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An Examination of the Relationship Between Prospective Teachers' Dispositions and Achievement in a Mathematics Content Course for Elementary Education Majors

James E. R. Beyers[1]

Abstract

The purpose of this study was to examine the relationship between prospective teachers' dispositions and their achievement in a mathematics content course for elementary education majors. Research suggests that components of student dispositions with respect to mathematics can mediate learning via how students may or may not take advantage of opportunities to learn. Consequently, one might expect that there would be measurable differences in the relationship between students' dispositions and achievement in mathematics. A total of 107 prospective teachers who enrolled in a teacher preparation program at a midsized, mid-Atlantic university participated in this study by taking a researcher-designed survey, the Mathematics Dispositional Functions Inventory. Achievement was measured by the average of grades participants earned on two exams given in the mathematics course. Three achievement groups (high, moderate, and low) were determined based on the distribution of achievement scores. Results indicate that significant differences in prospective teachers' dispositions with respect to mathematics exist according to achievement in mathematics in two of the three primary categories of dispositional functioning, affective and conative, but not in the third category, dispositional cognitive functioning.

Keywords

prospective teachers, mathematical dispositions, dispositions, mathematics, achievement

In light of concerns with students' lack of comprehension in mathematics (Lee, Grigg, & Dion, 2007), increased attention has been given to students' dispositions with respect to mathematics and how they may be related to learning of mathematics. Furthermore, increasing concerns regarding the preparation of elementary school mathematics teachers (National Mathematics Advisory Panel, 2008) have culminated with growing interest in the nature of prospective teachers' dispositions with respect to mathematics and how they may affect prospective teachers' development of mathematical knowledge used for teaching.

Several education researchers (e.g., Boaler, 2002; Royster, Harris, & Schoeps, 1999; Whitenack & Yackel, 2002; Yackel & Cobb, 1996) and prominent organizations (Kilpatrick, Swafford, & Findell, 2001; National Council of Teachers of Mathematics [NCTM], 2000) have made compelling arguments about the significance of students' dispositions as they relate to learning mathematics. For example, a student's tendency to experience math anxiety may preclude the student from meaningful engagement in mathematical tasks and thus limit his development of mathematical knowledge and understandings (Bessant, 1995), potentially resulting in lower achievement in mathematics. Existing empirical work (e.g., Royster et al., 1999; Whitenack & Yackel, 2002) has focused on isolated elements of students' dispositions with respect to mathematics (McLeod, 1992), for example, attitudes and beliefs, or mathematical argumentation rather than examining student dispositions comprehensively in relation to learning mathematics. One reason for this perhaps lies in the lack of a well-defined, comprehensive framework for student dispositions with respect to mathematics (Boaler, 2002), which could facilitate such a comprehensive examination of student disposition in the context of mathematics. Furthermore, as efforts have been focused on isolated elements of students' dispositions and how they relate to achievement in mathematics, it seems reasonable to wonder whether a union of such operationalizations and conceptions of students' dispositions might be similarly related to achievement in mathematics.

Little work has focused on how prospective elementary teachers' dispositions are related to learning outcomes as measured by achievement in mathematics content courses.

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Prospective teachers' dispositions with respect to mathematics warrant considerable attention because the dispositions prospective teachers exhibit may influence what they learn (Kilpatrick et al., 2001), such as the mathematical knowledge and understandings they learn for teaching. It is crucial then to examine the dispositions prospective teachers hold while enrolled in their teacher preparation programs to make explicit these dispositional issues that could in turn have the potential to support their learning of mathematics for teaching.

Therefore, the current study is an examination of prospective teachers' dispositions with respect to mathematics as well as potential relationships between their reported dispositions and measures of achievement in a mathematics content course for elementary education majors. This study uses an instrument, the Mathematics Dispositional Functions Inventory (MDFI), developed in light of a newly proposed conceptual framework derived from the relevant literature on students' dispositions with respect to mathematics (see Beyers, 2011a, 2011b), to examine comprehensively how dispositions, as measured by the MDFI, are related to prospective elementary teachers' achievement in a mathematics content course.

Conceptual Framework

There exist frameworks for thinking about mathematics knowledge, such as procedural, conceptual (Hiebert, 1986), relational, and instrumental (Skemp, 1976); however, structured frameworks for thinking about other important issues in mathematics education, such as students' dispositions with respect to mathematics (Boaler, 2002), do not yet exist in the literature. In response to the lack of structured frameworks, I developed a conceptual framework, based on my review of the literature, for categorizing elements of student dispositions with respect to mathematics in terms of dispositional cognitive, affective, and conative mental functions.[1] This framework represents an amalgamation of various operationalizations of the disposition construct. I used this framework to guide the current study and the development of an instrument designed to measure prospective teachers' dispositions with respect to mathematics: the MDFI. For a complete discussion of the development of this instrument, including estimates of reliability for scales and the overall instrument, as well as validity (e.g., construct, face), see Beyers (2011a).

I adopted a psychological perspective for the exploration of prospective teachers' dispositions. Consequently, dispositions with respect to mathematics can be considered those cognitive, affective, and conative functions, which a student of mathematics is inclined to engage in a mathematical context (e.g., doing and/or learning mathematics, etc.). I will now describe these mental functions and their connection to dispositions in the context of mathematics.

Educational Psychology and Modes of Mental Functioning

Three modes of mental functioning, cognition, affection (also called affect), and conation (also called volition) have been used to distinguish three categories under which all mental processes are classified (Snow, Corno, & Jackson, 1996). NCTM (1989, 2000) suggests that a mathematical disposition should be thought of as "not simply attitudes but a tendency to think and to act in positive ways" (p. 233). Considering the three modes of mental functioning together with NCTM's assertion, one could infer that there are dispositional cognitive, affective, and conative mental functions, which contribute to a student's mathematical disposition.

Cognitive mental functions are defined to be "process[es] whereby an organism becomes aware or obtains knowledge of an object . . . It includes perceiving, recognizing, conceiving, judging, reasoning . . . [I]n modern usage sensing is usually included under cognition" (English & English, 1958, p. 92). For the purposes of this review, a cognitive mental function is then considered dispositional, that is, a *dispositional cognitive function* with respect to mathematics, if a person has a tendency or inclination to engage (or not) in a particular cognitive mental process associated with perceiving, recognizing, conceiving, judging, reasoning, and the like in mathematics. For example, if a student were learning about the standard algorithm for division of rational numbers, the student could be inclined to reason why the algorithm calls for multiplying by the reciprocal of the divisor. Another student, as many do, could simply accept the algorithm at face value and have no inclination to engage mathematical reasoning to understand how the algorithm works. Consequently, reasoning may be considered a dispositional cognitive function.

