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Impact of Conceptual and Procedural Knowledge on Students Mathematics Anxiety

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ABSTRACT

The study investigated the relationship between conceptual knowledge and mathematics anxiety of remedial mathematics students in an urban community college. The study sample consisted of 105 remedial mathematics students from four elementary algebra sections. Two of these four sections were under Conceptual treatment. The other two sections were under procedural treatment and served as the control group. Students' mathematics anxiety was measured using the Mathematics Anxiety Rating Scale-Revised (Fennema and Sherman, 1976). To measure subjects' conceptual and procedural knowledge, the participants completed two quizzes (a conceptual quiz and a procedural quiz) a week before the final exam. The study found that the conceptual treatment had more positive impact on students' mathematics anxiety as compared to the procedural treatment.

Keywords:

Mathematics anxiety, Procedural knowledge , Conceptual knowledge.

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Introduction

Mathematics anxiety is commonly defined as "a feeling of tension, apprehension, or fear that interferes with math performance" (Ashcraft, 2002, p. 181). The emotional symptoms are panic, fear, and lack of confidence (Buxton, 1981). Several studies have uncovered the origins of mathematics anxiety. Sheila Tobias (1993) explains in her book, "Overcoming Math Anxiety", that mathematics anxiety is not due to a failure of intellect but a failure of nerve. However, she believes that mathematics anxiety can be overcome. According to Scarpello (2007), mathematics anxiety starts as early as fourth grade and then "peaks in middle school and high school" (p. 10). Jackson and Leffingwell (1999) found that 27% of their participants reported beginning to experience mathematics anxiety in their freshman year in college.

Hembree (1990) stressed that the construct of mathematics anxiety is larger than we can imagine because "it can be a tense emotional response to the intellectual appraisal of a threatening stimulus" (p. 34) Such an emotional response can be described as turbulence and is out of proportion to the threat (Beck & Emery, 1985). Hembree's construct appears to include a larger or more general fear of contact with mathematics, including classes, homework, and tests.

Mathematics anxiety has been a central issue in mathematics education and its literature for several decades. In 1972, Richardson and Suinn developed the Mathematics Anxiety Rating Scale (MARS). According to Richardson and Suinn (1972), MARS "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 and academic situations" (p.551).

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Statement of the Problem

Remedial mathematics has become an academic and career obstacle for many students, particularly community college students. In fact, it has become the largest single barrier to student advancement.

Approximately 24% of students who entered community college in the academic year of 2007-2008, enrolled in a remedial or preparatory course (NCES, 2013). However, the more levels of developmental courses a student must go through, the less likely that student is to ever complete college English or Math (Bailey, 2009).

A central goal for mathematics educators is to help students nurture their mathematics understanding. However, community colleges' teaching of Algebra is mostly procedural. In mathematics, it is important to know both the basic concepts and the correct procedures for problem solving. To overcome "negative attitudes" toward mathematics, educators should use "concrete manipulative materials" to form the connection between concrete learning and abstract thought (Taylor & Brooks, 1986, p. 10). Although The National Council of Teachers of Mathematics (1989) recommended that teachers emphasize the use of conceptual problems to help students understand mathematics subjects, to date, little research has been conducted regarding the impact that conceptual understanding in mathematics has on mathematics anxiety.

Research Question: Are there significant differences in mathematics anxiety between students who have been exposed to a conceptual treatment and those taught in ways that emphasize procedures?

Methodology

Setting and Participants:

In this study, the population consist of remedial mathematics students at LaGuardia Community College (LaGcc) in New York State. In fall 2015, 10% of the students at LaGcc were white non-Hispanic, 37% were Hispanic, and 15% were Black and 38% other races. The fall 2015 enrollment was about 18,623, of which 58% were female and 42% male. Among the 18,623 students in academic programs, 50% of them were non-native born students. One hundred sixty-four countries were represented and 128 different languages spoken natively. LaGcc was selected because of our familiarity with the environment. However, the authors did not teach any elementary section in which the data was gathered. The study was done throughout the second session of fall 2016 that started from January 4 to February 16. This was a 6 weeks' session including a final week. The elementary algebra courses including the ones that participated in this study met Monday to Thursday for 2 hours per day lecture, 2 hours' computer lab and 2 hours tutoring lab per week. The instructors led the lecture and the computer lab sessions. Students used a mathematics platform, "educosoft", to complete their homeworks in the computer labs. These homeworks were mainly procedural. College assistants– students who were in their final college year-led the tutoring labs using worksheets that were prepared by the course coordinator.

