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ABSTRACT

Dispositions of eighth graders accelerated into first-year algebra were described in this study. Data were collected through surveys, observations, interviews, and cumulative academic files. The most frequently reported reasons for enrolling in algebra were for acceleration of course-taking and preparation for high school. Males demonstrated a higher level of self-efficacy to perform in algebra and secondary mathematics. Students showed a high level of perseverance in terms of sacrifices made to take the course, but classroom performances indicated negative dispositions toward mathematics. Students were driven by a desire to please the teacher and earn grades rather than out of natural curiosity and interest. Neither students nor their parents recognized the real-world applications of algebra. Certain teaching methodologies appeared to evoke positive dispositions. Contains 17 references. (Author)

Mathematical Dispositions of Students Enrolled in First-Year Algebra

Daniel J. Brahier

Paper presented at the Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education

(17th PME-NA, Columbus, OH, October 21-24, 1995)

MATHEMATICAL DISPOSITIONS OF STUDENTS ENROLLED IN FIRST-YEAR ALGEBRA

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Dispositions of eighth graders accelerated into first-year algebra were described in this study. Data were collected through surveys, observations, interviews, and cumulative academic files. The most frequently reported reasons for enrolling in algebra were for acceleration of course-taking and preparation for high school. Males demonstrated a higher level of self-efficacy to perform in algebra and secondary mathematics. Students showed a high level of perseverance in terms of sacrifices made to take the course, but classroom performances indicated negative dispositions toward mathematics. Students were driven by a desire to please the teacher and earn grades rather than out of natural curiosity and interest. Neither students nor their parents recognized the real-world applications of algebra. Certain teaching methodologies appeared to evoke positive dispositions.

When students reach the eighth grade, they often either make a decision or have a decision made for them regarding the study of mathematics—whether to maintain a program that includes a general mathematics "survey" course or to pursue the study of first-year algebra. Traditionally, students have enrolled in a first-year algebra course in the ninth grade. However, over the past ten years, there appears to be a growing interest in eighth graders studying first-year algebra. In the 1991-1992 school year, 13% of the eighth graders in the United States were enrolled in a first-year algebra course (Blank & Gruebel, 1993), and the percentage was similar in 1990 (Mullis, Dossey, Owen, & Phillips, 1991). According to Epstein and Mac Iver (1992), 67% of all public and 47% of Catholic schools in the U.S. reported offering a full year of algebra to eighth graders.

Being a teacher of eighth grade algebra, I became curious as to why they were taking the course and what their attitudes and dispositions were toward the study of mathematics in general. In the Fall of 1994, I conducted a study to address these issues. While several research questions were pursued in the current study, the primary focus of this paper is on the following two questions: (1) Why do the students choose to take an algebra course, and what are the students' attitudes and classroom behaviors in the study of mathematics? (2) To what degree, if any, do the student dispositions as defined by the NCTM differ from the student simply having a "positive attitude" toward mathematics (e.g., "I like the subject," or "I think that math is useful")?

Conceptual Framework and Definitions

When the National Council of Teachers of Mathematics released the *Curriculum and Evaluation Standards for School Mathematics* (1989), they proposed an Evaluation Standard which they referred to as "mathematical disposition." Disposition, they explained, has several components: (1) interest and curiosity, (2) perseverance, (3) confidence, (4) flexibility, and (5) valuing the application of mathematics. The NCTM stated that "disposition refers not simply to attitudes but to a tendency to think and to act in positive ways" (p. 233). Motivation literature typi-

cally focuses on emotions (interest and curiosity), as well as confidence and goals. Definitions and descriptions follow.

Interest: Interest, as described by Dewey (1913), refers to one's desire to pursue some object because the person recognizes that it will promote personal growth. Research on interest that was particularly relevant to the current study was conducted with ninth graders by Harter (1981). She concluded that as students progressed through the grades, they showed more of a preference for easy work instead of a challenge and worked more for teacher approval and grades than out of curiosity and interest.