Affective mental functions are said to be "a class name for feeling, emotion, mood, temperament . . . a single feeling response to a particular object or idea . . . the general reaction to something liked or disliked . . . the dynamic or essential quality of an emotion; the energy of an emotion" (English & English, 1958, p. 15). McLeod (1992) suggested that attitudes toward mathematics, beliefs about mathematics as well as about one's self (in relation to mathematics), and emotions, for example, joy or aesthetic responses to mathematics, reside within the affective domain. An affective mental function is said to be dispositional, that is, a *dispositional affective function* with respect to mathematics, if a person has a tendency or inclination to have or experience particular attitudes, beliefs, feelings, emotions, moods, or temperaments with respect to mathematics. Alpert and Haber (1960) suggested that students who experience debilitative math anxiety avoid mathematical tasks, and thus the perceived source of the anxiety. Such persons have a tendency to experience angst when engaged in mathematical activity, and consequently, the affective function of anxiety can be thought of as dispositional.

Conative mental functions are said to be

> that aspect of mental process by which it tends to develop into something else; an intrinsic unrest of the organism . . . almost the opposite of homeostasis. [An impulse] to act, a conscious striving . . . It is now seldom used as a specific form of behavior, rather for an aspect found in all. Impulse, desire, volition, purposive striving all emphasize the conative aspect. (English & English, 1958, p. 104)

A conative mental function is said to be dispositional, that is, a *dispositional conative function*, if a person has a tendency or inclination to purposively strive, exercise diligence, effort, or persistence in the face of mathematical activity. As educators, we have experienced situations where students are faced with difficult mathematical tasks and seen different levels of student engagement in those tasks. Students may tend to exhibit high or low levels of persistence or effort, and be less likely to purposively strive in the face of challenging mathematical tasks, supporting the assertion that conative functions can be thought of as dispositional.

The conceptual framework outlined here provides categories for mapping out the vast domain of the dispositional functioning of prospective teachers and affords researchers and teacher educators a lens for exploring the nature of prospective teachers' dispositional functions with respect to mathematics.[2] This framework includes elements of prospective teachers' dispositional functioning that are not explicitly accounted for in previous conceptions of the disposition construct when considered individually.

Dispositional Functioning and Learning in Mathematics

Dispositions with respect to mathematics can affect student learning in terms of its influence on opportunities to learn mathematics, one of the single most important predictors of student achievement (Berliner & Biddle, 1995; Kilpatrick et al., 2001). The literature suggests that components of students' dispositions with respect to mathematics may (a) influence the ways they may or may not take advantage of opportunities to learn, for example, students' beliefs about mathematics can influence problem solving behaviors (Schoenfeld, 1989) or (b) preclude students from particular opportunities to learn mathematics, for example, students who experience mathematics anxiety may avoid the perceived source of that anxiety (Alpert & Haber, 1960; Bessant, 1995).

Dispositional cognitive functioning. An absence of components of students' cognitive dispositional functioning can influence students' access to particular opportunities to learn mathematics. In earlier discussions, several cognitive dispositional functions were identified, for example, students evaluating the acceptability, mathematical basis, and mathematical difference of their peers' explanations and justifications (McClain & Cobb, 2001; Yackel & Cobb, 1996) as well as making connections within or across mathematical domains (Boaler, 2002; Burton, 1999). Whitenack and Yackel (2002) suggested that all students can benefit from discussions such as those where students are evaluating the acceptability, mathematical basis, and mathematical difference of their peers' explanations and justifications, in that students have the chance to develop mathematical arguments and advance their mathematical ideas and thinking. Noss, Healy, and Hoyles (1997) argued that making mathematical connections is important because mathematical meaning is derived from making such connections, suggesting that making mathematical connections is linked to the knowledge and understanding they may promote. In both cases, these dispositional cognitive functions provide students with opportunities to extend their mathematical knowledge and understanding. In addition, if students do not tend to evaluate the acceptability, mathematical basis, and mathematical difference of their peers' explanations and justifications (McClain & Cobb, 2001; Yackel & Cobb, 1996) or make connections within or across mathematical domains, then their access to such opportunities, in a sense, is restricted.

Dispositional affective functioning. Students' beliefs about the nature of mathematics, a component of dispositional affective functioning, can influence how students may or may not take advantage of opportunities to learn mathematics. Researchers have described students' beliefs about the nature of mathematics as a continuum between a perception of mathematics as (a) a system of unrelated facts and procedures or (b) a system of connected concepts that can be constructed (Kloosterman, 2002; Kloosterman & Stage, 1992). Students who hold the belief that mathematics is a system of connected concepts that can be constructed tend to be more actively engaged in learning mathematics (Kloosterman, 2002; Kloosterman & Stage, 1992). Boaler (1998) observed two contrasting mathematical environments and found that students in the content-based mathematics environment tended to believe that mathematics was predominantly rule-based and that remembering rules and equations was the best way to learn mathematics. Furthermore, Boaler argued that this belief was consistent with the strategies students used in class. According to Boaler, the students' beliefs were indicative of their approach to mathematics and that simply learning rules and equations seemed to have stopped students from trying to interpret things mathematically.

Components of students' dispositional affective functioning have also been associated with limiting access to opportunities to learn mathematics. Researchers suggest that there exists a relationship between students' beliefs about mathematics and the number of mathematics courses they choose to take. Students who believe mathematics is useful for meeting their current and/or future needs tend to enroll in more mathematics courses than students who do not view mathematics as such (Fennema & Sherman, 1977; Reyes, 1984). By taking fewer mathematics courses, access to some opportunities to learn mathematics is restricted and consequently the mathematical knowledge and understandings can be limited.

Similarly, dispositional affective functions such as math anxiety can influence students' learning of mathematics, in that students who experience math anxiety may avoid mathematical tasks that induce feelings of anxiety (Bessant, 1995). Mandler and Sarason (1952) suggested that differences in high- and low-anxiety students result in one of the following two behaviors: task-relevant efforts to finish the task and thereby reduce the anxiety, versus self-directed, task-irrelevant responses that are intended to help escape the evaluative situation. These are also sometimes referred to as facilitative and debilitative anxiety. Debilitative anxiety is associated with behaviors intended to avoid feelings of anxiety. Debilitative anxiety may lead an individual to disengage from mathematical tasks, thus avoiding the perceived cause of the anxiety (Alpert & Haber, 1960). In avoiding the perceived source of the anxiety and, consequently, the mathematical task, it is reasonable to presume that without that particular opportunity to learn, the student's learning will be negatively affected.

Dispositional conative functioning. Dispositional conative functions such as effort can also influence students' learning of mathematics, by influencing the level of engagement in particular mathematical activities such as solving challenging problems. Cross-cultural studies have shown that children in the United States are less likely than students in East Asian countries to attribute success in mathematics to effort (Stevenson & Stigler, 1992). Students who view their ability as fixed and place low value on effort in mathematics are likely to be discouraged easily in the face of challenging problems (Dweck, 1986). Schoenfeld (1989) observed a belief among students that mathematics problems should be able to be solved in a short period of time. Students who exhibited this belief may not be likely to persist in the face of difficult, nonroutine mathematical tasks, which, in fact, require more than a few minutes to solve (Schoenfeld, 1989, 1992). Over time, exposure to challenging problems may lead students, who tend not to persist in solving such problems, to give up easily and disengage the mathematical activities thus limiting their opportunities to learn mathematics.

