Strategies for Reducing Math Anxiety in Post-Secondary Students

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Abstract: This literature review explores how educators might address adult math anxiety. Curricular, instructional, and non-instructional strategies are reviewed. The suggested approaches emphasize treating the cognitive and physical manifestations of math anxiety.

"Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551). Many adults, with and without disabilities, do not feel confident in their ability to do math (Duffy & Furner, 2002). The most intuitive definition of math anxiety is a fear of math. Quantiphobia (Goldberg & Waxman, 2003), mathophobia (Hilton, 1980), math phobia (Pan & Tang, 2005), and Mathematics-Learning Distress (MALEI, 2006) are descriptive phrases that represent the same phenomenon. Despite these variations, the majority of researchers prefer the term math anxiety.

The pervasiveness of math anxiety demands attention. About 85% of students studied by Perry (2004) in introductory math classes claimed to experience at least mild math anxiety. Jackson and Leffingwell (1999) found that only 7% of their 157 students did not have a stressful experience in their math classes from kindergarten through college. The freshman year in college was the starting point of mathematics-related stress for 27% of their participants. Forms of math anxiety range from moderate test anxiety to extreme anxiety (Perry, 2004). "Mathophobia may be compared with the loss of one of the primary senses" (Hilton, 1980, p. 175). Extreme anxiety can be debilitating inside the mathematics classroom. In Fall 2000, 22% of entering freshman enrolled in remedial mathematics courses at institutions of higher education (Parsad & Lewis, 2003), and the dropout rate in these courses can be as high as 25% per semester, with only one of two students completing remediation (McCabe, 2003). Often the passing rates in mathematics classes at this level are below 50% (McCabe, 2003). Intelligent and determined students often repeatedly fail their mathematics courses as a result of anxiety. Math anxiety contributes to these dismal statistics, so math instructors should mentor students to manage their math anxiety. The purpose of this literature review is to explore strategies for minimizing math anxiety.

Method

The data was collected by searching the ERIC, PsycInfo, WilsonWEB, and JSTOR databases using the keywords math and mathematics anxiety. Among the hundreds of articles listed (e.g., WilsonWeb listed over 700 results), those that focused on K-12 or were over 20 years old were discarded. The researcher sought peer-reviewed articles that represented a cross-section of empirical studies. However, some suggestions were included from non-peer reviewed sources that the author viewed as contributing to a gap in the peer-reviewed literature. The author included articles that focused on treatment options, looked for patterns in the research, and eventually constructed the categories of curricular, instructional, and non-instructional strategies.

Strategies for Minimizing Anxiety

Strategies for minimizing anxiety include (a) curricular strategies, such as retesting, self-paced learning, distance education, single-sex classes, and math anxiety courses, (b) instructional

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strategies, such as manipulatives, technology, self-regulation techniques, and communication, and (c) non-instructional strategies, such as relaxation therapy and psychological treatment.

Curricular Strategies

Colleges may offer courses that minimize math anxiety. Although face to face traditional lecture courses remain the prevalent method for math instruction, courses that incorporate retesting, self-paced learning, distance learning, and single sex formats may assist math anxious students. Colleges may want to consider these alternate methods of delivery.

Retesting. The literature suggests that retesting and mastery learning are possible instructional techniques that increase performance and, thereby, allay anxiety. A study on the results of retests in an intermediate algebra class showed students viewed retesting as helpful (Juhler, Rech, From, & Brogan, 1998). Approximately, 90% of the students improved their performance on the retest. Furthermore, 80% of the students reported that retesting eased anxiety, even if they did not use the option of the retest. Retests may help students counter past feelings of failure and offer an emotional safety net for test anxious students (Juhler et al., 1998). Retesting has become a more feasible option as test generators allow for effortless creation of multiple versions of exams. Although retesting may minimize anxiety, faculty may not consider it a viable option because of time constraints.

Self-paced learning. Self-paced learning could also be another suggestion for reducing math anxiety. Eppler, Harju, Ironsmith, and Marva (2003) found that learning goal oriented students were less anxious, indicating that one approach to allay math anxiety could involve the development of learning goal orientation over performance goal orientation. The students who had high learning goals performed significantly better in the lecture sections than in the self-paced sections, and students with high performance goals performed better in the self-paced classes. However, the researchers did not conduct a posttest to see which course format resulted in more decreased math anxiety, which could be an interesting proposition for future research. The self-paced courses in the study were not designed with the mastery learning component.