The study sample consisted of 105 remedial mathematics students from four elementary algebra sections. Thus, the sampling frame met the following criteria: (a) potential subjects were elementary algebra (MAT 096) students in LaGcc (b) they were students enrolled in the four sections selected to participate in this study. The mean enrollment for each elementary algebra section was 30.

Research Design:

For this study, we randomaly selected two elementary algebra sections to a conceptual treatment and the other two sections were under procedural treatment. Participants' assignment to groups was not randomized. This means that a quasi-experimental design was used in this study. Because of lack of randomized design, we tried to select groups that were as similar as possible so we could fairly compare them. For instance, participants in all groups were not repeating elementary algebra course. One procedural treatment section and one conceptual section were scheduled in the morning between 8am to 12pm. The other two sections were given in the afternoon between 12pm and 4pm. Each of theses sections met 2 hours a day from Monday to Thursday. The computer labs homeworks and tutoring lab worksheets were the same for all four sections. The instructors in all four sections were adjuncts and each has less than 2 years of teaching experience. Two of the four sections were under conceptual treatment: instructors in these sections followed lesson plans that focused on concepts rather than procedures. The other two sections were under procedural treatment. Instructors in the procedural treatment courses followed lesson plans that were focused on procedures rather than concepts. We prepared 7 conceptual lesson plans for the conceptual groups and 7 procedural lesson plans for the procedural groups. These lesson plans were split into 9 sessions throughout the semester. We fully observed all the four sections: procedural groups sections and conceptual groups sections–when instructors taught the lesson plans that we prepared. Before each class meeting, we met with the instructors for about 15 minutes to go over the lesson plan. This was done with all groups.

Instruments: The participants in this study completed the Mathematics Anxiety Rating Scale-Revised (Fennema and Sherman, 1976) at the beginning and end of the courses. This survey helped categorize students as "high case" or "low case" anxiety based on their scores. The Mathematics Anxiety Rating Scale-Revised (MARS-R) consists of five-point Likert-type items. Specifically, the MARS-R uses 10 items to measure mathematics anxiety for college students. The Likert scale was coded as follows: strongly disagree = 1, disagree = 2, neutral = 3, agree = 4, and strongly agree = 5 for the negatively weighted questions. The following numeric values were assigned to the positively phrased questions: strongly disagree = 5, disagree = 4, undecided = 3, agree = 2, and strongly agree = 1. Within this adjusted Likert scale, the total score for each component ranges from 10 to 50. The higher the score, the higher the level of math anxiety. MARS-R was used in this study because of its prevalence in the literature and its reliability coefficients particularly with university students.

In addition, the participants completed two quizzes (a conceptual quiz and a procedural quiz) a week before the final exam and a short questionnaire to gather biographical and educational background information.

Experiment: The experiment for this study was conducted throughout the second session of the fall 2016.

1. During the first week of class, instructors of the selected sections were given a brief introduction and a description of this study.
2. Each participant was assigned an identification code that was randomly chosen by the authors.
3. The participants completed the Mathematics Anxiety Scale-Revised (Fennema and Sherman, 1976). This was called the pretest mathematics anxiety scale.
4. Conceptual group instructors followed (throughout the semester) conceptual lesson plans (figure 1) that was designed by the authors. Procedural group instructors also followed procedural lesson plans (figure 2).
5. Each subject completed a mathematics conceptual quiz and a mathematics procedural quiz (see Figure 3) a week before the final exam. The conceptual quiz consisted of 10 questions which mainly focused on students' conceptual understanding. The procedural quiz also consisted of 10 questions that focused on students' procedural mathematics knowledge. Participants took the conceptual quiz two days before they took the procedural quiz. Subjects were given 25 minutes to complete each quiz.

Sequence of Data Analysis: First, we conducted exploratory data analysis to address the research question. Summary data on the MARS-R scores (pretest, posttest and difference) and quiz scores (conceptual and procedural) for all respondents were described. To answer the research question, a t-test was conducted to determine whether or not the means of the anxiety-difference (*anxiety-difference = anxiety-posttest – anxiety-pretest*) differ significantly between the conceptual and the procedural group at 5% level of significance. Next, a regression model was developed with anxiety-difference as response variable. The study revealed a model with statistically significant relationship between anxiety score difference and the rest of the variables.

