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Insert references in appendix A of this document. Insert tables and graphics in appendix B. Do not insert them into the body of the abstract.

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[*] Mosteller, F., Nave, B., & Miech, E. (2004). Why we need a structured abstract in education research. *Educational Researcher, 33(1),* 29–34.

Abstract Title Page

Not included in page count.

Title:

The predictive validity of critical thinking disposition on middle-grades math achievement.

Author(s):

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Abstract Body

Limit 5 pages single spaced.

Background/context:

Description of prior research, its intellectual context and its policy context.

Critical thinking is commonly cited as one of the most important abilities for students to develop. Although critical thinking is typically conceived in terms of skills, critical thinking disposition, that is, a student's intellectual curiosity and motivation toward productive disciplinary engagement, appears to be indispensable if students are to be critical thinkers. Our interest in critical thinking disposition stems from a need to identify measures that are sensitive to the effects of an integrated math/science treatment promoting deep conceptual understanding and problem solving. Student outcomes include measures of math and science achievement, problem solving through applied math and science tasks, and student disposition toward critical thinking. We are investigating critical thinking disposition as both an outcome and possible mediator/moderator in the relation between an integrated math/science curriculum and student achievement.

The goals of measuring, tracking, and influencing students' levels of critical thinking disposition align with the findings of the National Research Council (NRC*,* 2007) in relation to science education and student learning. According to the NRC, engagement is only a first step toward students' participating productively in science as a discipline. Drawing on work by Engle and Conant (2002), who define productive disciplinary engagement as involving classrooms where "there is contact between what students are doing and the issues and practices of a discipline's discourse" (p. 402), the Council adds the criterion that in order to be engaged productively in an academic discipline, students must be learning and growing intellectually. Moreover, the NRC maintains that the importance of students' attitudes, motivations, and identities cannot be overstated. Both experimental (Pintrich, Marx, & Boyle, 1993) and case studies (Lee & Anderson, 1993) suggest that students' goals as learners, confidence in their cognitive abilities, and the value they place on learning subject matter have important implications for their levels of cognitive engagement. If students are to move toward productive disciplinary engagement, positive critical thinking disposition may play a crucial role.

The NRC (2007) outlined several key indicators of students' disposition toward productive disciplinary engagement. The Council reports that affirmative responses to the following statements: "I can do science", "I want to do science", and "I belong" (p. 196-200) are indicative of students' productive disciplinary engagement. Specific behaviors associated with this level of engagement include: willingness to take academic risks, persistence with problem solving, motivation to select and tackle more difficult problems, enjoyment of challenging tasks, and efforts to understand at a deeper, more conceptual level.

Purpose / objective / research question / focus of study:

Description of what the research focused on and why.

Engagement might be most appropriately thought of as a meta-construct, encompassing many dimensions of behavioral, emotional, and cognitive features (Fredericks, Blumenfeld, & Paris, 2004). Our interest lies in contributing to the research base on the cognitive aspects of student engagement and motivation (e.g., critical thinking disposition). Evidence suggesting that cognitive features of engagement may be related to student achievement comes from mixedmethods studies of learning strategies and complex problem solving (Blumenfeld & Meece, 1988; Fredericks, Blumenfeld, Friedel, & Paris, 2002; Helme & Clarke, 2001; Lee & Anderson, 1993; Lee & Smith, 1995). Interestingly, in all the studies reviewed, higher levels of task complexity, questioning, information gathering, and communicating were associated with higher levels of cognitive engagement. Among these studies, most supplemented student and teacher survey reports with classroom observations, strengthening the trustworthiness of these findings. Nevertheless, there is a gap in the literature on how well students' academic achievement is predicted by measures of motivation and engagement (Steinmayr & Spinath, 2009). The current study will investigate the predictive validity of critical thinking disposition on student mathematics achievement.

In addition, this study will examine whether the ability of critical thinking disposition to predict students' mathematics achievement is moderated by student characteristics. Our study site is unique because, in addition to a general education program, the school offers a magnet program for academically advanced students. Higher levels of academic achievement and successful academic histories are thought to be positively related to engagement for middle and high school students (Lee & Smith, 1993, 1995; Marks, 2000; NRC, 2007). In a theoretical paper on engagement, Newman, Wehlage, and Lamborn (1992) postulated that success in school is involved in a reciprocal relation with student engagement. In this research project, participation in the magnet program may be considered a proxy for successful academic history, as students are invited to attend the magnet program based on prior years' standardized test scores and report card grades.