Perseverance: Perseverance can be described as the willingness of an individual to remain on task until completion of a difficult problem or situation. Perseverance has been linked to the dispositions of interest (Hidi, 1990) and self-efficacy (Collins, cited in Bandura, 1993; Multon, Brown, & Lent, 1991).

Confidence (Self-Efficacy): Personal agency beliefs have perhaps been most fully investigated under Bandura's (1977) term "self-efficacy." Bandura (1986) defined self-efficacy as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (p. 391).

Flexibility: Flexibility was defined by the NCTM (1989) as the student's tendency for "exploring mathematical ideas and trying alternative methods in solving problems" (p. 233). In the Standards document, they stated that classroom discussions can reveal information about student flexibility by the teacher reflecting on questions such as, "How willing are students to explain their point of view and defend that explanation?" (p. 234).

Research Methods

I conducted this research by using a sample of eighth grade students enrolled in first-year algebra in Catholic schools in a Midwest state. I chose this population, in part, because most of the students elected to take algebra instead of the traditional eighth grade mathematics course. The reader should not assume that any generalization of the data to other students in another Diocese, public school district, or state is necessarily implied.

Of the schools having eighth year classes in the Diocese studied, 45 had an algebra course available. The schools were located in diverse settings. Twelve of the classes were selected by using a stratified purposeful sample, as suggested by Patton (1990). These 12 classes served 19 schools, since some classes contained students from two or three different buildings. Participating schools were deliberately chosen to ensure a mix of demographics and a reasonable sample size. A majority of the algebra courses in the Diocese were taught in urban and suburban settings, so most of the participants were selected from this group. A total of 107 males and 96 females were included in a survey.

After issuing a 20-item, paper-and-pencil survey to these students, four of the schools were selected for additional study. They were purposefully selected to include large and small classes, male and female teachers with varied experience

levels, and a demographic mix. The students from these four selected schools were observed over a six-week period, and then six students were purposefully selected from each class for a student interview and an interview with their parents. The cumulative files of each of these 24 students were also examined. Field data were collected in the classroom and in interviews. Collection of data from multiple sources allowed for triangulation of the data.

Results

Reasons for Taking Algebra in Eighth Grade

On the survey, respondents were asked why they took algebra as eighth graders, and this issue was pursued in interviews with students and their parents. The survey responses to the question were categorized and are summarized in Table 1. In the subsequent interviews, acceleration and preparation for high school were also cited as primary reasons for taking algebra. Overall, students had primarily extrinsic reasons for taking algebra. Particularly prevalent was the attitude of interviewed students that failure to take the course might allow other students to "get ahead" of them. This finding suggests that most of the students held what Ames & Archer (1988) referred to as an ego goal orientation, in which individuals are motivated by their desire to outperform their peers.

Table 1.
Rank-ordered survey responses on why eighth graders took algebra.

Reason	Responses		
	Male (n = 107)	Female (n = 96)	Total (n = 203)
Acceleration of High School Mathematics	73	71	144
High School Preparation	19	19	38
Perceived Ability	6	13	19
Challenge	10	8	18
Like/Enjoy Mathematics	6	7	13
Coerced/Forced to Take the Course	7	3	10
Opportunity or Desire to Learn More	5	5	10

Note. Students frequently provided multiple reasons for taking algebra.

Dispositions

Some of the most interesting results of the study were in the area of self-efficacy of students. The respondents were asked to report past grades in mathematics and to project grades in algebra and beyond on the survey. The survey results are reported in Table 2.

Table 2.
Survey responses to 7th grade mathematics grades and predicted algebra grades.

Course	Responses Male (n = 106)	Female (n = 96)	t
7th Grade (Reported)			
M	11.47 (A-/A)	11.65 (A/A-)	1.00
SD	1.34	1.19	
Algebra (Projected)			
M	10.43 (B+/A-)	9.83 (B/B+)	2.61*
SD	1.55	1.71	
Repeated Measures t	6.16*	8.48*	

Note. In computing the mean, an F = 1 point, D- = 2 points, D = 3 points, ... , and A+ = 13 points. Therefore, the higher the mean score, the higher the reported or projected grade in that course. * $p < .05$.

