DOCUMENT RESUME

ED 380 279 SE 055 889

AUTHOR Gutbezahl, Jennifer
TITLE How Negative Expectancies and Attitudes Undermine Females' Math Confidence and Performance: A Review of the Literature.
PUB DATE [95]
NOTE 33p.
PUB TYPE Information Analyses (070)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Elementary Secondary Education; *Females; *Mathematics Achievement; *Mathematics Anxiety; Mathematics Education; Parent Attitudes; Self Esteem; Sex Differences; *Student Attitudes; Teacher Attitudes; Teacher Expectations of Students

ABSTRACT

Females' underperformance in mathematics is discussed as a function of negative expectancies by parents, teachers, and peers. These negative expectancies of significant others lead to negative self-expectancies and negative attitudes about mathematics on the part of female students. These negative expectancies and attitudes lead to lower performance, reinforcing parents' and teachers' negative expectancies. Thus a cycle of low expectancies leading to low performance leading to even lower expectancies is perpetuated. Some reasons this cycle persists are: (1) girls, more than boys, tend to believe that mathematical ability is something individuals either have or do not have; (2) girls are more math anxious than boys; (3) girls may believe that "girls just cannot do math"; (4) girls' belief that their ability is so low that no amount of work will compensate, may drain their willingness to persist; and (5) girls may self-handicap by withholding effort. Implications of this continuing cycle and possible ways to break it are discussed. Contains 10 references. (Author/SW)

Running Head: NEGATIVE EXPECTANCIES AND ATTITUDES

How Negative Expectancies and Attitudes Undermine Females' Math Confidence and Performance: A Review of the Literature

Jennifer Gutbezahl

University of Massachusetts, Amherst

Abstract

Females' under-performance in mathematics is discussed as a function of negative expectancies by parents, teachers and peers. These negative expectancies of significant others lead to negative self-expectancies and negative attitudes about mathematics on the part of female students. These negative expectancies and attitudes lead to lower performance, reinforcing parents' and teachers' negative expectancies. Thus a cycle of low expectancies leading to low performance leading to even lower expectancies is perpetuated. Presented are some reasons why this cycle persists and implications for its continuation into the future.

How Negative Expectancies and Attitudes Undermine Females' Math Confidence and Performance: A Review of the Literature

"When a woman becomes a scholar, there is usually something wrong with her sexual organs."

-- Friedrich Nietzsche

"Math is hard."

-- Teen Talk Barbie™

There is a common belief that females are less mathematically capable than males. This belief is fairly constant across populations (see e.g. Eccles, 1987). Classroom studies have shown that this belief is in place by the time children enter the third grade (Crawford, Herrmann, Holdsworth, Randall & Robbins, 1989). This belief is mirrored by students' parents. By the time children enter kindergarten, parents expect girls to do better at verbal tasks and boys to do better at math (Lummis & Stevenson, 1990). This belief continues through elementary school (Entwistle & Baker, 1983) and on throughout the academic process (Hyde & Linn, 1988; Yee & Eccles, 1988).

This belief is not entirely unfounded. Although evidence from the many studies performed on gender differences in mathematics is inconsistent, small but statistically significant differences are the norm (see Feingold, 1988; Hyde, Fennema & Lamon, 1990; Lubinski & Benbow, 1992; Maccoby & Jacklin, 1974 for some reviews of the literature). These

between-gender differences are generally quite small compared to variability within each gender. Furthermore, these differences are becoming smaller over time (Linn & Hyde, 1989). There are no significant differences between boys' and girls' math achievement in elementary school, and few differences at any age (Feingold, 1988; NAEP, 1983; Shipman, Krantz & Silver, 1992). Although these differences are small, parents and teachers often expect large discrepancies between boys' and girls' performance in math class. Because others' expectations can have a strong influence on one's attitudes (Tocci & Engelhard, 1991; Triandis, 1971; Zimbardo & Ebbersen, 1970) and behavior (Snyder, 1979; Snyder & Swann, 1978), parents' and teachers' negative expectations put girls at a distinct disadvantage in the classroom.

