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Attitude of Electronics Technology Majors at Indiana State University Toward Mathematics

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Introduction

Electronics technology programs prepare students for careers in diverse areas such as electrical power, application engineering, instrumentation, control systems, robotics, electrical machinery maintenance, computer technology, etc. Students who enroll in electronics technology programs are expected to have taken some mathematics in high school, take more mathematics classes in college, and to use mathematics in electronics classes. High-school Algebra and Geometry are the typical mathematics classes considered a minimal prerequisite for entry into a college-level electronics technology program. Algebra, Trigonometry, and Applied Calculus are typical college-level mathematics classes taken by electronics technology students.

Although mathematics educators have studied various student groups' attitudes toward mathematics and their achievements in mathematics, there is a lack of study of electronics technology students' attitudes. Attitude has often been studied because of the argument that students with positive attitudes toward mathematics tend to be more willing to use mathematics both in and out of school. Usefulness, confidence, anxiety, and attributions for success/failure are some of the affective variables studied and measured by mathematics education researchers when attempting to determine how attitude and performance are interrelated.

Because mathematics plays a role in the learning and degree completion requirements of college-level students studying electronics technology it seems appropriate that this groups' attitudes toward mathematics should be studied. Study of their attitude toward mathematics may provide information about their perception of the relevance mathematics has to studying electronics technology.

The Research

During 1996, this researcher surveyed 148 electronics technology majors at Indiana State University about some of their attitudes toward mathematics, mathematics in electronics technology, and electronics technology. The effect of taking mathematics classes on learning electronics technology was also studied. Usefulness, confidence, anxiety, and attributions for success and failure were the affective variables considered. Several students also participated in individual and small-group interview sessions.

In this study, attitude toward mathematics or electronics technology was defined as a general emotional disposition toward these subjects. This definition was based on the 1983 study by Haladyna, Shaughnessy, and Shaughnessy. For this researcher's study, mathematics in electronics technology refers to mathematics that is utilized in the discipline of electronics technology, and attitudes toward it refer to those student perceptions and experiences associated with using and learning mathematics as a part of electronics technology. The definition of attitude includes affective responses students express toward these areas and themselves as learners. General feelings such as liking/disliking were considered, along with perceptions of difficulty, confidence, self-concept, usefulness, attributions of success and failure, and anxiety.

Using responses to questions on a survey instrument, students participating in this study were separated into four groups based on a definition of how well they were doing. In brief, students who had not repeated either of two required college mathematics courses and had received grades of 'B' or higher in both were defined as doing well at mathematics. Students who had not taken an electronics technology class more than once and who had received grades of 'B' or higher in all electronics classes taken were defined as doing well at electronics. Using these criteria, students were assigned to exactly one of the following groups: those who did well at mathematics and at electronics (Group 1), those who did not do well at mathematics or at electronics (Group 2), those who did not do well at mathematics but did at electronics (Group 3), and those who did well at mathematics but not at electronics (Group 4). Each Group and its number of participants are shown in Figure 1 (page 3).

The affective variables of usefulness, confidence, anxiety, attributions for success, and attributions for failure were used to create 112 statements on the survey instrument. This part of the instrument used a Likert-type scale and asked students to respond to the statements by marking a scale of "strongly agree", "agree", "uncertain", "disagree", and "strongly disagree". Statements were classified as positive or negative. Positively worded statement responses were those that high achieving students were expected to agree with and were scored as 5 = strongly agree down to 1 = strongly disagree. For negative statements the scoring was reversed. There were six statements each on confidence in learning mathematics, confidence in learning electronics that involves mathematics, confidence in learning electronics, and effect of mathematics courses on confidence in learning electronics. Similarly, there were six statements each on the other affective variables. Table 1 shows each affective variable for each of the areas studied. Each group of six statements for each variable was used to form a scale. For example the six statements on confidence in learning electronics became the scale, CILE. These scales were based on the Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976) and the Autonomous Learning Behavior Attribution Scale (Fennema & Peterson, 1984).

One-Way Analysis of Variance was used to compare the means of the four groups for each affective variable, confidence, usefulness, and anxiety. Cronbach's alpha, mean, standard deviation, range, and mean/item were computed for each attitude scale. Bivariate correlation coefficients between all scales were computed.