Objective: The objective of this lesson plan is to help students gain a deeper understanding of slope and to be able to quantify it from a conceptual approach. This objective can be achieved through real life settings or experiences. By gaining a clear understanding of slopes, students will be able to appreciate how a concept such as slope is useful in understanding the world around us.

Methodology: A real life setting of skiing resorts is used to illustrate the concept. For the computational part, a triangle made of blocks is used. This lesson plan includes 7 stages.

Stage 1: Students are introduced to the rating level of ski runs. The ratings are: easy, moderate, steep, and vertical; a horizontal aspect is added here for completeness. The class is put into groups, and each group is asked to place the 6 different hills into the categories listed above by the ratings.
Stage 2: The class comes together and discusses why students placed the hills in each category. The idea of measuring steepness is introduced, and the teacher asks the groups to develop a way to measure steepness.
Stage 3: The groups are given a worksheet (see worksheet below) ….and …. to help them develop a formula to measure the steepness of given lines (using rise over run). They are asked to consider what lines have in common, what their differences are, and how a formula for steepness might be developed. Groups develop their own formula and then share them with the class.
Stage 4: The groups share their formulas with the class. The formulas are then tested on lines that go in different directions from which the class has been using.

Math Topics

Geometric context: Slope analysis and interpretation, calculation of slopes, ordered pairs, graphing lines.

Tools

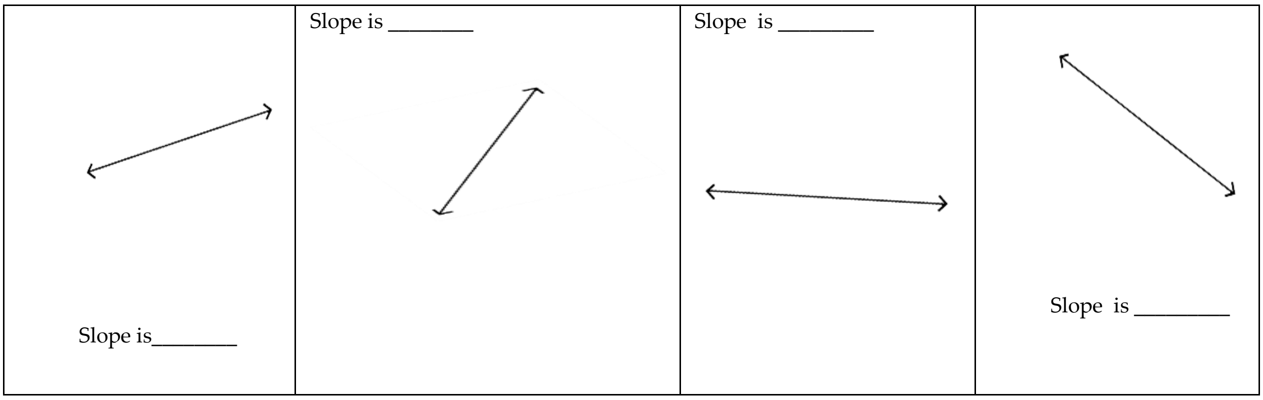
Multimedia projector, Computer, educational blocks, Picture of Ski resorts

Time 60 minutes

When to Introduce

This approach should be introduced to students at their first exposure to equation of a line.

Teacher's response: Teacher brings out a triangle made of blocks to illustrate how slopes differ in size, using the pictures, the lines and the number line to show how the sign of the slope could be generated. At this point, the notion of first quadrant and second quadrant of the Cartesian plane may be used. Teacher will then generalize students answers to come up with the formula: Slope = $(y_2-y_1)/(x_2-x_1)$ given two points (x_1, y_1) and (x_2,y_2). **Mini-Experiment 1:** Now that you've developed a formula for finding the slope of the line, you are to use your transparent graph chart to find the slope of the lines below.



Mini-Experiment 2: Now that you've learned how to find the slope of a line, we're going to switch things up. You are going to be given a slope, and you need to graph a line with that given slope. There are infinite number of lines that all have the same slope, so there's no one-way to do this. Instructors will ask some students to share their answers with the class.

Stage 5 (practice): Students get to practice the following problem using the slope formula.
Problem: Find the slope of the line passing through:
a. (1, 2) and (3, 3) b. (3, 4) and (-3,-6) c. (-1,-2) and (-1,2) d. (3,2) and (3,7)
Have volunteer students share their answers with the class.