What Parents and Teachers Expect of Girls

When Benbow and Stanley (1980) found that boys performed better than girls on the quantitative portion of the Scholastic Aptitude Test, the mainstream press immediately reported the results. These reports included the assertion that, because the experimenters had controlled for the number of classes each student had taken, the difference must have some biological basis. For example, Newsweek (December 15, 1980) carried the headline "Do Males Have a Math Gene?" and gave the answer as yes (reported in Hyde, Fennema, Ryan, Frost & Hopp, 1990). The study had some serious flaws. The investigators had not collected any biological data, but claimed that environmental factors could not have affected the students' performance because boys and girls had taken the

same number of math classes. Unfortunately, by the time critics pointed out that even in the same classroom, boys and girls may have very different experiences (Eccles, 1983; Eccles & Wegfield, 1985), the mainstream press had moved onto other stories. This study reinforced the stereotype of girls as people who are simply unable to do math.

Parent Expectations

Girls whose parents were familiar with the Benbow and Stanley studies did significantly worse in math than girls whose parents were unfamiliar with the studies (Eccles & Jacobs, 1986). Even parents unfamiliar with this study tend to rate daughters as less mathematically able than sons, even if these daughters and sons are performing at the same level. Many parents accept their sons' mathematical successes as evidence of innate ability, while they think of their daughters' successes as hard work compensating for innate lack of ability. (Eccles, 1989; Yee & Eccles, 1988). Children whose parents attribute success to effort have lower self-esteem than children whose parents attribute success to ability (Eccles-Parsons, Adler & Kaczala, 1982).

Parents treat boys and girls differently from birth. They are more physically active with boys than with girls (Huston, 1983; Lewis, 1972; Parke, 1976) and give boys more spatially complex toys and more opportunities to explore their physical worlds (Baennenger & Newcombe, 1989; Miller, 1987; Serbin & Conner, 1979). These differences may contribute to the well-documented gender differences in spatial ability (see Baennenger & Newcombe, 1989; and Halpern, 1992 for reviews).

Spatial ability is an important component of math skills and facilitates comprehension of abstract mathematical concepts used in geometry, trigonometry and calculus.

Parents may allow boys more chances for active interaction with the physical world, but they talk more to girls (Maccoby & Jacklin, 1974; Unger & Crawford, 1992). Interestingly, experimenters talk more to animals they believe to be dull than to those they believe to be bright, although they handle the dull animals less. Thus, these supposedly dull animals get verbal but not physical stimulation from the experimenter. These animals do not learn as quickly as animals alleged to be bright, even when there are not actual differences between the two groups. (Rosenthal & Fode, 1963; Rosenthal & Lawson, 1964).

Teacher Expectations

Teachers' expectations can have a direct influence on students' grades, with students who are expected to do well consistently outperforming those who are expected to do poorly (Feldman & Theiss, 1982; Good & Brophy, 1987; Rosenthal & Jacobson, 1968). Teachers expect less academically from girls than from boys and treat girls quite differently from the way boys are treated. Boys are praised for their ability when they do well, and criticized for not working harder when they don't. Girls are complimented on their hard work and neat performance when they succeed in math; they are told they are not bright when they fail (Dweck, 1986; Dweck, Davidson, Nelson & Enna, 1978; Stockard, 1980). Boys also are attended to by teachers more than

girls are, receive more help from teachers on areas in which they have problems academically, and are called on more often to give answers in class (Becker, 1981; Epperson, 1988; Fennema & Reyes, 1981; Koehler, 1990; Simpson & Erikson, 1983).

In schools which group students by ability, girls are significantly less likely to be put in high-ability groups than are boys of equal ability, and are significantly more likely to be misassigned than boys (Hallinan & Sorenson, 1987). Even in the same classroom, the questions asked of girls tend to be at a lower cognitive level than the more conceptual questions asked of boys (Clewell, Anderson & Thorpe, 1992; Fennema & Reyes, 1981; Good, Sikes & Brophy, 1973). These lower-level questions do not provide the opportunity to apply basic math skills to higher-order concepts (Coles & Griffen, 1987). Students who have the opportunity to apply skills to higher order concepts themselves (as opposed to simply seeing teachers or peers go through the process) perform better mathematically (Fennema & Peterson, 1985; Koehler, 1990; Webb & Kenderski, 1985).