Also measured were attributions for success and failure. Five Likert-type items were used for each of the following: Success in Learning Mathematics, Success in Learning Mathematics that Involves Mathematics, Success in Learning Electronics, Effect of Mathematics on Success in Learning Electronics, Failure in Learning Mathematics, Failure in Learning Electronics that Involves Mathematics, and Effect of Mathematics on Failure in Learning Electronics. The five items for each of the above were based on the Autonomous Learning Behavior Attribution Scale (Fennema & Peterson, 1984). Number of cases, mean per item, standard deviations, and range were reported for each. This method of analysis was used because the five items for each of the above do not address

Figure 1. Groups

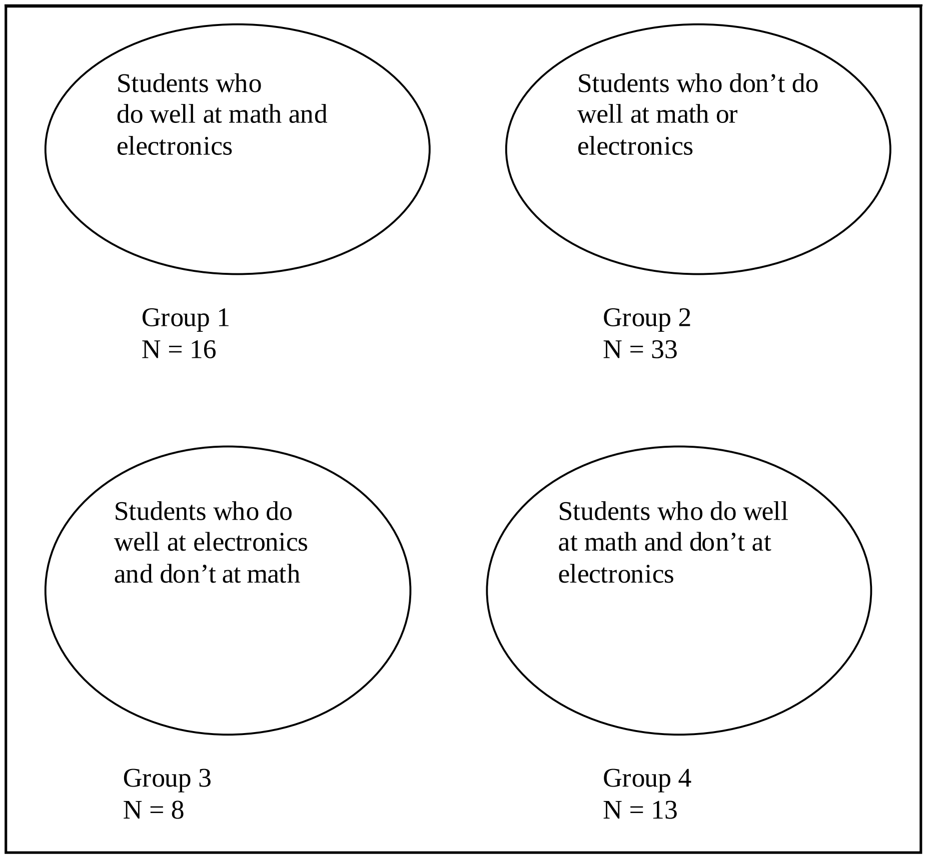

Table 1. Affective Variable by Content Area Matrix

Affective Variable	Content Area			
	Mathematics	Mathematics in Electronics Technology	Electronics Technology	Effect of Mathematics Courses on Learning Electronics
Confidence	Confidence in Learning Electronics	Confidence in Learning Electronics that Involves Mathematics	Confidence in Learning Electronics	Effect of Mathematics on Confidence in Learning Electronics
Usefulness	Usefulness in Learning Electronics	Usefulness in Learning Electronics that Involves Mathematics	Usefulness in Learning Electronics	Effect of Mathematics on Usefulness in Learning Electronics
Attributions for Success and Failure	Success and Failure in Learning Electronics	Success and Failure in Learning Electronics that Involves Mathematics	Usefulness in Learning Electronics	Effect of Mathematics on Success and Failure in Learning Electronics
Anxiety	Anxiety in Learning Electronics	Anxiety in Learning Electronics that Involves Mathematics	Anxiety in Learning Electronics	Effect of Mathematics on Anxiety in Learning Electronics

related but distinct attributes and thus do not form a scale.

Review of Literature

The next part of this article describes each affective variable and relevant literature is cited.

Usefulness

Many studies on attitude toward mathematics have examined students' perceptions of the usefulness of mathematics (Armstrong, 1980; Armstrong & Price, 1982; Fennema & Sherman, 1977, 1978; Kloosterman & Cougan, 1994). In these studies the importance or relevance a student attaches to his/her study of mathematics is related to his/her perception of its usefulness.

