disagree (2) or strongly agree (1) to items such as, "I am good at math" or "I like doing math." The maximum possible score is 4 for each question.

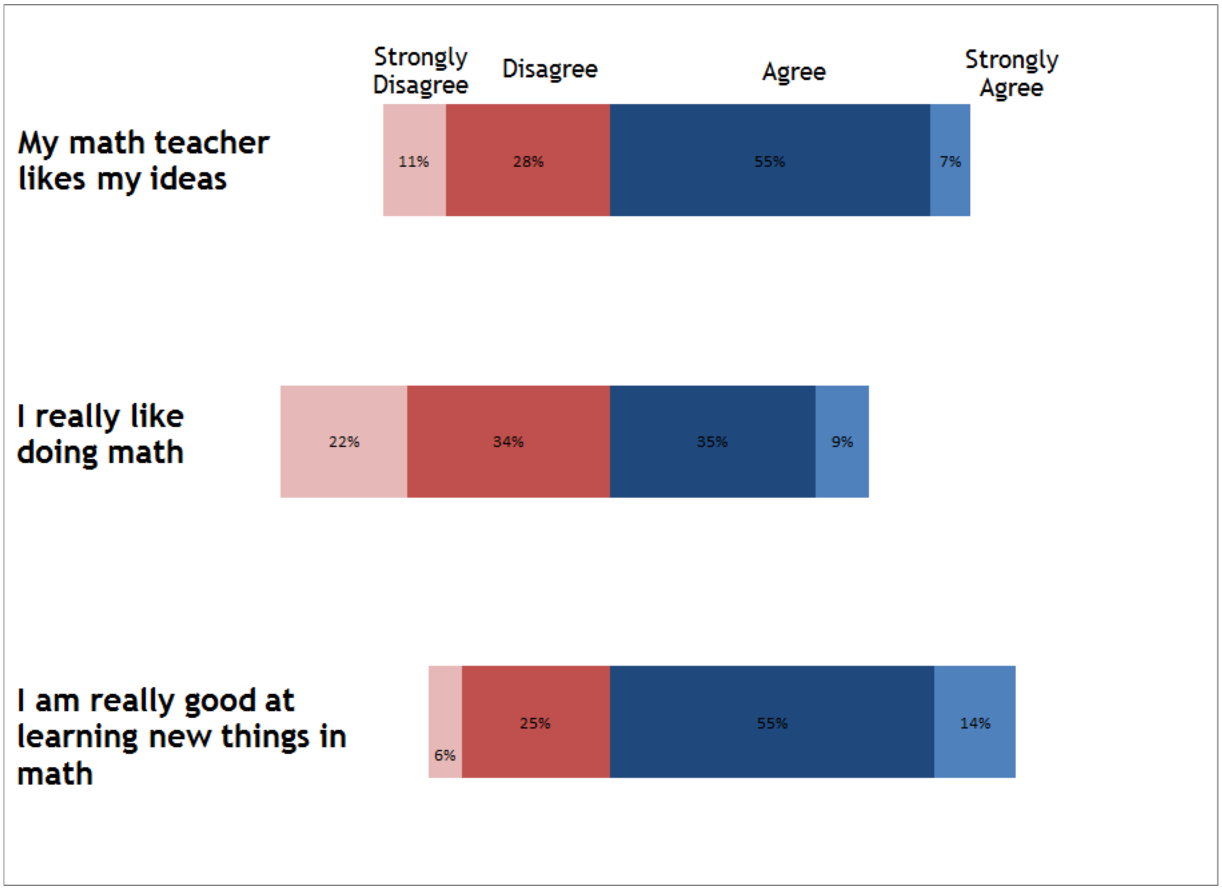
Students with higher scores indicated more positive math self-perceptions, and those with lower scores indicated less positive math self-perceptions. We calculated an average score based on student responses to all ten items. We created similar average scores for items related to the other two areas (nine items related to opportunities to learn math and five items related to math aspirations). Below is a summary table describing your average student survey responses and the overall average for all students in Alabama who completed the survey.

	Your Students (n = 24)		*Alabama Students (n = 1,135)*	
	Mean	*Standard Deviation*[1]	*Mean*	*Standard Deviation*
Math Self-Perceptions	3.07	0.62	2.64	0.54
Opportunities to Learn Math	2.97	0.45	2.95	0.52
Math Aspirations	2.60	0.81	2.10	0.76

[1]The standard deviation is a measure of the spread of the student responses. A higher standard deviation indicates greater range in student responses. A lower standard deviation indicates less range in student responses.

Math Self-Perceptions

The figure below describes how 1,135 Alabama students responded to three of the eleven math self-perception items.



Relationship to Other Areas

There is a relationship between math self-perception scores and scores on the other two areas (opportunities to learn math and math aspirations). Students with more positive math self-perceptions were more likely to express interest in taking more math courses in high school and work in a career involving math. Students with less positive math self-perceptions were less likely to want to take more math courses in high school or to work in a career involving math. In addition, students with more opportunities to learn math were also more likely to express positive math self-perceptions.

The survey responses were anonymous (we could not identify how individual students responded) and will not be used to evaluate your teaching. Instead, consider this information about your students' math perceptions that could be used as another indicator to better understand your students. If you have any questions, please contact Marsha Ing (marsha.ing@ucr.edu), or Julia Phelan (julia.phelan@ucla.edu). Thank you for helping with this effort. We appreciate your assistance.

Sincerely,

Julia Phelan, Ph.D.