Given that opportunity to learn is considered one of the best predictors of achievement in mathematics (Berliner & Biddle, 1995; Kilpatrick et al., 2001), and the previously discussed elements of student dispositions can affect how students may or may not take advantage of opportunities to learn mathematics, one might expect to find differences in dispositional functioning as they relate to achievement in mathematics. Particular elements of students' dispositional functioning can influence opportunity to learn and therefore could be expected to be related to varied levels of achievement in mathematics, but how does a comprehensive amalgamation of student dispositions as captured by the proposed framework and assessed using the MDFI relate to achievement in mathematics? By using the MDFI in this study, I was able to assess comprehensively the components of student dispositions and then examine how students' dispositional cognitive, affective, and conative functioning are related to achievement in mathematics, a task not previously undertaken. The following research questions guided this study:

Research Question 1a: What is the relationship between 1st-year prospective elementary teachers' reported dispositional functioning and measures of achievement in a mathematics content course for elementary education majors?

Research Question 1b: Are there significant differences among the relationships between prospective teachers' reported cognitive, affective, or conative dispositional functioning and measures of achievement in mathematics content course for elementary education majors?

Research Question 2: What do high-achieving prospective teachers' dispositional profiles look like?

Method and Participants

Context

The participants in this study were 107 (a 78% response rate) prospective elementary teachers from a mid-Atlantic university enrolled in a mathematics content course for elementary education majors. Of the 107 participants, 105 were females, that is, 98% of the sample was composed of female participants, which is a similar proportion to the population from which the sample came. All 137 students enrolled in this course were invited to participate in this study. This course is the second in a series of three mathematics content courses required for elementary education majors. The course explores concept development in rational numbers, operations with rational numbers, proportional reasoning, and probability. There were five sections of this course with three instructors each teaching a single section while the fourth taught two sections.[3] Prospective teachers enrolled in the second course of the series were chosen for two reasons. First, these students have had experience with the novel approaches enacted in these content courses. Second, by working with students at this stage of the elementary education program, the potential for restriction of range in achievement was reduced, as students who are permitted to continue in this program are required to earn a C− or better, making the students who are in the latter stages of the program, generally higher performing students. This allows for more sensitivity toward uncovering significant differences among students in the sample.

Having taught each of the three mathematics content courses, the researcher believed that students' dispositions were affected by their experiences with those courses. Particularly, in the first course of the series, students are exposed to nontraditional approaches to elementary mathematics that contrast their previous experiences as learners of mathematics, which may have a jarring effect on their dispositions. Consequently, during the first course, students' dispositions may be in a period of transition from one orientation to another. For example, students' experiences in the first content course can influence their fundamental beliefs about the nature of mathematics as the instructional approach emphasizes conceptual understanding of mathematics content that they will be expected to teach, and their prior experiences with this content has typically been more procedural. There are expectations in the first content course that require students to think more abstractly about topics than they may have before. Students are required to provide conceptually based explanations for many procedures that probably had not been expected in previous coursework. By having to explain the conceptual underpinnings of procedures when they are used to engaging in this content through executing procedures, students' beliefs about the nature of mathematics may be challenged. In addition, in an environment where students are encouraged to actively challenge peers' explanations and develop mathematical arguments as opposed to listening to a lecture, their dispositional cognitive functions may be influenced. It would have been somewhat problematic to try to capture students' dispositions early in the program given the potential for such culture shock during the first content course.

The alternative was to recruit prospective teachers who have been in the program longer and have had time to adjust to the nontraditional approaches enacted in the elementary mathematics courses. Students in the third course were not chosen because at that stage of the program, only the "best-of-the-best" are still in the program; students can take the third content course only after they have been successful in its two prerequisites. This could have led to a restriction of range in the achievement data, which, in turn, may not have allowed for potentially significant relationships between dispositions and achievement to be detected. Hence, students in the second course of the series were invited to participate in this study.

The Instrument

The MDFI is a questionnaire developed for this study. The MDFI is composed of 60 forced-response items designed to assess prospective teachers' dispositions with respect to mathematics.[4] The forced-response items are formatted on a 5-point Likert-type scale, from *strongly agree* to *strongly disagree*, with a neutral option (for a complete discussion of the MDFI, see Beyers, 2011a). The MDFI is intended to facilitate a comprehensive examination of student dispositions with respect to mathematics, a task not undertaken in previous research. A full report on the development and analyses of the instrument has been published in a separate report (see Beyers, 2011a).

The items on the questionnaire were designed to assess three scales: (a) Cognitive, (b) Affective, and (c) Conative Dispositional Functioning with respect to mathematics. Within the Cognitive Dispositional Functioning scale lie items designed to assess dispositional functions of making connections and ideas about argumentation. The appendix shows each of the items and the associated scales. Within the Affective Dispositional Functioning scale lie items designed to assess beliefs about the nature of mathematics, its usefulness, its worthwhileness, its sensibleness, beliefs about one's own mathematics self-concept, attitude, and math anxiety. By design, there are no subcategories of dispositional functions within the Conative Dispositional Functioning scale. The three primary scales as well as the nine subcategories of dispositional functions were designed using a rationale/correspondence method (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999), that is, the construction of each of the scales and subsequent categories is based on the conceptual framework derived from my review of the literature.

Procedures

The researcher visited each section of the mathematics content course to recruit participants for the study and to introduce himself. Through subsequent email communication, the researcher invited all prospective teachers enrolled in the course to participate in the study. Participants were given the opportunity to take the questionnaire at one of three administrations lasting approximately 1 hr conducted by the researcher; all administrations occurred on the same evening in a lecture hall at the university. Prospective teachers who agreed to participate were given a packet containing a letter explaining the nature of the study and instructions on how to fill out the questionnaire, a consent form, and a copy of the questionnaire (see Beyers, 2011a), at the beginning of each of the three administrations. The administrations of the questionnaire occurred after the students completed their second midterm examination, but prior to the administration of the final exam.

Measures of Achievement

Two measures of achievement were used as the independent variable for this study: grades on the second and final exams. The data for the measures of achievement were collected from instructors at the end of the semester. These measures of student achievement were used to have multiple data points for each student allowing for a more robust estimate of achievement in mathematics, thus strengthening any assertions that might be made about the relationship between achievement and dispositions. From the two scores provided by course instructors, a percentage of the total possible points that could have been earned were calculated. For example, if a student scored 83 out of the possible 100 points on the first exam and 120 points out of the possible 135 points for the final exam, then the score for this student's measure of achievement was (83 + 120)/235 or 83.68%. The maximum number of points that could have been earned between the two exams was 235 points.

Exams were chosen, as opposed to quizzes or other assessments that occur in the course, because they are extensive assessments of student learning in the course. The first exam was not included as a source of data because instructors' experiences suggested that students' performances on the first exam have been negatively influenced by the novelty of the tasks. The final exam was included because it is a comprehensive assessment of student learning for the course. The MDFI was administered between the second midterm and final exams to have measures of achievement before and after the assessment of student dispositions with respect to mathematics.