Armstrong (1982) concluded perceived usefulness of mathematics for educational and career goals is one factor affecting women's and men's participation in mathematics. Reyes (1984) stated that a better understanding of the importance of mathematics in a wide range of careers and in education beyond high school is important for students as they make decisions about how much mathematics to take in high school.

Confidence

Confidence, in learning situations, can be defined as how sure a student is of being able to perform or accomplish some task. Confidence in learning mathematics is a particular component of self-concept that is specific to mathematics (Reyes, 1984). In general, mathematics education research has shown a relatively strong correlation (*r* about 0.4) between confidence in learning mathematics (an affective variable) and mathematics achievement (Reyes, 1984). Students who are confident tend to learn more, feel better about themselves, interact more with their teachers, spend more time on task, and be more interested in pursuing mathematical ideas than students who lack confidence (Reyes, 1984). In general, students who are confident in their ability in mathematics are more comfortable when confronting mathematical situations (Kloosterman, 1988).

Anxiety

Spielberger (1972) discusses two types of anxiety, trait and state. Persons who exhibit trait anxiety, which is neither situation nor time specific, are exhibiting anxiety that is relatively stable. They are likely to be anxious in any situation or at any time. State anxiety is time and situation specific, meaning that it manifests itself at identifiable times or situations. These times or situations are seen as potentially harmful or threatening.

A common complaint of students who are not doing well in school is that they have trouble taking tests. Often they state tests cause them to experience high levels of anxiety. This may be true, or it may be just another way of justifying or rationalizing poor performance. In the research literature, test anxiety has been described as anxiety aroused by evaluative situations (Byrd, 1982). Hembree (1988) had also found test anxiety causes poor performance, and that it to relates inversely with students' self-esteem and directly to their fears of negative evaluation, defensiveness, and other forms of anxiety.

Dowaliby and Schumer (1976) investigated what kind of student does best with what kind of teaching. They found that a student's performance under what they termed a "structured" or teacher centered approach depended on the student's level of manifest anxiety. High anxious students did better in a teacher-centered approach (teacher does most of the talking). Low anxious students did better in a student-centered mode (students did most of the talking).

Attributions for Success and Failure

Much research (Horn, Bruning, Schraw, & Curry, 1993; Marsh et al., 1984; Nicholls, Cobb, Wood, Yackel, & Patashnick, 1990) in education and mathematics education examines students' perceptions on the causes of success or failure on various educational or mathematical tasks. In the literature, ability and effort appear to be the dominant of the achievement-related attributions (Weiner 1979). Students often attribute their success or failure on academic tasks to such causes as ability, effort, task difficulty, and luck. Reasons students attribute to their academic success or failure have been categorized according to the dimensions of locus, stability, and controllability by Weiner (1979). Locus is where an individual attributes a cause, for example, within the individual or to a different individual. Stability is whether an attribute remains stable over time. Controllability for causes of success and failure relate to effort. Effort is controllable; ability, described as a stable attribute, is not. Students classified as high achievers generally attribute success to high ability while low achievers tend to attribute success to effort expenditure. Low achievers tend to be less confident when performing academic tasks. These three dimensions and their respective reasons for academic success and failure provide some indication of what students' attribute to their perceived level of confidence. For example, Weiner noted that if an individual perceived that success was caused by ability, then competence and confidence were reported as high.

Brown and Weiner (1984) claim that students who fail at academic tasks often prefer to blame a lack of effort rather than a lack of ability as the reason for the failure. By doing this, they preserve their self-esteem and the belief that they can be successful if they try hard enough. When success is attributed to good luck, the increase in expectancy for future success in that situation will be smaller than if the success had been attributed to ability or ease of the task (Reyes, 1984).

Survey Results

Because this study consisted of two parts, a questionnaire and interview, the results are presented separately. Statements from students during the interview seem to elaborate or expand on the results from the survey. In this study, two one-half hour interviews were conducted with fifteen students, eleven students participated in a group interview.

Study results show that students in this study had positive attitudes in the attitude scales designed to measure confidence, usefulness, and anxiety. In general for all respondents, the highest means for the attitude scales came from those scales designed to measure confidence, usefulness, and anxiety toward electronics. The results of the reliability analysis and the means, standard deviations, ranges, and means per item for each scale are given in Table 2. These students consider learning electronics useful, are not very anxious about learning electronics, and are confident about being able to learn electronics. They also had positive attitudes toward mathematics, were confident in learning electronics that involves mathematics, considered learning electronics that involves mathematics as useful, and felt that taking required mathematics classes was useful for learning electronics.