Stage 6: Students will be asked to find two points from the given equations to find the slope
a. y = 2x+1 b. y = 2 c. x=3
Students share their findings and discuss about easier ways to find the slope (given an equation) without using points. The goal of this assignment is to come up with the slope intercept form y = mx +b (m is the slope and b is the y-intercept).

Figure 1: Conceptual Approach to Teaching Slope

Objective: Students will be able to develop an accurate formula for finding the slope of a line.

Methodology: The given formula of slope is used to solve problem. This lesson plan includes 7 stages.

Stage 1 (10 minutes): The students are introduced to definition of slope: In coordinate plane, the slope of a straight line is defined by the change in y divided by the change in x. Slope = Change in y / Change in x = $(y_2 - y_1)/(x_2 - x_1)$.
Give an example applying the formula above.
Stage 2 (15minutes): Students are put into groups to practice using the slope formula. Practice problem: Graph each pair of given points below then find their slopes. (use separate graphs)
a. (1,2) and (3,3) b. (3,4) and (-3,-6) c. (-1,-2) and (-1,2) d. (-3,2) and (0,7) e. (1,0) and (0,2) f. (1,2) and (1,7)
Stage 3 (10 minutes): Students are asked to go to the board to share their results with the rest of the class.
Stage 4 (10 minutes): Now that we have a slope and a line from each given pair, let's have a discussion about when the slope is positive, negative, zero or undefined.

Math Topics

Geometric context: Slope formula and interpretation, calculation of slopes, ordered pairs, graphing lines.

Tools

Multimedia projector, Computer.

Time 60 minutes

When to Introduce

This approach should be introduced to students at their first exposure to equation of a line.

Stage 5 (7 minutes): Instructor introduces the slope intercept formula: y = mx + b and how to find the slope using the slope-intercept form. Example: Instructor solves the following:
a. y = 2x+1 b. y = 2 c. x = 3
Stage 6 (8 minutes): Students solve the following problem and share their results with the class.
Practice Problem: Find the slope of the following equations:
a. y = 3x+1 b. 2y = x-1 c. 3x+2y = 2 d. x+2 = 2 e. 2y+1 = 0

Figure 2: Procedural Approach to Teaching Slope

Conceptual Quiz (25 min)

1. Explain why the equation x+ 1 = x+3 has no solution.
2. Explain the difference (in terms of the solutions) between x+1 = 3 and x+1 > 3
3. Do you agree or disagree with the following statement? $x^2 = -1$ has no solution. Explain your answer
4. x (x-1) = 1 implies x = 1 and x-1 = 1. Do you agree or disagree? Explain your answer.
5. Explain the following statement: The graph of a function can have infinite x intercepts and at most one y intercept.
6. Explain the following:
   a. $|x| < -2$ has no solution.
7. The system of equations 2x+5y = 6 and 2x+5y = 5 has no solution.
8. The equation y = 2 has a slope of 0 (m = 0) and x = 2 has an undefined slope. Explain both cases.
9. You want to rent a car for your coming vacation. One rental agency charges a flat fee of $55 per day, while another charges $10 per day plus 20 cents for each mile driven. You expect to drive an average of 150 miles a day during your vacation. How much more money will you spend per day if you use the first rental agency?
10. –x < 3 implies that x > -3. Explain the change of the symbol < to >.

Procedural Quiz (25 min)

1. Solve the equation x+ 1 = x+3
2. Solve the inequality 2x + 1 < 3x-1
3. Solve $2x^2 = 18$
4. Solve $x^2-2x-1 = 0$
5. Find the intercepts of the equation: 3x+5y = 15
6. Solve and graph the solution: $|x+1| < 2$
7. Solve the system of equations: x+5y = 6 and 2x+5y = 5
8. Find the slope of the equation 3x+5y = 15
9. Find the equation of the line containing the points (2, 3) and (4, -1).
10. Evaluate f (–1) for the function $f(x) = x^2-2x+1$

Figure 3: Conceptual and Procedural Quiz
Note: Each quiz is worth 10pts and 25minutes were allowed to complete each one of them

Findings

***Data Analysis*:** Table 1 indicates that the average anxiety-difference is -6.52. These results illustrate that the level of anxiety for respondents in the conceptual group on average decreased by the end of the course.

The results of Table 2 below show that subjects in the procedural treatment had an anxiety-difference mean for respondents of 0.73 with a standard deviation of 3.237. The table illustrates that the anxiety level for subjects in the procedural group slightly increased. For this group, the conceptual quiz average (4.54) and procedural quiz average (5.85) were also lower compared to the overall respondents.