Thus both parents and teachers expect girls to do poorly in mathematics. Their failures are accepted as a necessary shortcoming of being female, and their successes are discounted. Not surprisingly, girls come to have lower confidence in their mathematical ability than boys have (see Chipman & Wilson, 1985 for a review).

What Girls Expect of Themselves

Girls show less confidence in their ability to learn than boys do (Betz & Hackett, 1983; Fox, Brody & Tobin, 1985; Matsui, Matsui & Ohnishi, 1990) and are less willing to approach new material (Reyes, 1984). Girls are less confident about future math performance: when predicting future grades in math, girls are less optimistic than boys of equal ability (Eccles, 1983; Eccles-Parson, Meece, Adler & Kaczala, 1982; Heller & Parsons, 1981; Lantz & Smith, 1981; Tapasak, 1990). Even when they are successful in school, girls' confidence often remains low (Eccles, Adler, Futterman, Goff, Kaczala, Meece & Midgley, 1985; Fennema & Sherman, 1976; Meyer & Koehler, 1990). By the time women enter college, their confidence in their ability to do mathematics is practically uncorrelated with their actual ability (Singer & Stake, 1986).

This lack of confidence is devastating for several reasons. If girls believe that they are incapable of performing well in math class, they may experience a sense of helplessness in the classroom (Covington & Beery, 1976; Dweck & Repucci, 1973; Kloosterman, 1988). Girls who have little faith in their own ability tend to attribute success in math class to external causes, such as luck, or to situational causes, such as effort (Eccles-Parsons, Adler & Kaczala, 1982; Ryckman & Peckham, 1987). It isn't simply a matter of girls having lower overall self-esteem than boys. Girls are as likely as boys to attribute success in areas other than mathematics to their ability (Ryckman & Peckham, 1987). However, for many girls, these attributions to ability don't seem applicable to their

successes in math class. This gives female students little reason to believe that the next mathematical dilemma they encounter will be overcome.

This lack of confidence may be part of the reason girls take fewer math courses than boys, a pattern that begins in high school and continues throughout college (Chipman & Thomas, 1985; McDade, 1988; Wilson & Boldizar, 1990). The more confident students are of their ability to do well in mathematics, the more likely they are to continue with higher level courses (Hackett, 1985; Lantz & Smith, 1981; Meece, Eccles, Futterman, Goff & Kaczala, 1982). As a matter of fact, the decision to enroll in math courses beyond the minimum required for graduation is more highly correlated with perceived ability than with actual ability (Eccles, 1983). The more success in mathematics is attributed to ability (rather than to effort or luck), the more likely students are to persist in their studies (Pedro, Wolleat, Fennema & Becker, 1981).

Why Girls See Themselves as Mathematically Inferior

Carol Dweck (1986) has offered an explanation as to why girls may be more susceptible to these effort attributions, and more likely to be affected negatively by them, than boys. According to Dweck, girls are more likely to hold an entity theory of intelligence: they believe that intelligence in a given domain is something a person either has or doesn't have. Boys are more likely to hold an incremental theory of intelligence: they believe that intelligence in a given domain may be increased by hard work.

These entity and incremental theories can apply to any type of intelligence. However, in our society, math ability is often viewed as something you either have or you don't (Tobias, 1978). As noted earlier, many parents and teachers count girls among those who don't have it. This may be why, although there are some differences between boys' and girls' intelligence theories in other subject areas, they are far more pronounced in the mathematical domain (Eccles-Parsons, et al., 1982; Gitelson, Peterson & Tobin-Richards, 1982; Ryckman & Peckham, 1987).

Boys and girls come to hold different beliefs as a result of differential treatment in the classroom. Boys are given more feedback as to the quality of their work, more chances to generate correct answers and more encouragement to persist on problems that they initially get wrong. Girls, on the other hand, have their incorrect answers attributed to poor ability and are not encouraged to continue working to get the correct answer (Golombok & Fivush, 1994; Good & Brophy, 1987; Rosenthal, 1973; Stockard, 1980). Negative feedback given to boys often focuses on their poor behavior or lack of effort, while negative feedback given to girls often focuses on their intellectual shortcomings (Dweck, et al., 1978).