One-Way Analysis of Variance was used to compare the means of Groups 1 through 4 for each affective variable. Differences between groups on each attitude scale were determined using the Scheffe procedure with a significance level of 0.05. Group 1 and Group 2 were found to be significantly different on the following scales, "Confidence in Learning Mathematics" (CILM), "Confidence in Learning Electronics that Involves Mathematics" (CILEM), "Anxiety in Learning Mathematics" (AILM), and "Anxiety in Learning Electronics that Involves Mathematics" (AILEM) between Groups 1 and 2 at the 0.05 level. Although these two groups differed on confidence when mathematics was involved, there was no significant difference between them when "Confidence in Learning Electronics" (CILE) was analyzed. Also, the results show that Group 2 did not significantly differ from Group 1 or any other group on the scale "Anxiety in Learning Electronics" (AILE), which means Group 2 students were no more anxious about learning electronics than any other group.

Results from this study indicate students from Groups 1, 2, 3 and 4 tended to attribute some of their success to a teacher's explanation of a topic. Students in all four groups did not attribute their failure at electronics, electronics that involves mathematics, or mathematics to lack of ability. When the attitude scales for each group were analyzed, Group 1 had only one noticeable difference from the other groups. This group's means for the anxiety scales were higher (meaning anxiety was lower) than the other groups for the same scales with the exception of the "Anxiety in Learning Electronics" (AILE) scale for Group 3. Group 2's confidence mean (25.06) for "Confidence in Learning Electronics" was not noticeably different than the means for the other groups, and its

Table 2. Summary by Scale for all Respondents

Scale	Cases	Cronbach's alpha	Mean	S.D.	Range	Mean/Item
Confidence in Learning Mathematics	147	0.86	23.34	4.50	6-30	3.89
Confidence in Learning Electronics that Involves Mathematics	146	0.85	23.10	3.87	6-30	3.85
Confidence in Learning Electronics	145	0.81	25.19	3.46	6-30	4.20
Effect of Mathematics on Confidence in Learning Electronics	117	0.40	20.88	2.50	6-30	3.48
Usefulness in Learning Mathematics	147	0.71	23.55	3.36	6-30	3.93
Usefulness in Learning Electronics that Involves Mathematics	146	0.65	24.02	3.07	6-30	4.00
Usefulness in Learning Electronics	145	0.78	25.68	3.42	6-30	4.28
Effect of Mathematics on Usefulness in Learning Electronics	115	0.90	22.68	4.37	6-30	3.78
Anxiety in Learning Mathematics	147	0.86	20.25	5.21	6-30	3.38
Anxiety in Learning Electronics that Involves Mathematics	146	0.86	20.82	4.76	6-30	3.47
Anxiety in Learning Electronics	146	0.80	22.45	4.17	6-30	3.74
Effect of Mathematics on Anxiety in Learning Electronics	117	0.52	20.90	2.91	6-30	3.48

Table 3. Group Summary

Group 1	Group 2	Group 3	Group 4
Less anxious about math than the other groups as expected. Felt that natural ability was at least a modest reason for success at solving problems in mathematics.	Did not have a noticeable difference in confidence in learning electronics from other groups. Had a lower mean score (higher level of anxiety) for Anxiety in Learning Mathematics.	Were not noticeably anxious about learning electronics, but did have a low mean (higher level of anxiety) for Anxiety in Learning Mathematics.	Mean scores for this group indicate that students in it were generally less confident in learning electronics and more anxious about learning electronics than the other groups.

anxiety scale mean (18.36) for "Anxiety in Learning Mathematics" (AILM) is lower than the other groups. In other words Group 2 members were most anxious about learning mathematics. Table 3 is a group summary.

When the data for the attitude scales on confidence, usefulness, and anxiety were analyzed by group the results show that students in these groups were generally confident in learning mathematics, confident in learning electronics that involves mathematics, and confident in learning electronics. Usefulness appeared to be the most consistent variable across groups. The mean for each usefulness scale for all four groups remained within a range of 21.82 (Effect of Mathematics on Usefulness in Learning Electronics for Group 2) to 26.50 (Usefulness in Learning Electronics for Group 3). The anxiety scale means for each of the groups varied the most, 18.36 (Anxiety in Learning Mathematics for Group 2) to 25.38 (Anxiety in Learning Electronics for Group 3). Although the means per scale for Group 2 did not appear to be different from those of the other three groups, the results for this group seemed to indicate Group 2 members were more anxious about mathematics, electronics, and the effect of mathematics on learning electronics than the other groups. Given that students in Group 2 were low achievers in both mathematics and electronics this finding is not surprising.