Statistical Method

Relationship between reported dispositional functioning and achievement (Research Question 1a). To obtain an indication of how prospective teachers' dispositional functioning is related to achievement, a one-way independent ANOVA[5] was conducted. The students were divided into three groups based on their measures of achievement (high-, moderate-, and low-achieving). The groups were formed using cutoff scores deemed to reflect high- (approximately B+ or better, that is, a score of 87% on the measures of achievement, n = 36), moderate- (C to B, that is, a score between 73% and 87% on the measures of achievement, n = 35), and low-achievement (C- or below, that is, a score below 73% on the measures of achievement, n = 36). Students whose achievement measures were borderline, for example, low- to moderate-achieving depending on whether the score was rounded up or down, were classified in the achievement group which would ensure roughly equivalent group sizes.[6]

The means for those groups on the MDFI were compared using a one-way independent ANOVA to see whether the groups differed significantly. Three groups were used to provide a clear distinction between the high- and low-achieving groups. The respondents' dispositional functioning was determined by summing the scores of all of the items on the MDFI. Levene's test for homogeneity of variances was conducted to ensure that the results from the ANOVA had been found appropriately.[7] The effect size was then determined (the square root of the ratio of the between-group effect to the total amount of variance in the data) using η^2. For the relevant analyses, the effect size, ω, was found by taking the square root of η^2. This was used to describe how much of the variability in the scores on the MDFI can be explained by achievement level. A post hoc pairwise comparison was conducted using *Bonferroni's* test to determine how the groups differ from each other. This post hoc procedure was chosen because it retains power for a relatively small number of comparisons (three or fewer) while controlling Type I errors.

Differences among primary scales, subscales, and measures of achievement (Research Question 1b). Potential differences among the prospective teachers' reported dispositional cognitive, affective, and conative functioning on the MDFI and measures of achievement was explored using a MANOVA. MANOVA was performed to determine whether significant differences exist among respondents' measure of achievement and their reported dispositional cognitive, affective, or conative functioning on the MDFI. The same groupings (high-, moderate-, and low-achieving) described above (for Research Question 1a) were used for these analyses. The respondents' dispositional cognitive, affective, and conative functioning was determined by summing the scores of the relevant items on the MDFI (see the appendix for items associated with each of the three primary scales and subcategories of functions). Three groups were formed to provide a clear distinction between the high- and low-achieving groups. The test for multivariate normality cannot be done on SPSS, so I tested for univariate normality, as it is a necessary condition for multivariate normality, that is, I tested (using Levene's test for homogeneity of variances) whether the dependent variables are normally distributed within each of the three achievement groups.[8] The achievement groups differed in size by at most one respondent; therefore, Box's preliminary test for the equality of covariance matrices was discarded and it could be assumed that a subsequent test statistic is robust. Pillai's trace was used to test for the significance of the MANOVA model, because if there was group differentiation along more than one of the dependent variables, Pillai's trace retained the most power. As Pillai's test statistic was significant,[9] post hoc analyses were conducted to determine the nature of the relationships between respondents' dispositional cognitive, affective, and conative functioning and achievement in mathematics. For the subsequent analyses, a sequence of univariate ANOVAs for each of the dependent variables was conducted. Separate one-way independent ANOVAs were followed using contrasts with Bonferroni's corrections applied to determine how the achievement groups differ for each of the dependent variables.

Dispositional profiles by achievement group (Research Question 2). A dispositional profile for each achievement group was found by calculating a total score on the MDFI according to achievement group. The proportions of respondents' choices of either *agree* or *strongly agree* by achievement group were found to show trends in frequencies of agreement with statements about particular dispositional functions. This was done to reveal the extent

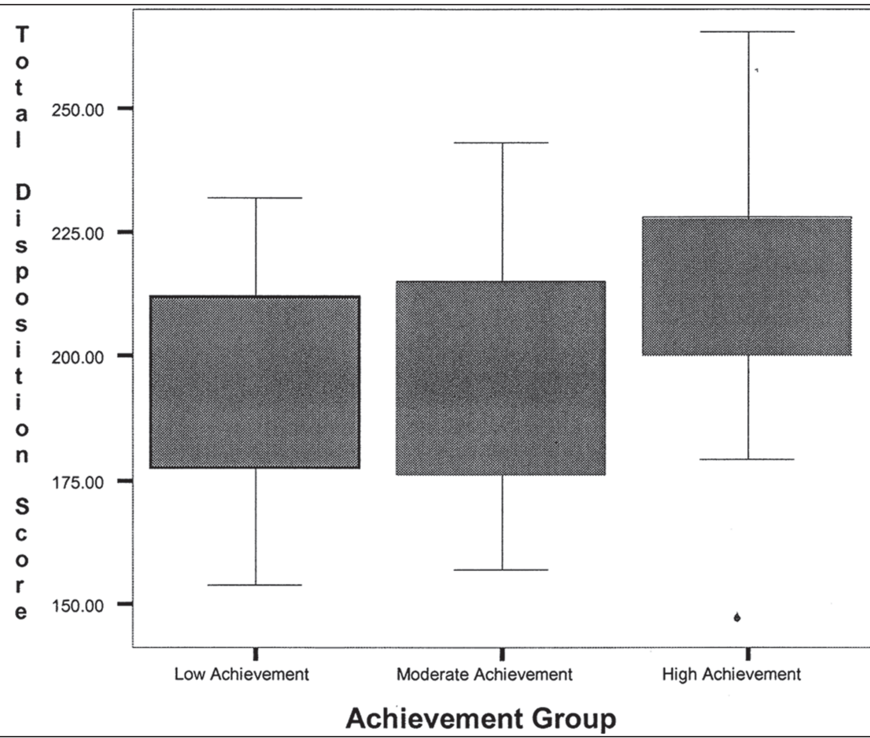

Figure 1. Total score on the MDFI by achievement group
Note: MDFI = Mathematics Dispositional Functions Inventory.

to which each achievement group was consistent with recommended dispositions.

Results

Relationship Between Reported Dispositional Functioning and Achievement (Research Question 1a)

A one-way independent ANOVA[10] was conducted with achievement group serving as the independent variable and total disposition score on the MDFI serving as the dependent variable. This analysis was used to determine whether there was a significant difference among the means of the total disposition score by achievement group. The null hypothesis was that there is no significant difference in overall reported dispositional functions by level of mathematics achievement. The ANOVA revealed that there are significant differences among the means of the total dispositions scores on the MDFI by achievement group, $F(2, 103) = 7.10$, $p < .05$, $\omega = .33$. Thus, the data supported rejection of the null hypothesis, meaning there is a significant difference in reported dispositional functioning—students' dispositional profiles—by achievement in mathematics.

A post hoc pairwise comparison was conducted using Bonferroni's test to determine how the groups differed from each other. This comparison revealed that the dispositional profiles for high-achieving students ($M = 215.42$, $SD = 24.7$) were significantly higher[11] than those for both the moderate- ($M = 197.11$, $SD = 24.64$) and low-achieving ($M = 194.23$, $SD = 20.72$) students. However, there was no significant difference between the dispositional profiles for moderate- and low-achieving students (see Figure 1).