Table 1. Descriptive Statistics for Conceptual treatment group (n = 53)

	Minimum	Maximum	Mean	Std. Deviation
Anxiety-difference	-22	2	-6.52	0.79
Conceptual-quiz	4	10	6.81	1.532
Procedural-quiz	3	10	7.08	2.111

Table 2. Descriptive Statistics for Procedural treatment (n = 52)

	Minimum	Maximum	Mean	Std. Dev.
Anxiety-difference	-6	10	0.73	3.237
Conceptual-quiz	2	8	4.54	1.434
Procedural-quiz	3	10	5.85	1.742

***Test of normality and linearity for conceptual group using anxiety-difference*:** It appears that the variable, anxiety-difference for the conceptual treatment is normally distributed, as shown in figure 4. The Q-Q plot (figure 4) shows no major departures from the fitted line.

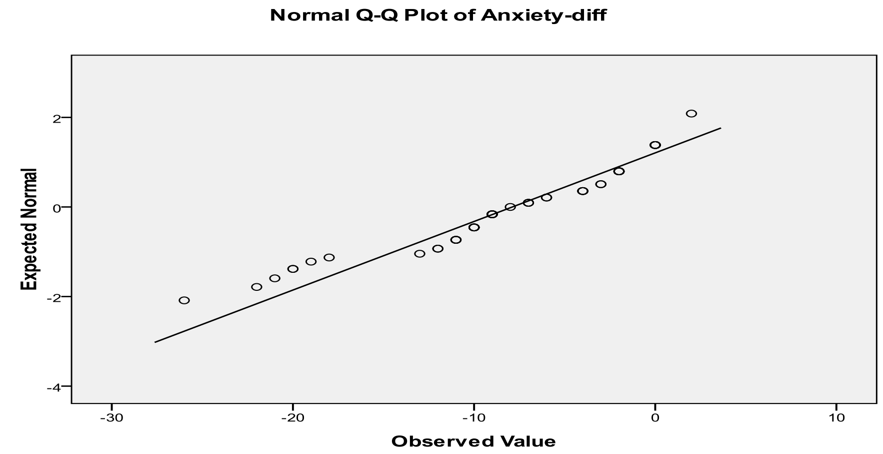


Figure 4: Normal Q-Q Plot Using Mathematics Anxiety-difference for the Conceptual Group

Test of normality and linearity for procedural group using anxiety-difference: Figure 5, illustrating the normal Q-Q plot for Mathematics Anxiety-difference for the procedural group reveals that anxiety-difference variable is normally distributed for the procedural group.

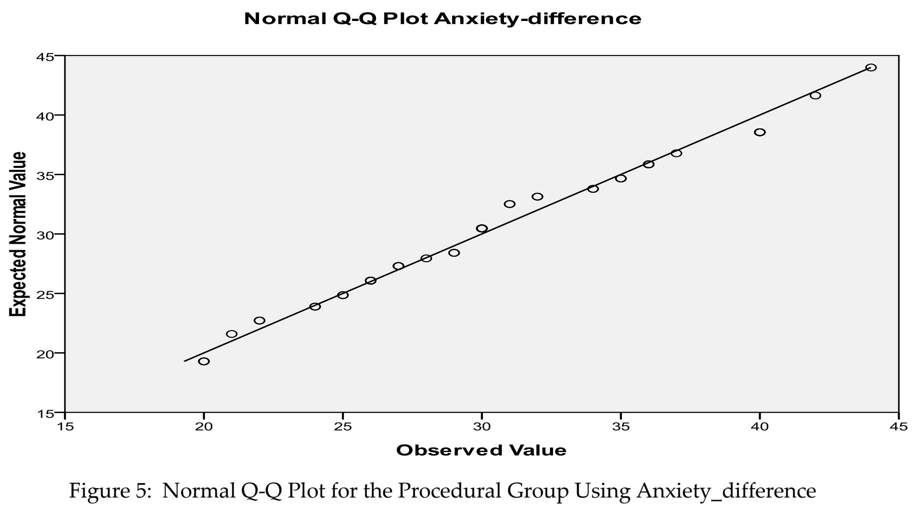


Figure 5: Normal Q-Q Plot for the Procedural Group Using Anxiety_difference

Independent T-test comparing overall means of anxiety-difference for both groups: The descriptive statistics for each group are reported in Table 3.

