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AUTHOR Blum-Anderson, Judy
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ABSTRACT

The attitudes and beliefs that students hold about the subject of mathematics and about themselves as learners of mathematics contribute as much to the school's mathematical environment as do the concrete and cognitive aspects of mathematics. This paper considers the effects of mathematical affect and the use of intervention programs to increase the retention of women and minorities in higher-level mathematics courses. Mathematical affect plays a role in the development of long-term mathematical persistence behaviors, such as course-enrollment decisions. The most critical period in which to use interventions to influence mathematical affect is the middle/junior high school age level. More students will be able to develop the short-term persistence behaviors necessary to experience success within the mathematical environment when attention to affect begins to be included as a regular part of the mathematics curriculum. Once students possess short-term persistence behaviors, it will be easier to motivate them to continue to enroll in mathematics courses. (YP)

AFFECT AND MATHEMATICS:

PERSISTENCE IN THE MATHEMATICAL ENVIRONMENT

Judy Blum-Anderson, Ph.D. Candidate
Washington State University
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The components of a school's mathematical environment consist of much more than pages of textbooks, mathematical achievement test scores, and grade reports; the students are a major part of that environment. The attitudes and beliefs that students hold about the subject of mathematics and about themselves as learners of mathematics contribute as much to that environment as do the concrete and cognitive aspects of mathematics. It is not likely that students will be highly motivated to persist in the study of mathematics if little attention is given to the development of their attitudes and beliefs about mathematics (their mathematical affect). A mathematical environment cannot be considered to be healthy if any one of its individual components is not functioning to its potential.

Healthy mathematical environments have enrollment patterns in upper-division courses that include equal numbers of male and female students from all levels of the school's achievement range. Traditionally, participation in higher-level mathematics courses has been heavily weighted towards white males who occupy not only the majority of the seats in the higher-level mathematics classrooms but, in turn, hold the majority of the positions in economically-rewarding professions which required higher-level mathematics in order to gain entrance to those professions.

When students fail to develop the persistence behaviors that are necessary in order for them to continue to enroll in higher-level mathematics courses, they are effectively filtering themselves out of complete freedom of educational and occupational choice (Davis & Hersh, 1986; Wiggans et al., 1983; Sells, 1978). Some examples of the filtering effects of mathematics are when employers use scores from standardized mathematical tests as quick and easy ways to screen job applications even if the ability to perform mathematical operations is not part of the actual job requirements, and when some graduate schools of business use a calculus requirement as an inexpensive way of screening out applicants when the number of applications exceeds the number of spaces available (Davis & Hersh, 1986). When mathematics scores are used to screen applications, the consequence is that the applications from women and minorities are the ones that are most often eliminated.

Recent research on gender-related differences and mathematics achievement indicates that while there are few gender-related differences in cognitive mathematical achievement when the amount and type of mathematics taken is controlled (Smith & Walker, 1988), there are consistent and significant differences between the sexes in several affective areas (Reyes, 1984; Fennema & Sherman, 1977). Additionally, gender-related differences in mathematical affect exist even when there is no evidence of differences in achievement (Fennema, 1985). It appears that it might be likely that the differential mathematical course-taking behaviors that are found between females and males are more dependent upon affective, socio-cultural factors instead of differences in cognitive abilities (Eccles & Jacobs, 1986; Day, Langbort, & Skolnick, 1982; Fennema & Sherman, 1977).

Mathematical Affect

Schemas related to mathematical affect are constructed by students during interactions with mathematical concepts within the confines of formal mathematical environments. The nature of the affective components of each students' mathematical schemata influences whether or not students will develop short-term and long-term persistence behaviors in the study of mathematics (Marshall, 1989). Affective schemas hypothesized to be the most influential in the development of mathematical persistence are those which are related to a belief in the usefulness of mathematics, confidence in the ability to learn mathematics, and attributional style (Fennema & Peterson, 1985). No single affective variable, alone, will determine whether or not a student will persist in the study of mathematics.

Positive mathematical affect can assist students in bringing routine and nonroutine problems to completion; however, negative mathematical affect can serve to scramble or even arrest cognitive processes and prohibit selection of appropriate completion strategies (Goleman, 1985; Isen, Daubman, & Gorgolione, 1987). Students demonstrate short-term persistence behaviors by having the ability to delay and become temporarily removed from the situation when emotions (negative affect) begin to interfere with cognition (Mandler, 1984, 1989), by developing an attributional style where failures are attributed to controllable factors (i.e. the applications of erroneous strategies or lack of effort) rather than to the uncontrollable factor of lack of ability (Weiner, 1986), and by recognizing that frustration is a normal part of learning mathematics (McLeod, 1988).

Mathematical affect plays a great role in the development of long-term mathematical persistence behaviors. These behaviors are demonstrated at the time of course-enrollment decisions. Long-term mathematical persistence behaviors are influenced, in part, by the dictates of one's cultural reference group (Weiner, 1986; Mandler, 1984), by the sense of self-worth that one gains from participation in the activity in question (Covington, 1984), and by the information that one possesses with regard to the personal value that engagement in the activity will bring (Weiner, 1986; Maehr, 1984).

Influencing Mathematical Affect

Research has shown that affective variables leading to persistence in mathematical environments can be influenced by using intervention programs (Fennema, Wolleat, Pedro & Becker, 1981; Casserly, 1980; Brush, 1980). The use of mathematical intervention programs which highlight affective variables has resulted in increases in enrollment and/or in intentions to enroll in higher-level mathematics courses. The most critical period in which to use intervention to influence mathematical affect is the middle/junior high school age level. During this period, sex-typing is at its peak and the school culture indicates that mathematics is becoming more difficult (Center for Early Adolescence, 1984; Casserly, 1980). Females and males possess nearly identical attitudes towards mathematics during middle/junior high school; it is not until high school that the beliefs of males and females differ substantially, and enrollment patterns begin to favor males (Armstrong, 1980). High school is often too late to influence mathematical affect. It is nearly impossible to motivate students to return to the mathematics classroom after they have already elected to opt out of the mathematical sequence (Center for Early Adolescence, 1984).

Although research has shown that one-shot intervention programs can be used to motivate students, in particular females and minorities, to desire to persist in the study of mathematics, it is not likely that the number of female and minority students taking higher-level mathematics courses can be substantially increased unless attention to affective issues is included as a regular component of the mathematical environment. When attention to affect begins to be included as a regular part of the mathematics curriculum, more students will be able to develop the short-term persistence behaviors that are necessary to experience success within the mathematical environment. When students possess short-term persistence behaviors with regard to mathematics, it will be easier to motivate them to continue to enroll in mathematics courses throughout their high school and college years.

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