Differences Among Primary Scales, Subscales, and Measures of Achievement (Research Question 1b)

A MANOVA was conducted with achievement group serving as the independent variable and the three scale scores, Cognitive, Affective, and Conative Dispositional Functioning serving as the dependent variables. Pillai's trace revealed a significant multivariate effect among the three scales by achievement in mathematics, $F(6, 103) = 3.62$; $p = .002$, $\eta^2 = .096$. Subsequent univariate ANOVAs were then conducted to test whether there were significant differences in mean scores for the Cognitive, Affective, and Conative Dispositional Functioning scales by achievement group.[12] The null hypothesis was that there is no difference in mean scores for the three scales by achievement group.

The subsequent univariate ANOVAs revealed significant differences among the mean scores for affective dispositional functioning, $F(2, 103) = 9.072$, $p < .001$, and conative dispositional functioning, $F(2, 103) = 8.53$, $p < .001$, but not cognitive dispositional functioning, $F(2, 103) = 2.71$, $p = .071$. The data supported rejection of the null hypothesis in part, but not fully, in that there were significant differences in mean scores by achievement group for affective and

Table 1. Mean Differences and Corresponding Significance Values by Achievement Group for the Three Primary Scales

Scale	Achievement group pairings		Mean difference
Cognitive	High achievement	Low achievement	3.1405
		Moderate achievement	1.9405
Affective	High achievement	Low achievement	15.8135**
		Moderate achievement	14.5278**
Conative	High achievement	Low achievement	2.2431**
		Moderate achievement	1.8341*

*$p < .05$ level. **$p < .001$ level.

conative dispositional functions, but there was no significant difference in mean scores for cognitive dispositional functioning.

Thus, a pairwise post hoc comparison using Bonferroni's test was conducted to determine how the mean scores for reported affective and conative dispositional functioning differed by achievement group (see Table 1). This comparison revealed that the reported dispositional affective functioning for high-achieving students (M = 160.53, SD = 18.06) was significantly higher[13] than that of both the moderate- (M = 146, SD = 19.07) and low-achieving students (M = 144.71, SD = 14.79). Similarly, the reported dispositional conative functioning for high-achieving students (M = 20.81, SD = 2.15) was significantly higher than that of both moderate- (M = 18.97, SD = 2.57) and low-achieving students (M = 18.57, SD = 2.57).

Composite Dispositional Profile of Prospective Teachers (Research Question 2)

A total disposition score for prospective teachers was found by summing all of the items on the MDFI. A higher total score indicates a disposition, which is considered more desirable, or availing, in that it is more consistent with recommended dispositions found in the literature (e.g., Kilpatrick et al., 2001; Royster et al., 1999).

A total disposition score could range from 58 to 290. The actual range of scores was 146 to 265 with a mean of 202.13 and a standard deviation of 25.09 (see Table 2, for a complete list of score ranges on the MDFI, primary scales, and subcategories of dispositional functions).

Table 3 shows the percentages of prospective teachers' responses for the MDFI, primary scales, and subcategories of dispositional functions for which the respondents indicated either *agree* or *strongly agree* for the corresponding statements. For example, from Table 3, we can see that 57.63% of the responses to all items on the MDFI were either *agree* or *strongly agree*, that is, the respondent indicated either 4 or 5, suggesting that collectively, a majority of this sample of prospective teachers reported dispositional profiles consistent with recommended dispositions. This finding will be discussed in more detail later in the article.

Table 2. Possible and Actual Ranges for MDFI (Minimum, Maximum), Primary Scales, and Subcategories of Dispositional Functions

	Possible range	Actual range
Total score	**58, 290**	**146, 265**
Cognitive	**10, 50**	**18, 49**
Connections	5, 25	8, 25
Argumentation	5, 25	10, 25
Affective	**43, 215**	**109, 193**
Nature of Mathematics	10, 50	24, 45
Usefulness	11, 55	19, 50
Worthwhileness	3, 15	8, 15
Sensibleness	4, 20	9, 20
Mathematics Self-Concept	6, 30	9, 28
Attitude	4, 20	7, 25
Math Anxiety	5, 25	6, 24
Conative	**5, 25**	**13, 25**

Note: MDFI = Mathematics Dispositional Functions Inventory. Bold font is used to highlight range scores for the overall MDFI as well as the three primary scales.

Table 3. Percentages of Responses Indicating Agree or Strongly Agree on the MDFI, Primary Scales, and Subcategories of Dispositional Functions

	Percentage of responses indicating agreement
Total score	**57.63**
Cognitive	**46.06**
Connections	46.72
Argumentation	45.4
Affective	**58.02**
Nature of Mathematics	55.03
Usefulness	52.4
Worthwhileness	83.8
Sensibleness	76.88
Mathematics Self-Concept	61.85
Attitude	52.58
Anxiety	45.58
Conative	**77.38**

Note: MDFI = Mathematics Dispositional Functions Inventory. Bold font is used to highlight the overall MDFI as well as the three primary scales.

Table 4. The Possible Ranges (Minimum, Maximum) for Scores for the MDFI, Primary Scales, and Subcategories of Dispositional Functions

	Score ranges by achievement group[a]		
	High	Moderate	Low
Total score	**146, 265**	**157, 243**	**154, 232**
Cognitive	**22, 49**	**22, 43**	**18, 40**
Connections	10, 25	10, 22	8, 20
Argumentation	11, 25	10, 22	10, 20
Affective	**109, 193**	**117, 183**	**118, 170**
Nature of Mathematics	26, 45	24, 44	27, 38
Usefulness	26, 50	26, 45	19, 46
Worthwhileness	9, 15	9, 15	8, 15
Sensibleness	11, 20	9, 19	11, 18
Mathematics Self-Concept	9, 28	11, 27	15, 26
Attitude	9, 25	7, 24	8, 24
Math Anxiety	6, 24	8, 22	8, 20
Conative	**15, 25**	**14, 24**	**13, 22**

Note: MDFI = Mathematics Dispositional Functions Inventory. Bold font is used to highlight the overall MDFI as well as the three primary scales.
[a]The possible ranges are still the same as for the total score as seen in this table.

Composite Dispositional Profiles by Achievement Group (Research Question 2)

A disposition score for each achievement group was determined by summing the items scores using the achievement groupings outlined in the methods section. There were 36, 35, and 36 prospective teachers in high-, moderate-, and low-achievement groups, respectively. Just as with the total score discussed earlier, a higher score on the MDFI for each achievement group indicates a disposition more consistent with those recommended in the literature. The range of disposition scores for each achievement group is the same as that for the total disposition scores (58-290). For a complete list of ranges by achievement groups, see Table 4.