Means per item for attribution for success/failure were computed for each group. These means per item could range from 1 to 5. Each item was considered separately because the items within an area, for example, "Success in Learning Electronics (SILE), addressed more than one attribute. The mean per item for item 96, "When I did well in electronics it was because my teacher explained the topic well.", was at 4.00 or above for all four groups indicating that students agreed with a statement about how well they did in electronics was attributable to how well a teacher explained a topic. A similar result occurred on item 41 (item mean ³ 3.85) with "When I did well in mathematics it was because my teacher explained the topic well." It appears that the influence of the teacher is important to how these students view their success at either electronics or mathematics.

Interview Results

The most interesting interview discussion occurred when some students responded that they did not believe there were any differences between mathematics in mathematics classes and mathematics in electronics classes. However, almost all the students then stated that often in mathematics classes you worked problems without knowing why you were working them and what they might be used for. They finished by saying that electronics problems were understandable and that they knew what to solve for in an electronics problem and knew why the problem was useful. Several students stated that they often felt ill at ease in mathematics because they could not understand what was going on in the problem-solving situations in their classes. Some students from Groups 2, 3, and 4 expressed that taking mathematics tests made them very nervous.

Most interviewees said they did not believe that taking mathematics classes had affected their study of electronics and they described mathematics as useful and seemed to have a positive attitude about that usefulness. The positive attitude expressed in the interviews corresponds with the positive responses about usefulness of mathematics and usefulness of electronics on the survey. When questioned about the type of job they might have in the future, the students expressed that they would not be concerned about working in a position that required them to do a lot of mathematics.

Each student representing Group 1 chose natural ability as the reason for his success at mathematics. One student from Group 2 also chose natural ability. Effort was chosen as the reason for success at mathematics by all other interviewees. Lack of effort was chosen by all students as the reason for failure at mathematics. All interviewees agreed that the teacher can have an impact on whether a student succeeds or fails at mathematics. When asked about natural ability, the students were not sure whether people who claimed to have natural ability at mathematics had any difference in attitude toward mathematics than people who did not have natural ability at mathematics. Students did think that you could get better at mathematics however, some students described that they sometimes reached a point when studying mathematics where they felt like they had run into a wall and would not be able to learn the mathematics because it was too hard.

Students described teachers has having a major influence on their success at studying either mathematics or electronics technology. Students discussed mathematics teachers who had helped them to understand mathematics. Students also pointed out that they did not like teachers who acted like students were not very smart or who tried to intimidate students.

One description of mathematics classes that seemed to occur often during the interviews was that they were too fast, too much material was covered, and that if you did not understand what was going on, the teacher did not care. Several interviewees described this as typical procedure in their mathematics classes and that this was why they did not like or do well in those classes.

Implications For Teaching Electronics Technology

In the interviews and on the survey instrument students agreed that how well they did in their electronics technology classes was affected by how well they thought their teachers explained the class material. Some of the students commented that doing laboratory exercises in their electronics classes helped them to understand the class material. Others stated that those exercises made them aware of the usefulness of what they were studying. Electronics technology educators need to be aware of the impact of class presentations and class methodology on student understanding.

From the data gathered on the survey instrument and from student comments, it seems that many of these electronics technology students did not take much mathematics while in high school, and don't understand how much mathematics they will take or use as they study college-level electronics. These students while in high school may not have been aware of the role of mathematics in the study of electronics. They also may need to take remedial mathematics classes before enrolling in certain electronics classes. Electronics technology educators need to be aware that some of their students may be inadequately prepared and should advise those students accordingly. Also, college-level electronics technology programs need to distribute information to high schools about the amount and types of mathematics high-school students should take. Students may better understand the importance or usefulness of taking mathematics courses in high school or even earlier in middle or grade school by being informed about the role of mathematics in careers.

Since students in technical programs are required to take courses in mathematics, more information is needed about the effect mathematics anxiety might have on their chances for success when they take their required mathematics classes. With this in mind, it is important to consider what might be done to reduce the level of student anxiety. It is important to consider how various subgroups, such as electronics technology majors, may manifest anxiety as they participate in classes with teachers from various disciplines who exhibit different styles of teaching.

