14

The Study of Affect and Mathematics: A Proposed Generic Model for Research

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During the last 15 years, much understanding has been gained about cognitions in mathematics. Starting with the content area of early number concepts, progressing through rational numbers and algebra, and culminating with problem solving by university mathematicians, scholars have been probing cognitions and determining how human beings think with mathematical ideas. This knowledge is beginning to be useful not only in understanding human thought processes, but also in the development of new paradigms for curriculum development (Carpenter, in press). This knowledge has grown and become useful because a relatively consistent research methodology has been used in relation to a fairly concise theoretical model of cognitive processing. Usually this cognitive science research methodology started with an explicit definition of some specific mathematics content; questions relating to this definition have been formulated; subjects were asked to think aloud (or self-report) as they answered the questions; their responses were studied for patterns of thinking; and, finally, the identified patterns were compared with the overall theory to see if the theory was supported or needed modification.

Research on affective variables, their development and relation to mathematical learning, has also used a self-report methodology. This methodology, although usually implemented with groups of learners, rather than with individuals, has resulted in certain kinds of knowledge that have also been useful in developing theories. However, the research on affective variables has not yet resulted in a cohesive picture, nor are there many implications that can be derived from this research area for teacher education or instruction. The purpose of this chapter is to explore the character of research dealing with affective variables and to discuss its strengths and weaknesses. I propose a theoretical model for work in the affective domain that might provide a cohesive framework for understanding the development of affective variables as well as their influence on mathematical learning. Such a model is generic in the sense that it can be useful in a variety of situations investigating diverse variables with many age groups. I also propose a blending of the traditional affective research methodology with a cognitive science methodology.
Descriptive Work on Affect

During the years that our knowledge about cognitions in mathematics has been growing, other scholars have been attempting to understand how beliefs, emotions, feelings, and attitudes are related to the learning of mathematics. Although there are major problems with definitions (see Hart, this volume, Chapter 3; Leder, 1987), this broad spectrum of variables can be referred to as affective variables (see Krathwohl, Bloom, & Masia, 1964).

Traditional Methodology

There have been many reported studies on affective variables. Some have been done in an attempt to understand the variables within the broad educational community (e.g., Shavelson, Hubner, & Stanton, 1976). Within the mathematics education community, the initial motivation for most of this work has been the desire to understand variables related to gender differences in mathematics. Using a traditional research methodology, variables thought to be important in explaining gender differences in mathematics were identified, and their components defined and operationalized into items combined into scales. Comparisons of scores on these scales have been made between groups of females and males, correlations computed between the variables and mathematics learning, and/or scores regressed onto achievement measures (see Meyer & Fennema, 1988, and Eccles, 1986, for reviews of this work).

This work has produced some interesting and useful knowledge. We know, for example, that confidence in one's ability to learn mathematics is correlated with mathematical achievement at about the .45 level (Fennema & Sherman, 1978); it is an important predictor of mathematics achievement, and it appears to be a better predictor of females' performance than of males' performance (Meyer, 1985). Perceived usefulness of mathematics is also correlated with achievement and predicts performance (Elliott, 1987). Subjects' beliefs about the usefulness of mathematics have been modified, and this modification has resulted in increased willingness to enroll in more mathematics courses (Fennema, Wolleat, Pedro, & Becker, 1981). Males report causal attributional patterns that are different than those reported by females (Wolleat, Pedro, Becker, & Fennema, 1980), and the pattern reported by males has been hypothesized to have a positive influence on learning.

Although some of the work on gender and affective variables has dealt with causal modeling (see Meyer, 1985; Eccles, 1986; Fennema & Peterson, 1985), most work has been descriptive, and focused on describing the differences between groups of people, usually males and females, on traits assumed to be relatively stable. The work has produced replicable results that have shown positive relationships between certain affective variables and achievement measures of various kinds. Indeed, this set of studies provided information that confirms the belief that attitudes toward mathematics are important. Moreover, the results of this research appear to be more significant than the studies produced over a