The means of means and standard deviations for achievement groups can be found in Table 5. From Table 5, we can see that, generally, the high-achievement group reported higher levels of agreement with items on the MDFI, the primary scales, and within the subcategories of dispositional functions. For example, we can see that with a mean of means of 3.65 and a standard deviation of 0.42 for the total score, that a large majority, approximately 75% of the high-achievement group, tended toward the favorable side of the Likert-type scale, while less than 60% of the moderate- or low-achievement groups tended toward the favorable side of the scale.[14]

Table 6 shows the percentages of prospective teachers' responses within each achievement group that were either *agree* or *strongly agree* for the entire MDFI, primary scales, and subcategories of dispositional functions. For example, we can see in Table 6 that 66% of the high-achievement group's responses for the entire MDFI were either *agree* or *strongly agree*, while only 54% and 52% of the moderate- and low-achievement groups, respectively, indicated some level of agreement. These results further support the finding that prospective teachers in the high-achievement group reported dispositions more consistent with recommendations found in the literature, that is, more availing dispositions. This finding will be discussed further in the following section of the article.

Table 5. The Means of Means and Standard Deviations for the MDFI, Primary Scales, and Subcategories of Dispositional Functions for Each Achievement Group

	Achievement groups (mean of means, *SD*)		
	High	Moderate	Low
Total score	**3.65, 0.42**	**3.34, 0.42**	**3.28, 0.35**
Cognitive	**3.41, 0.64**	**3.21, 0.52**	**3.09, 0.54**
Connections	3.41, 0.71	3.22, 0.59	3.03, 0.61
Argumentation	3.41, 0.68	3.21, 0.58	3.16, 0.56
Affective	**3.65, 0.41**	**3.32, 0.43**	**3.28, 0.34**
Nature of Mathematics	3.42, 0.43	3.33, 0.42	3.25, 0.28
Usefulness	3.45, 0.47	3.18, 0.49	3.14, 0.54
Worthwhileness	4.12, 0.54	3.94, 0.49	3.96, 0.57
Sensibleness	4.06, 0.48	3.79, 0.49	3.78, 0.43
Mathematics Self-Concept	3.81, 0.66	3.32, 0.74	3.41, 0.44
Attitude	3.80, 0.86	3.21, 0.97	3.14, 0.82
Math Anxiety	3.56, 0.76	2.97, 0.78	2.79, 0.60
Conative	**4.16, 0.43**	**3.79, 0.51**	**3.71, 0.51**

Note: MDFI = Mathematics Dispositional Functions Inventory. Bold font is used to highlight the overall MDFI as well as the three primary scales.

Table 6. The Percentages of Responses That Were Either Agree or Strongly Agree on the MDFI, Primary Scales, and Subcategories of Dispositional Functions by Achievement Group

	Achievement group		
	High (%)	Moderate (%)	Low (%)
Total score	**66.38**	**54.24**	**52.68**
Cognitive	**54.18**	**44**	**40.01**
Connections	55.56	45.72	38.9
Argumentation	52.8	42.28	41.12
Affective	**66.73**	**53.89**	**53.68**
Nature of Mathematics	59.72	51.43	50.55
Usefulness	57.58	47.8	50
Worthwhileness	87.96	82.86	80.56
Sensibleness	86.11	70.71	73.61
Mathematics Self-Concept	72.22	55.71	57.41
Attitude	68.75	46.43	42.36
Math Anxiety	64.44	45.14	40.56
Conative	**87.78**	**77.71**	**69.44**

Note: MDFI = Mathematics Dispositional Functions Inventory. Bold font is used to highlight the overall MDFI as well as the three primary scales.

Discussion

There was a significant positive relationship between prospective teachers' dispositions with respect to mathematics, as measured by the MDFI, and achievement in mathematics. Results indicated that high-achieving prospective teachers had more availing dispositions than both moderate- and low-achieving students. On a whole, high-achieving prospective teachers would be more inclined to (a) make mathematical connections within and across mathematical topics, (b) engage in mathematical argumentation, (c) believe that mathematics is composed of connected concepts rather than disconnected facts and procedures, (d) believe that mathematics can be made sense of, (e) believe that learning mathematics has been and will continue to be worth it, (f) believe that mathematics is useful for meeting current and future needs both in and out of school, (g) have a high sense of mathematics self-efficacy, (h) like mathematics, and (i) exert effort when doing mathematics.

However, this was not exactly the case. On further analysis, the second finding, that there were only significant differences in affective and conative dispositional functioning by achievement group, became apparent. One might have expected a linear relationship between dispositions and achievement in mathematics. In other words, one might have expected that low-achieving students would have lower scores on the MDFI, moderate-achieving students would exhibit dispositions between the low- and high-achieving students, and high-achieving students would have the highest overall disposition scores as measured by the MDFI. A simple correlation was not sensitive enough to highlight the relative contributions of each of the primary categories of dispositions, that is, cognitive, affective, and conative functions, to the relationship with achievement, hence masking the nonlinearity of the relationship. Along the Cognitive Dispositional Functions scale, high-achieving students were not actually significantly more likely to indicate that they make connections within or across mathematical topics or engage in mathematical argumentation than the moderate- and low-achieving students in this sample.

Although high-achieving students did not differ significantly from the other two achievement groups in their cognitive dispositional functioning, there were significant differences in both the affective and conative dispositional functioning by achievement group. Interestingly, compared with the other subcategories of dispositional functions, a substantially larger majority of high-achieving students either agreed or strongly agreed with statements pertaining to the worthwhileness of mathematics (affective dispositional functions), sensibleness of mathematics (affective dispositional functions), and the extent to which persistence or effort matters (conative dispositional functions), 87.96%, 86.11%, and 87.78%, respectively, whereas in the other categories of dispositional functions, the percentages of occurrences of *agree* or *strongly agree* were generally in the 50% to 65% range for the high-achievement group. Furthermore, the proportion of high-achieving students who indicated agreement within each of the subcategories of dispositional functions was higher than that of moderate- and low-achieving students in every subcategory of dispositional functioning.

Prospective teachers in the high-achievement group were more likely to indicate that they believe mathematics is composed of connected concepts and related ideas as opposed to unrelated facts and procedures than moderate- and low-achieving students. This may be a consequence of deeper understandings that they may possess or at least an awareness of connections among conceptual underpinnings of mathematical ideas as evidenced by their higher achievement in the content course; however, this is merely speculation as this was not entirely determinable in the current study. High-achieving students were also more likely to indicate that studying and learning mathematics has been worthwhile to them. This is possibly a consequence of their having achieved in this particular content course, because in some cases, the extrinsic motivator of good grades may make the work that goes into earning high grades worth it.

Although the high-achievement group was higher than the other two achievement groups for this subcategory, it is curious that all of the achievement groups reported a relatively high sense of the worthwhileness of mathematics as compared with the other subcategories of dispositional functions. Although the current data do not reveal this, one might expect that because of the expectation each of these prospective teachers has that they may eventually be teaching mathematics, the work they are doing to study and learn mathematics has been worth it because of their motivation to teach mathematics (Beyers, 2005). High-achieving students were also more likely to agree that mathematics is a sensible discipline. Again, the current study does not enable this to be explicitly determined, but it could be the case that when students are achieving in mathematics, then it may be that they are able to make sense of the mathematics to the extent that they believe that mathematics is a sensible subject.