Distance education. Although learning mathematics at home may seem counterproductive to math anxiety, it could have some benefits. For instance, students do not have to be anxious about being called on unexpectedly in class and worry about looking stupid in front of peers. The anonymity of an online course may actually serve to decrease the anxiety. Taylor and Mohr (2001) found that 90% of students in their sample of developmental distance learning students with low or very low confidence levels declared that they felt more confident to manage everyday mathematics and mathematics in their future studies. Also, 51% of 53 students reported they had overcome their declared feelings of math anxiety to successfully pass the course. However, one must take into account that this online course was designed with awareness of student anxiety issues.

Single-sex classes. Curricular strategies for coping with gender have occasionally been tested. To address gender issues, single-sex classes might provide some relief. Campbell and Evans (1997) found that females in the single-sex class had a statistically significant lower mathematics anxiety rating than did the females in the coed class. However, the sample size was very small (n =15) and the institution was a rather unusual small Catholic high school. Brunson (1983), in a study at Indiana University on the offering of a single-sex women's basic mathematics course found that students in the optional all female section had significantly higher achievement scores than women in the mixed sections, even though they had lower initial SAT scores. However, there was no significant difference in changes in measures of math anxiety for the two groups as measured by the Math Anxiety Rating Scale (MARS).

Math anxiety courses. A semester long math anxiety course may be beneficial for decreasing math anxiety and improving subsequent success in the course. Several colleges have math anxiety relaxation/confidence groups. For nearly 20 years, the University of Florida has had a Math Confidence Group where students meet weekly (Carroll, 2006). Several postsecondary institutions also offer math anxiety courses. Butte College (2006) offers a one credit MATH 100: Math Without Fear, where students meet for two hours a week for eight weeks. "This course is designed to explore the connections between anxiety and a student's ability to do math. It will include techniques that will enable the student to overcome the barriers impeding their success in mathematics" (Butte, 2006, Math 100 Section). American River College (2006) offers Math10: Developing Confidence in Math. "This course helps students to recognize common fears and misconceptions of mathematics, and to overcome math anxiety and avoidance. Strategies to achieve success in mathematical situations are discussed" (Math 10 Section). Chabot College (2006) offers a math anxiety course through its counseling department, PSCN 4901: Dealing with Math Anxiety that is worth ½ credit. Although the literature on the effectiveness of such courses is sparse, some students must be deriving some benefits because the colleges continue to offer such courses.

Instructional Strategies

Instructors remain the primary resource for many students. Teachers can suggest many techniques that may help students allay their math anxiety. The savvy instructor can incorporate anti-anxiety measures in presentation and assessment of mathematics material.

Manipulatives. Many studies have focused on pre-service teachers perhaps since they reported the highest mean math anxiety score on MARS (Hembree, 1990). Since these future teachers develop future generations of math students, they should break the cycle of passing along math anxiety from instructor to student. Studies by Gresham, Haynes, Sloan, and Vinson (1997), Harper & Daane (1998) and Vinson (2001) found that the instructor's use of a hands-on manipulatives approach to a mathematics methods course resulted in a significant reduction in math anxiety. "The students also liked 'doing something' with manipulatives as opposed to sitting and taking notes since the manipulatives enabled them to 'see' math and better understand how it works" (Harper & Daane, 1998, Results, ¶ 6). Sloan, Daane, and Giesen (2002) studied pre-service teachers and found that global learners, learners that approach problems in an intuitive manner, reported higher levels of mathematics anxiety and could reduce their anxiety by avoiding traditional instruction. Manipulatives and the hands on approach used in these methods courses may prove successful to other populations as well.

Technology. Using technology to cope with math anxiety is rarely reported in the literature. Hembree (1990) mentioned in his meta-analysis that special classwork on computers or with calculators did not seem effective in reducing math anxiety. However, Goldberg and Waxman (2003) discuss using Excel as a means for curing quantiphobia. Students used Excel as part of the course to focus on improving their quantitative and computer skills. As students experienced successes, their quantiphobia decreased and, students were more confident about enrolling in additional quantitative reasoning courses. Although the data for that study were anecdotal reports, it demonstrates how technology may be a tool for minimizing anxiety.