Future Research

This researcher now believes that the effect of taking or studying electronics on learning in mathematics should be considered. This is considered necessary after reading students' comments on a questionnaire and from discussions with students during the individual and group interviews. The students' comments on open-ended questions and statements during the interviews seemed to indicate that they believed the effect of taking classes in their major, electronics technology, affected their attitude toward learning mathematics. During those interview discussions, the students most often noted that taking electronics classes had a positive effect upon their attitude toward mathematics and that they did not believe taking mathematics classes had any effect on the way they viewed learning in electronics.

Conclusion

Electronics technology students, in general, have positive attitudes toward mathematics, mathematics in electronics technology, and electronics technology. As expected, the results of this study showed that students in electronics technology are aware of the usefulness of mathematics to the study of electronics. However, the data from the survey also indicate that they do not opt to take other mathematics classes. This is disturbing. Awareness of the usefulness of mathematics to the study of electronics does not seem to extend to the idea that more or advanced mathematics courses would also be useful.

Future studies with students from similar electronics technology programs need to be conducted and then compared with this study. This future research could be used to determine whether students from other electronics technology programs have a similar attitude toward mathematics, mathematics in electronics technology, and electronics technology.

References

Armstrong, J.M. (1980). *Achievement and participation of women in mathematics: An overview*. Denver: Education Commission of the States.

Armstrong, J.M., & Price, R.A. (1982). Correlates and predictors of women's mathematics partictipation. *Journal for Research in Mathematics Education, 13*, 99-109.

Brown, J., & Weiner, B. (1984). Affective consequences of ability versus effort ascriptions: Controversies, resolutions, and quandaries. *Journal of Educational Psychology, 76*, 146-158.

Byrd, P. (1982). *A descriptive study of mathematics anxiety: its nature and antecedents*. Unpublished doctoral dissertation, Indiana University, Bloomington.

Dowaliby, F. J., & Schumer, H. (1973). Teacher-centered versus student-centered mode of college instruction as related to manifest anxiety. *Journal of Educational Psychology, 64*, 125-132.

Fennema, E., & Peterson, P.L. (1984). Classroom processes, sex differences, and autonomous learning behaviors in mathematics. Final Report to the National Science Foundation. Madison: University of Wisconsin. Wisconsin Center for Education Research.

Fenema, E., & Peterson, P.L. (1976). Fenema-Sherman mathematics attitude scales: Instruments designed to measure attitudes toward learning mathematics by females and males. *Catalogue of Selected Documents in Psychology, 6*, 31-32.

Fenema, E., & Sherman, J. (1978). Sex-related differences in mathematics achievement and related factors: A further study. *Journal for Research in Mathematics Education, 9*, 189-203.

Fenema, E., & Sherman, J. (1977). Sex-related differences in mathematics achievement, spatial visualization and affective factors. *American Educational Research Journal, 14*, 51-71.

Haladyna, T., Shaughnessy, J., & Shaughness, J.M. (1983). A causal analysis of attitude toward mathematics. *Journal of Research in Mathematics Education, 14*, 19-29.

Hembree, R. (1988). Correlates, causes, effects, and treatment of test anxiety. *Review of Educational Psychology, 58*, 47-77.

Horn, C., Bruning, R., Schraw, G., & Curry, E. (1993). Paths to success in the college classroom. *Contemporary Educational Psychology, 18*, 464-478.

Kloosterman, P., & Cougan, M.C. (1994). Students' beliefs about learning school mathematics. *Elementary School Journal, 94*, 375-388.

Marsh, H.W., Cairns, L., Relich, J., Barnes, J., & Debus, R.L. (1984). The relationship between dimensions of self-attribution and dimensions of self-concept. *Journal of Educational Psychology, 76,* 3-32.

Nicholls, J.G., Cobb, P., Wood, T., Yackel, E., & Patashnick, M. (1990). Assessing students' theories of success in mathematics: Individual and classroom differences. *Journal for Research in Mathematics Education, 21*, 109-122.

Reyes, L.H. (1984). Affective variables and mathematics education. *Elementary School Journal, 84*, 558-581.

Spielberger, C. (1972). Conceptual and methodological issues in anxiety research. In C. Spielberger (Ed.), *Anxiety: Current trends in theory and research*. Vol. 2. New York: Academic Press.

Weiner, B. (1979). A theory of motivation for some classroom experiences. *Journal of Educational Psychology, 71*, 3-25.