Another troubling result was that a majority of the non-high-achieving students did not report that mathematics is useful to them for meeting current or future practical needs, which is particularly interesting given that their professional work will likely involve teaching the mathematics they learn. Furthermore, there are several daily activities, such as cash transactions for purchases, balancing a checkbook, tipping in the service industry, parallel parking, and so on that require the use of mathematics. However, it is possible that the respondents may not have had these referents in mind when considering whether "mathematics" is useful to them. It is not as surprising, however, that a substantially larger majority of high-achieving students have a high sense of mathematics self-concept, that is, they believe they are competent learners of mathematics. This is understandable, as their achievement in the content course may have contributed to building or reinforcing their confidence in themselves as learners of mathematics (Hackett, 1985).

Similarly, that a large majority of the high-achieving students reported that they enjoy mathematics or have positive attitudes toward mathematics is not all that surprising. However, it is somewhat alarming that a substantial majority of the moderate and low-achieving students did not report that they enjoy or like mathematics. Poor attitudes toward mathematics could limit the willingness of the prospective elementary teacher to engage in meaningful mathematical activity (McLeod, 1992).

Another somewhat disconcerting result was that only a minority of the moderate-and low-achieving students indicated that math anxiety was not an issue for them. It seems problematic that only a minority of the prospective teachers in this sample indicated that they do not experience mathematics anxiety, given that math anxiety can affect performance on mathematical tasks (Hembree, 1990) or engagement in mathematical activity altogether (Bessant, 1995).

It is encouraging, however, that a large majority of the sample indicated agreement with the notion that, when necessary, effort and persistence are important for meaningful engagement in mathematical activity. If students believe that ability to do mathematics is fixed, then the incentive to put forth effort decreases (Kilpatrick et al., 2001). The National Mathematics Advisory Panel suggests that changing students' beliefs from a focus on ability to effort increases their engagement in mathematics learning (National Mathematics Advisory Panel, 2008). Consequently, there is a need to move away from the notion that innate ability determines who will be successful at mathematics. That such a large number of the prospective teachers in this population do believe that effort rather than some innate talent is responsible for success in mathematics is promising.

Implications for Teacher Preparation Programs and Future Research

If we are aware that not all prospective teachers demonstrate availing dispositions during their tenure in teacher preparation programs and those dispositions can negatively affect their learning of mathematics, then we have a professional responsibility to better understand these dispositional issues in the hope that they can be addressed to support student learning of mathematics. This of course requires careful consideration for possible interventions that may be available or that need to be designed and whether they may be able to nurture more availing dispositions in prospective teachers. One direction for future research could be a comparison of a proposed intervention (to a control without that intervention) using pre- and post-administrations of the MDFI to detect any changes in prospective teachers' dispositions. For example, consider knowing that a cohort of prospective teachers (via a pre-administration of the MDFI) has demonstrated a nonavailing affective dispositional function such as an absence of the belief that mathematics is useful for meeting their current or future needs. Perhaps developing a project or series of tasks where students identify a problem that they have in their own life that could be addressed using mathematics and then incorporating that into the curriculum could help to foster a belief that mathematics is in fact useful to them for meeting a practical need. Furthermore, given that only a minority of the prospective teachers in this sample indicated that math anxiety was not an issue for them suggests that teacher educators may need to consider options or interventions that could possibly ease math anxieties of students in their program. Perhaps making the issue of math anxiety transparent early on during classroom experiences and discussing with prospective teachers' possible causes or roots of that anxiety could help them to face and overcome those anxieties so that they do not subconsciously or even intentionally begin to avoid mathematical situations, which may be inducing feelings of anxiety.

As teacher educators, we would all hope that students we are preparing to teach mathematics exhibit availing dispositions which do not detract from their learning experiences while enrolled in teacher education programs. The finding that there are high-achieving students who do in fact report availing dispositions is encouraging; however, there is a somewhat alarming concern as well. There is a substantial portion of the prospective teachers in this study, largely low- and moderate-achieving students, who reported dispositions that were less than optimally consistent with recommended dispositions found in the literature. It is not to say that prospective teachers' dispositions precluded them from high-achievement in the mathematics content course, but to have some prospective elementary teachers who are non-high-achieving in mathematics and demonstrating nonavailing dispositions has some unsettling implications.

Ma (1999) suggested that developing a profound understanding of mathematics is necessary (but not necessarily sufficient) to teach mathematics effectively. If, as it was suggested earlier, dispositions with respect to mathematics can affect the ways students may or may not take advantage of opportunities to learn mathematics and consequently the knowledge and understandings they develop, then we as teacher educators can identify availing dispositions, which may positively affect the ways in which prospective teachers engage in mathematical activities. This requires that we understand what those availing dispositions are (using the MDFI) and how to link those dispositions to specific choices or behaviors that our students make, which do in fact support their learning experiences. This is another point for future research which involves, however, more than simply administering the MDFI, but which perhaps could not be done without this instrument. However, by using a mixed-methods approach, one could observe and document mathematical behaviors in students who reported availing dispositions, looking for trends in behaviors and choices, and compare those with the behaviors and trends in students who did not report availing dispositions. In follow-up interviews, a researcher could discern whether the choices made by students were in fact related to or a consequence of the dispositional functioning reported on the MDFI.

Additional possibilities for future research could include issues related to the stability of student dispositions with respect to mathematics. Do students' dispositions with respect to mathematics fluctuate regularly? How much of a change in a students' disposition might one expect to capture over the course of a week, a month, or a semester? This is an important question to address as it has implications for whether there could even be an immediate effect of a targeted intervention. In addition, whether a students' disposition evolves over the course of his or her tenure in a teacher preparation program is an important issue to consider. Or does a student's disposition digress? What impact, if any, do the collective experiences in a teacher preparation program have on students' dispositions? Can a teacher preparation program deliberately effect the dispositions of prospective teachers? A repeated measures design could track changes in students' dispositions over a prescribed time period to identify both developmental issues associated with dispositional functioning or potential influences of teacher preparation programs on students' dispositions. And now, we have an additional tool in our arsenal to do more than just wonder about these issues.

Limitations

One issue, which warrants further consideration, is related to the measure of achievement used in this study as a proxy for learning in mathematics. Although two sources of achievement data were used in this study in an attempt to provide a more robust measure of prospective teachers' achievement in mathematics, it is somewhat problematic in that the two assessments used occurred approximately 5 weeks apart from each other while the MDFI was administered between these two assessments. An underlying assumption here is that the dispositions that were assessed for this study are somewhat stable as well as the related achievement during the semester. There is, however, no guarantee that if the MDFI were given at a different time, either at the end of the semester after the final exam or prior to the administration of the second midterm exam, that the results would be similar because the student could have been low-achieving according to one measure, but high- or moderate-achieving according to the other. However, an analysis of the rankings of students' achievement revealed that there were no significant shifts in rankings by achievement. One way to possibly amend this issue is to incorporate a mixed-methods approach for exploring students' dispositions, including observations of mathematical activity with follow-up interviews to supplement the survey data while collecting more examples of student work, such as a portfolio of a semester's work.

