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Student Attitudes toward STEM (S-STEM) Survey:
Development and Psychometric Properties

The S-STEM survey invites students to give information about their attitudes toward science, technology, engineering, and mathematics subjects, postsecondary pathways, and career interests. Two versions have been developed: one for 4-5th graders (the "Upper Elementary S-STEM"), and one for 6-12th graders (the "Middle/High School S-STEM").

Table 1: *S-STEM Survey Summary*

Survey Section	Psychometric Profile	Negatively Worded Items	Measurement Application
Math Attitudes	construct	Item # 1, 3, 5	attitudes toward math – consists of items measuring self-efficacy related to math and expectations for future value gained from success in math
Science Attitudes	construct	Item # 8	attitudes toward science – consists of items measuring self-efficacy related to science and expectations for future value gained from success in science
Engineering and Technology Attitudes	construct	none	attitudes toward engineering and technology – consists of items measuring self-efficacy related to engineering and technology and expectations for future value gained from success in engineering and technology
21st Century Learning	construct	none	attitudes toward 21st century learning – consists of items measuring students confidence in communication, collaboration, and self-directed learning
Your Future	items	none	interest in 12 broad categories of STEM career fields
More About You	items	none	predication of future academic performance, plans to take advanced classes, interaction with STEM professionals, postsecondary plans

The math attitudes, science attitudes, and engineering and technology attitudes constructs were adapted from a survey developed for a female, middle-school-student, engineering program (Erkut and Marx, 2005). The careers section was further developed using the Bureau of Labor Statistics' Occupational Outlook Handbook (2010-11). The 21st century learning attitudes construct was adapted from the Friday Institute's Student Learning Conditions Survey (2010).

Validity and Reliability

Phase I. The Middle/High School S-STEM was piloted on 109 students. Several analyses were conducted on the items measuring attitudes toward science, math, and engineering and technology to identify constructs. Exploratory factor analysis was used, applying principal axis factoring and promax rotation to allow factors to be correlated. Item loadings above .40 were classified as significant. Five subject matter experts rated each item as "Essential," "Useful but not Essential," or "Not Necessary," and Lawshe's content validity ratio was calculated for each item. Survey-takers' open-ended responses to "do you have any suggestions for how we can improve this survey?" were collected and analyzed for themes. Finally, engineering education experts assisted in rewriting the engineering and technology attitudes section. New items that measure technologist roles were added and items containing gender bias were revised or removed. In addition to these changes, seven other survey items were dropped and several others were rewritten. Improvements were made to the "Your Future" section as well. Originally consisting of 43 items measuring student interest in as many specific STEM professions, the pilot section was edited based on factor analysis, expert feedback, participant feedback, and literature review. This revision process resulted in a "Your Future" section measuring student interest in 12, broad, STEM career fields. In addition to these survey improvements, an Upper Elementary version of the S-STEM Survey was developed based on the revised Middle/High School S-STEM survey. Cognitive interviews were conducted with five 5th graders and information gathered was used to revise wording for improved decoding and comprehension.

Phase II. The revised Upper Elementary (4-5th) and Middle/High (6-12th) S-STEM Surveys were administered to 799 fourth through fifth grade students and 9,081 sixth through twelfth grade students. Results from another exploratory factor analysis (significant item loading at .40) indicated that two items in the "Math Attitudes" construct needed to be dropped. Four additional questions were dropped to improve survey length. Overall, results showed a clear factor structure with each survey section acting as a single construct. The constructs' reliability levels, measured with Cronbach's Alpha, are:

Table 2: *S-STEM Survey Reliability*

Construct	Number of Items	Cronbach's Alpha	
		Upper Elementary	Middle/High
Math Attitudes	8	0.85	0.90
Science Attitudes	9	0.83	0.89
Engineering and Technology Attitudes	9	0.84	0.90
21st Century Learning Attitudes	11	0.87	0.92

Student reading levels were analyzed using both tests for differential item functioning and expert feedback. Ten upper elementary teachers rated each of the upper elementary items as "Too Easy (below grade level)," "Just Right (at grade level)," or "Too Hard (above grade level)." Seven middle and high school teachers did the same for the middle/high school survey. Both sets of experts uniformly indicated that the surveys were at an appropriate length and difficulty for students. Differential item functioning tests were conducted to assess the internal validity of the surveys. Results indicated that students in the different grade levels targeted separately by the upper elementary survey (4th and 5th graders) and the middle/high school survey (6th through 12th graders) comprehend the survey in a similar manner. For example, a 6th grader and a 10th grader similarly comprehend the Middle/High School S-STEM Survey. Results from these tests show that measurement invariance held at all five levels. Responses from male students and female students were also analyzed using differential item functioning. Measurement invariance held at the first three, most essential, levels. Lack of factor covariance invariance indicated that males and females view the relationships between STEM subjects differently.

Citation and Further Information

Recommended citation:
Friday Institute for Educational Innovation (2012). Middle and High School STEM-Student Survey. Raleigh, NC: Author.

For further details on the S-STEM survey validation, please see Unfried, Faber, Stanhope, & Wiebe (2015).

For more information, and to find out how to access the surveys for your own use, please visit:
http://miso.ncsu.edu/articles/evaluation-tools

Or email Alonzo Alexander at abalexan@ncsu.edu.

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