Self-regulation techniques. Students can also act to minimize their own math anxiety, and instructors can encourage them to do so. Perry (2004) offered students three valuable suggestions. First, students must direct their energies towards improving their mathematical abilities and solving problems, not at scapegoats. Next, students should not fall prey to negative racial or gender stereotypes that may lead them to believe that they cannot do well in

mathematics. Finally, the most important counter-anxiety technique is simply to keep a positive attitude. Math biographies, journaling, attacking the root of math anxiety, and positive math self-talk can all help (Steele & Arth, 1998). Perry (2004) essentially expressed a student math anxiety mission statement, "Students need to acknowledge their mathematical difficulties and formulate a plan to overcome them, including seeking appropriate assistance when necessary" (p. 324). Although Perry's advice is logical, he may be oversimplifying the problem.

Communication. Much influence remains in the hands of the instructor. Instructors need to remain aware of and sensitive to the ego of the fragile math student. By encouraging mutual respect, professors ensure that the classroom environment is psychologically safe (Jackson & Leffingwell, 1999). Instructors can help by cautioning against stereotype threat and by emphasizing effort over innate ability (Osborne, 2001). They can refine their verbal and non-verbal communication and allow for opportunities for small successes early in the course. Instructors can consider using the factors Harper and Daane (1998) found that decreased student math anxiety: (a) working with a partner, (b) working in cooperative learning groups, (c) working with small groups or in centers, (d) using manipulatives, and (e) writing about mathematics in journals. Perhaps some of the same suggestions for the treatment of learning disabilities in mathematics may be considered for math anxious students. These suggestions include flexible methods of content presentation, flashcards, math related computer software, breaking problems into subtasks, using graph paper for organizing numbers, manipulatives, visual models, and glossary of math terms and concepts (McGlaughlin, Knoop, & Holliday, 2005). Ultimately, instructors should carefully look at the delivery methods and their effects on student anxiety.

Non-Instructional Strategies

Relaxation therapy and psychiatric treatment are two non-instructional avenues for math anxiety reduction. Some of the emotional needs of students may best be handled outside of the classroom. Since this may be outside the expertise of most instructors, they may encourage students to seek support from the appropriate professionals.

Relaxation therapy. Meditation, yoga, and psychotherapy could be valid treatments. However, the educational research community does not seem to be particularly interested in these alternative treatments as indicated by the infrequent publication of studies. Trent and Fournet (as cited in Green, 1990, p. 324) found empirical evidence to support the conclusion that the hypnotherapeutic restructuring treatment aided in improving the mathematics performance and the mathematics attitudes of the students relative to the systematic desensitization and expectancy control groups. However, all three treatments significantly decreased the levels of students' mathematics anxiety.

Psychological treatment. In a meta-analysis, Hembree (1990) found that whole class psychological treatments were not effective in reducing math anxiety, but the out of class treatments of systematic desensitization along with anxiety management training seemed to be effective. The behavioral treatments and cognitive behavioral methods brought the performance level of high anxiety students to the level of non treated low anxiety students. However, Zettle (2003) found that acceptance and commitment therapy compared favorably to systematic desensitization. Both interventions were associated with significant reductions in math anxiety. Students may also require treatment for a math learning disability such as dyscalculia, the math version of dyslexia. Dyscalculia includes a lack of intuition about the relative size of numbers (McCrone, 2002; Vaidya, 2004). Estimates are that 5% of the school population is affected

(McCrone, 2002). However, adult dyscalculia, its relationship to math anxiety, and its treatment as a disability are uncharted territory.

Conclusion

The research calls for further confirmation of the effectiveness of the identified and for the study of new strategies that minimize math anxiety. The research implies that reducing math anxiety and increasing the achievement of students remains a college wide endeavor; institutions can remain aware of math phobic students when designing course offerings; advisors can aid students by matching anxious students with courses that complement their learning styles, and instructors can identify and assist math anxious students. If the strategies that the research offers are implemented, math anxious students may soon find success and colleges may be labeled as welcoming math zones. Math educators dream for the day when students can confidently say, "I enjoy math!" This dream will only be realized when the entire educational community strives to prevent, recognize, and treat math anxiety.

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