Another issue worth noting is related to the potential for students' performance to influence how they may have responded to items on the MDFI. Researchers suggest that past performance can have an influence on aspects of students' dispositions (e.g., Hackett, 1985). It is possible that the success or failures, which occurred on the second exam, may have skewed results in one direction or another for particular students. However, by having a second source of achievement data which occurred after the administration of the MDFI and a large enough sample to ensure sufficient power, it was hoped that the relationship revealed by the methods used in this study would be as close to a stable representation of the actual relationship as possible.

In addition, the assessments of achievement in mathematics used here are specific to prospective elementary mathematics majors, whereas several items on the MDFI ask about mathematical experiences outside of an elementary education teacher education program. There is no measure of achievement for mathematics outside of an elementary education program used in this study. A point for future consideration would be to include measures of achievement which are not so specialized as to be limited to the mathematics specific to an elementary education program, but which are not too broad as to include mathematics, which the students have not learned, thus providing a more comprehensive assessment of achievement in mathematics.

Conclusion

Typically, previous studies have focused on isolated components of students' dispositions with respect to mathematics, such as attitudes and beliefs (Royster et al., 1999) or mathematical argumentation (e.g., Yackel & Cobb, 1996), and so on. However, this study provided a comprehensive examination of student dispositions with respect to mathematics and how they are related to achievement in mathematics while maintaining an appreciation for the many nuances of dispositions highlighted in previous research such as those earlier (e.g., Kloosterman & Stage, 1992; Royster et al., 1999). Findings suggest that although prospective teachers' dispositions with respect to mathematics are significantly related to achievement in mathematics, the relationship is not quite so simple. Although prospective teachers' affective and conative dispositional functioning was significantly related to achievement, their cognitive dispositions were not, a surprising result.

The results of this study indicated that prospective teachers do in fact hold some availing dispositions, for example, beliefs about the worthwhileness of mathematics or beliefs about the role of effort and persistence in learning mathematics; however, some concerns have been identified about potentially nonavailing dispositional functions, such as their beliefs about the usefulness of mathematics or mathematics anxiety. The MDFI now affords researchers and teacher educators a comprehensive assessment for identifying potentially nonavailing dispositions with respect to mathematics so that appropriate measures can be taken to positively affect the dispositions of prospective teachers, as leaving these issues unchanged may propagate dispositions which detract from their learning experiences as students of mathematics. In addition, the MDFI offers another resource for School of Education teacher education programs to track dispositional changes among its teacher candidates further supplementing data sources for accreditation.

Appendix

The Primary Scales and Subcategories of Dispositional Functions With Associated Items

Scale	Subcategory	Sample items
Cognitive	Connections (inspired by Boaler, 2002)	19, 27, 53, 29, 51 19—When I think about mathematical ideas, I try to think about how they connect to other ideas in math.
	Argumentation (inspired by NCTM, 2000; Yackel & Cobb, 1996; language for all items borrowed from NCTM, 2000)	18, 26, 12, 48, 14 18—Even if I'm not asked to justify something, I still try to use mathematical reasoning and justification to explain how I did something in math classes.
Affective	Nature of mathematics (inspired by Grouws, 1994; Kloosterman & Stage, 1992; Kilpatrick, Swafford, & Findell, 2001)	6,[a] 31,[a] 38,[a] 41,[a] 13,[a] 58,[a] 21, 33, 35, 45 6—When I am doing a math problem, I look for solutions to similar problems and follow the steps from those solutions to find an answer to my problem.
	Usefulness (inspired by Kilpatrick et al., 2001; items constructed based on language used by Kilpatrick et al., 2001)	5,[a] 10,[a] 20, 2, 3,[a] 17, 24,[a] 32,[a] 34,[a] 39,[a] 54,[a] 55 (repeat of item 20) 5—If I weren't going into a profession that required training in mathematics, I would have little use for taking mathematics in college.
	Worthwhileness (inspired by Kilpatrick et al., 2001; items constructed based on language used by Kilpatrick et al., 2001)	16, 4, 50 16—All the work I have (or will) put into learning mathematics here at the university will be worth it to me.
	Sensibleness (inspired by Kilpatrick et al., 2001; items constructed based on the language used by Kilpatrick et al., 2001)	44,[a] 25, 60,[a] 47 44—A lot of times, topics in mathematics can be so disconnected from each other that it is next to impossible to make sense of the "big picture."
	Mathematics self-concept (inspired by Kilpatrick et al., 2001; Reyes, 1984; Fennema & Sherman, 1977)	7, 28,[a] 30, 40, 46,[a] 59 28—In general, math is too challenging for me to really understand it well.
	Attitude (inspired by McLeod, 1992)	11, 15[a] (negatively worded repeat of Item 52), 49,[a] 56,[a] 52 49—In general, I don't like math.
	Math anxiety (inspired by conceptions of math anxiety, Alpert & Haber, 1960; McLeod, 1992; and test anxiety, Alpert & Haber, 1960)	1, 9,[a] 37,[a] 42,[a] 57[a] 42—In general, I get more stressed when I have to take a math test than any other kind of test.
Conative	(Inspired by Kilpatrick et al., 2001; items constructed based on the language used by Kilpatrick et al., 2001)	8,[a] 22,[a] 23,[a] 36, 43 8—No matter how much effort some people put into learning math, they just won't understand it.

[a]These items were negatively worded and for the purposes of the analysis were reversed when coded.

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Notes

1. These terms will be formally defined in the conceptual framework section of this proposal.
2. It should be noted that this conceptual framework is not strictly limited to the dispositional functioning of prospective teachers; it applies to students of mathematics generally. However, for the purposes of this study, I am using the framework to guide a study of prospective teachers' dispositions with respect to mathematics.
3. It should be noted that the researcher was not one of the course instructors.
4. Although there are 60 items on the final version of the MDFI given to participants, only 58 items were used in the analyses, as two items were repeated items. Items 15 and 20 are repeated versions of items 52 and 55, respectively. Two items were repeated to bolster confidence that the respondents were responding to items genuinely.
5. For this and each subsequent analysis, the significance of all relationships will be determined by setting $\alpha = .05$, that is, for all *p*s $\leq .05$, the corresponding relationships will be considered significant.
6. There were 36, 35, and 35 prospective teachers in the high-, moderate-, and low-achieving groups, respectively. The same groupings were used for all analyses.
7. Levine's test of homogeneity of variances was not significant, that is, the variances of the groups did not differ significantly.
8. Levene's test for homogeneity of variances was not significant.
9. Pillai's trace revealed a significant multivariate effect.
10. An alpha level of .05 was used for all statistical tests.
11. The mean differences from high- to low-achieving (+21.19) and from high- to moderate-achieving (+18.31) students were both significant, whereas the mean difference between moderate- and low-achieving students (+2.88) was not significant.
12. Levene's test of equality of variances for each of the dependent variables was not significant. Thus, the assumption of homogeneity of variances has been met and subsequent ANOVAs may be performed.
13. See Table 1 for a complete list of the mean differences for the three scales by achievement group.
14. Each of the distributions for the values given in Table 5 was essentially normal.

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Bio

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