In summary, we will examine whether critical thinking disposition can predict academic achievement in mathematics. We will also investigate differences in the predictive ability of critical thinking disposition for various subgroups of students. The research questions posed here:

1. What is the predictive validity of critical thinking disposition on students' mathematics achievement?
2. Is the ability of critical thinking disposition to predict students' mathematics achievement is moderated by student characteristics (e.g., male, magnet program, white, high-SES)?

Setting:
Description of where the research took place.

The study site is a north Florida, low-SES, high minority suburban middle school (N = 812) with a magnet program for academically advanced students that serves approximately one-third of the student body.

Population / Participants / Subjects:
Description of participants in the study: who (or what) how many, key features (or characteristics).

The general education program population (n = 537) is as follows: African American (77%), Free/Reduced Lunch (63%), and female (44%). No students in the general education program are identified as gifted. The magnet program population (n = 275) is as follows: Caucasian (45%), African American (32%), Asian (17%), Free/Reduced Lunch (17%), and female (53%), with a notable percentage of students identified as Gifted (26%).

The faculty at the research site was organized by a team structure. Each team served the same group of students. Although each team consisted of other subject matter teachers, only the math and science teachers participated in this project. There were eight science and eight math teachers: eight math/science teacher teams. The general program had five teams: two 6th grade, one 7th grade, one 7th/8th grade (some periods are 7th and some are 8th), and two 8th grade. The magnet program had three teams: one for each grade.

Intervention / Program / Practice:

Description of the intervention, program or practice, including details of administration and duration.

A modified version of the Integrated Math, Science, and Technology curriculum (IMaST; Center for Mathematics, Science and Technology, 2004) is the treatment condition with which our measure of critical thinking disposition will be used. This curriculum promotes complex problem solving, deep conceptual understanding, and critical thinking; the counterfactual being the business-as-usual math and science curricula. Math/science teacher teams ($N = 8$) were the unit of assignment. In the larger project, the research design was within-subjects, with treatment and business-as-usual conditions alternating each quarter. Teachers were the treatment implementers. The intervention consisted of the following three independent variables: (1) Integration of knowledge domains to promote relevance and applicability; (2) Hands-on, inquiry-oriented activities to promote authentic learning and student interest; (3) Dialogue and scientific journaling to promote deep conceptual understanding.

Research Design:

Description of research design (e.g., qualitative case study, quasi-experimental design, secondary analysis, analytic essay, randomized field trial).

This is a validation study, designed to determine whether a measure of critical thinking disposition is predictive of student mathematics achievement.

Data Collection and Analysis:

Description of the methods for collecting and analyzing data.

This study will investigate the predictive validity of students' levels of critical thinking disposition, as measured by the California Measure of Mental Motivation (CM3; Giancarlo, Blohm, & Urdan, 2004) for students' math achievement, as measured by the Mathematics assessment included in the Florida Comprehensive Assessment Test (FCAT). The CM3 is a general inventory of critical thinking dispositions. It is not curricula or subject-area specific. Through four independent studies, the authors of the CM3 established it as an appropriate tool for the assessment of secondary students' critical thinking dispositions. The CM3 is a twenty-five item, four category Likert-style student questionnaire comprising four sub-scales (Learning Orientation, Creative Problem Solving, Mental Focus, and Cognitive Integrity). The response categories range from *strongly agree* to *strongly disagree*. Reverse coding is used with approximately half of the items on the questionnaire.

Data were collected throughout the 2008-2009 academic year: a pretest at the beginning of the year and outcomes at the end of each quarter. Additionally, two waves of baseline data, at the third and fourth quarter, were collected during the previous academic year (2007-2008). The current study will report the predictive validity of the third quarter 2007-2008 baseline CM3 for students' performance on the math achievement assessment included in the FCAT, Spring 2009. We will use HLM to account for the nested structure of these data.

Findings / Results:
Description of main findings with specific details.

Preliminary results indicate small to moderate statistically significant correlations between students' math achievement and critical thinking disposition for three of the four subscales on the CM3. Please see Table 1 for these preliminary findings.

Conclusions:
Description of conclusions and recommendations based on findings and overall study.

Data analysis is on-going, and results and conclusions are not yet available. Because much of the prior research on academic engagement has focused on behavioral and emotional facets of student behavior, we look forward to better understanding the cognitive features of engagement and motivation. With improved understanding of the predictive validity of measures of students' critical thinking disposition, we will contribute to the knowledge base of the relation between cognitive aspects of engagement and academic achievement.

Appendices

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Appendix A. References

References are to be in APA version 6 format.

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Appendix B. Tables and Figures

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Table 1

Correlations Between CM3 Subscales and Math Achievement

Subscale	Correlation	n
Learning Orientation	.00	616
Creative Problem Solving	.23***	605
Mental Focus	.22***	611
Cognitive Integrity	.43***	602

$p < .001$