With this type of feedback it is not surprising that girls learn to attribute their failures to lack of ability and boys learn to attribute theirs to lack of effort. Because moving from subject to subject in mathematics (e.g. moving from arithmetic to algebra to trigonometry to calculus) often involves learning entirely new concepts, it is unlikely

that students will understand new subjects completely when they are first presented. Girls, who are more likely to hold an entity theory, may attribute this lack of immediate comprehension to inability and assume that math is simply too difficult for them. So they stop trying. Boys, who are more likely to hold an incremental theory, may attribute failure to lack of effort and work harder. This hard work is necessary for success in mathematics.

Because girls may assume that math is going to be difficult, they may have trouble distinguishing between work that will yield results and work that will not. Students who cannot gauge when tasks should be abandoned are at a disadvantage (Janoff-Bulman & Brickman, 1981). These students not only give up too soon when they are capable of solving a problem, but they persist in inappropriate strategies when there is little hope of a solution. This leads to frustration and is taken as further evidence of low ability.

The tendency of girls to hold an entity theory about math packs a double whammy when combined with the belief that they are incapable of performing well. This cognitive combination affects female students negatively in many ways. First, females have a higher level of math anxiety (Fennema & Sherman, 1976; Tobias, 1978). Second, females are vulnerable to the stereotype that "girls just can't do math" which leads to increased frustration and decreased performance in the face of difficult math problems (Spencer & Steele, 1994). Third, females' belief that their ability is so low that no amount of work will compensate may

drain their willingness to persist (Bandura, 1978). Finally, if female students believe that they will fail no matter how much effort they expend they may self-handicap by withholding effort (Arkin & Baumgardner, 1985; Berglas, 1985).

Math Anxiety

Several reviews have concluded that there are significant gender differences in math anxiety (Fox, 1977; Meyer & Fennema, 1988; Meyer & Koehler, 1990; Reyes, 1984, but see Hyde, et al., 1990). Eysenck (1992) has argued that one of the key purposes of anxiety is to facilitate the early detection of signs of threat or potential danger. Anxious people process information in a highly selective way: they attend to the most threatening elements of the information presented (Eysenck, MacLeod & Mathews, 1987; Mogg, Mathews & Weinman, 1989; Richards & French, 1990). This selective attention may cause math-anxious students to focus on irrelevant parts of a math problem. This drains cognitive resources and lessens performance (Ashcraft & Faust, 1994; Dew, Galassi & Galassi, 1984; Eysenck & Calvo, 1992; Tobias, 1978).

Stereotype Vulnerability

High-performing females seem to be particularly vulnerable to the stereotype that "girls just can't do math." Women who continue in mathematics perform just as well as their male peers throughout high school. However, when these same women go on to high level courses such as calculus and analytic geometry they fare less well than men who have shown equal promise up to that point (Fennema & Sherman, 1978;

Kimball, 1989; Spencer & Steele, 1994). This does not seem to be due to lack of persistence, because females work just as long on hard math problems as males do (Spencer & Steele, 1994), but for men this hard work pays off, while for women it does not.

Steven Spencer and Claude Steele (1994) suggest that when female students are frustrated by the difficulty of math problems, they associate this frustration with the belief that they as women are not supposed to be able to do math. This leads to anxiety, which impairs performance. To test this hypothesis. Spencer and Steele (1994) performed a number of experiments utilizing males and females who were highly skilled at mathematics and highly motivated to perform well. As was predicted, females scored as well as males on a test of moderate difficulty, but underperformed relative to males when the test was more difficult. This is in keeping with earlier findings.

This same difficult test was given to another group of students with one minor change in the procedure: some students were told that the test was gender-fair (i.e. females performed as well as males on the test), while others were told that the test differentiated between males and females. When females believed that they could do as well on the test as males, they did so. There were no significant differences between males' and females' performance in this condition. Females who expected the test to be difficult for females showed the usual pattern of underperforming relative to males.