Overall, females in the survey reported slightly higher grades in seventh grade mathematics than their male peers, but they predicted significantly lower grades in algebra. Likewise, both males and females predicted that their algebra performances would be at least one letter grade lower than their previous mathematics grades. Successful past performances in mathematics did not generally result in a high level of self-efficacy to perform in algebra and high school mathematics courses in general. Phillips (1984) and Dweck (1986) reached similar conclusions in their research. In the interviews for the current study, students described their perceptions of algebra and high school mathematics as being "different" and more difficult, citing cases of friends and siblings who struggled with these advanced courses as influencing their attitudes.

Since most of the students took the algebra course by choice, they described the types of sacrifices that they were making to accommodate the course. Some students were taking two mathematics courses at once, while others were involved in athletics, activities, and part-time jobs that kept them up late at night to complete homework, which concerned their parents. However, classroom observations showed that students showed little signs of perseverance on day-to-day tasks. When confronted with a difficult task in class, they tended to become quickly frustrated and immediately sought assistance from the teacher.

Interviews with students about their classroom behaviors indicated that most eighth graders found it extremely important to please the teacher by following classroom rituals, such as properly correcting errors on papers and writing solutions the way that the teacher had modeled. They appeared much more interested in impressing the teachers and earning high grades than learning for the sake of learning.

Many classroom observations in this study were disappointing in terms of collecting data on dispositions because of the nature of the lessons being taught.

Since most of the lessons followed a traditional path of checking homework, "showing" new sample problems, and allowing students to begin their homework, there was little opportunity for students to demonstrate positive dispositions. A problem posed in the classroom needs to be rich enough to evoke curiosity or to make the students feel that it is "worth" pursuing. Though very infrequent in my observations, the classroom experiences that involved teamwork, calculators, and "real-life" problems appeared to evoke positive dispositions.

Finally, students and their parents saw little use or real-world applications for algebra. They felt that the course was important, but only as a prerequisite for other classes. Students felt that the individuals who most needed an algebra course were future algebra teachers. This is similar to the circular argument that the reason we study algebra is to prepare for geometry, which prepares us for more algebra and so forth. Misconceptions about the nature of algebra appeared to stem from teacher-directed classroom experiences that emphasized rote, mechanical symbol manipulation over problem solving.

Discussion

Prior to an algebra course, it appears that a student's dispositions are affected by experiences and perceived ability, as suggested by Schunk (1991). In addition, a model such as a peer or sibling may affect an initial disposition. After the class begins, however, feedback and modeling from the teacher, as well as peer models and parents begin to interact on the student. When faced with peers, siblings, parents, and even teachers who have poor dispositions in algebra, the student becomes part of a recurring cycle of negativism toward mathematics. The only way that a student can get out of this cycle and develop a positive disposition, therefore, is for the teacher to instruct in a way that would assist the student in appreciating that algebra is worth knowing in and of itself. This type of instruction, however, depends upon a strong curriculum and relevant curricular materials, and it assumes that the teacher understands the relevance of algebra and uses effective instructional techniques.

The NCTM (1991) established a teaching Standard that educators should "promote mathematical disposition." They stated that it is the teacher's role to model positive disposition. The assumption is that the classroom environment established by the teacher will affect student dispositions and general beliefs about mathematics, similar to Schunk's (1991) assertion that positive classroom models have a direct effect on student self-efficacy and persistence. When teachers model positive attitudes, they have the potential to create a learning environment that fosters inquisitiveness and curiosity.

Additional research is needed on the development of student dispositions toward mathematics. For example, theory-driven issues such as the relationship between self-efficacy and persistence of eighth graders could be pursued, as well as a comparison of goal orientations by gender. In addition, longitudinal work with students involved in the survey and interviews described in this study could shed light on how many of these students actually move on to take four more years

of high school mathematics, as well as how and why their dispositions toward mathematics evolve over the next several years.

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