Lowered Persistence

Many girls both hold an entity theory of intelligence and harbor doubts about their own ability . When these girls do well in math, they attribute this success to effort in the face of low ability and see no reason to persist as the difficulty of the material increases beyond what they believe to be their limits. When these same girls do poorly in math, they attribute their failure to low ability, conclude that increased effort will yield little in the way of results, and so see no reason to persist on material they consider too hard for them.

Albert Bandura's (1977) persistence hypothesis states that self-efficacy (the sense that one has the ability to do well at a task) is positively related to persistence. Students who persist at a mathematics problem in the face of obstacles and frustration are more likely to arrive at the correct answers than those who throw up their hands in despair. Indeed, research has shown that self-efficacy is positively related to both persistence and performance in mathematics. (Brown, Lent & Larkin, 1989; Hackett & Betz, 1981; Multon, Brown & Lent, 1991; Schunk, 1987).

Self-Handicapping

Because lack of ability is a stable cause of failure that cannot be overcome, students who believe their ability to be low withhold effort rather than risk failing and confirming their low opinion of their ability. After all, doing poorly in a class which one "blows off" all semester is to

be expected, but making a sincere effort and failing anyway can be devastating to the ego (Arkin & Baumgardner, 1985; Berglas, 1985).

If girls are more likely than boys to attribute success to external causes and to attribute failure to internal causes, then they would be expected to feel less pride in their success and more shame in response to failure (Stipek & Gralinski, 1991; Weiner, 1986). Success is not particularly rewarding for students who do not attribute this success to ability. Even if these students expect to and do perform well in certain classes, they attribute this success to luck, the low level of difficulty of the class, or leniency on the part of the teacher (Tapasak, 1990). Students who believe that they will receive a good grade in a particular class, but who do not believe that they are capable of learning and understanding the concepts in the class, are not strongly motivated to persist in their work in that class. Nor does their confidence increase as a result of their high grade (Lent, Lopez & Bieschke, 1991; Siegel, Galassi & Ware, 1985; Wheeler, K. G., 1983).

If expectations of future successes are low, or if these successes are discounted, students will withhold effort and will avoid contact with the subject in the future (Weiner, 1986). The decision to continue in mathematics is crucial to a student's continued success, both academically and professionally. The small differences found between boys' and girls' math performance nearly disappear when the students have taken the same courses (Chipman & Wilson, 1985; Lent, Brown & Larkin, 1984; but see Benbow & Stanley, 1980). Many college majors and

fields of graduate study are closed to students who have not taken the requisite math courses (Fennema, 1990; Wise, 1985).

Summary and Conclusions

What we have then, is a circle of expectancies and fulfillment of these expectancies. Society as a whole believes that females are less mathematically capable than men. This belief is communicated to parents and teachers, who pass it along to students. Girls come to view their failures in math as evidence that they are indeed inferior and to view their successes as flukes. This reinforces the belief that they are not capable of doing well in math. Females stop taking advanced math courses in high school or college, believing them too difficult. Girls fail to acquire the knowledge necessary to achieve in mathematics. In the end, the expectancies of their parents and teachers are fulfilled, and society has further "proof" of females' inferior math ability.

What is most surprising about this whole cycle is that females perform as well as they do. Differences between males' and females' performance is quite small compared to the stereotypes that many people hold. And these differences are getting smaller over time (Hyde & Linn, 1988). This bodes well for the future. As these differences decrease, parents and teachers will see more and more that females are capable of performing well in mathematics. This will lead to more parental and academic support, further enhancing females' ability. In this way, the cycle may be broken.

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Author Note

Jennifer Gutbezahl, Department of Psychology.

This paper was originally written as part of the comprehensive exam required to receive a Master of Science in Social Psychology at the University of Massachusetts. It has not been published or submitted for publication in an APA journal, nor is it intended for that purpose. It has been made available electronically in several forums.

Any correspondence concerning this manuscript should be addressed to Jennifer Gutbezahl, Department of Psychology, University of Massachusetts, Amherst, Massachusetts 01003. Electronic mail may be sent via Internet to jennyg@twain.oit.umass.edu.