Table 3: Group Statistics using anxiety-difference

	Group	N	Mean	Std. Deviation	Std. Error Mean
Anxiety-Difference	Conceptual	53	-6.53	5.810	0.798
	Procedural	52	0.73	3.237	0.449

The results from the independent t-test are given in Table 4. The equality of variance test indicates that the null hypothesis of equal variance is rejected with a p-value of 0.001 at the 5% level of significance. This indicates that there is statistical evidence that the variance between the anxiety-difference of the two groups differ. In other words, anxiety-difference varies depending on the group.

Table 4. Independent sample t-test for Anxiety-difference

	Levene's Test for Equality of Variance		T.test for Equality of Means						
								95% Confidence Interval of the Difference	
Anxiety-Difference	F	Sig.	t	df	Sig.	Mean Diff	Std.Err Diff	Lower	Upper
Equal Variance	12.61	0.001	-7.89	103	0.000	-7.26	0.92	-9.08	-5.43
Unequal Variance			-7.93	90.36	0.000	-7.26	9.16	-9.08	-5.44

A test of equality of means also shows that the null hypothesis of equal means is rejected at the 5% level with p-value less than 0.0001. There is statistical evidence that the mean anxiety-difference is not the same for the two groups. A one tail test concluded that the mean anxiety-difference of the conceptual group is statistically less than the procedural group.

Modeling using Anxiety-difference as a response variable: In developing the best fit linear model for anxiety-difference as the response variable, the following explanatory variables: conceptual quiz, procedural quiz, and treatment group were used. A dummy variable (groupdummy) was created for the treatment group which takes value "1" for the conceptual group and "0" for the procedural group. Hence, the following analytical linear model:

$$\textit{Anxiety-Difference} = \alpha + \beta_1 * \textit{procedural-quiz} + \beta_2 * \textit{conceptual-quiz} + \beta_3 * \textit{groupdummy} + \varepsilon$$

The regression analysis performed on anxiety-difference and the explanatory variables produced the regression coefficients in table 5 and the corresponding analysis of variance (ANOVA) in table 6. Using the regression coefficients from table 5, the developed linear model is given by,

$$\textit{Predicted Anxiety-Difference} = 4.103 - 3.596 * \textit{groupdummy} - 0.99 * \textit{conceptual-quiz} + 0.064\ \textit{procedural-quiz}$$

The explanatory variables in the model are statististically significant with p-values less than 0.05 except variable procedural-quiz with p-value 0.842. However, the F-statistic from the ANOVA (table 6) is 18.707 with p-value less than 0.0001. Therefore, the overall developed linear model is statistically significant at the 5% level.

Table 5. Coefficients of the anxiety-difference model

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	4.103	1.991		2.061	0.042
	Groupdummy	-3.596	1.408	-0.262	-2.555	0.012
	Conceptual-quiz	-0.99	0.411	-0.268	-2.409	0.018
	Procedural-quiz	0.064	0.318	0.019	0.2	0.842

Table 6: ANOVA Using Anxiety-difference as the Response Variable

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	2411.282	5	482.256	18.707	.000[a]
Residual	2552.108	99	25.779		
Total	4963.39	104			

Conclusions

This study investigated the relationships between mathematics anxiety and conceptual understanding of the subject. In other words, it examined the mathematics anxiety of students who had been exposed to a conceptual treatment as compared to those taught in ways that emphasized procedures.

The ANOVA test showed a statistically significant relationship between mathematics anxiety and the teaching approach applied.

Results indicated that the conceptual treatment had more positive impact on mathematics anxiety as compared to the procedural treatment. The mean anxiety-difference for the conceptual group was smaller than the procedural group. In fact, the mean anxiety-difference for the conceptual group was negative (-6.53) as compared to the procedural group, which was 0.73. This is an indication that the conceptual treatment had an impact on the mathematics anxiety scores of the conceptual group. The mean score for the posttest anxiety in the conceptual group was substantially lower than the mean score for the pretest anxiety. This was not the case for the procedural teaching groups. The procedural teaching, which was similar to the traditional approaches to teaching mathematics, made no impact on reducing the mathematics anxiety of the procedural group. This difference indicates that the procedural groups averaged, on their posttest-anxiety surveys, a score higher than the mean scores of their pretest-anxiety surveys, illustrating that the mathematics anxiety of the procedural groups increased at the end of the semester. Not only did the procedural or traditional teaching fail to reduce mathematics anxiety, but also the study's results suggest that procedural teaching methods exacerbated mathematics anxiety. The results support Skemp's (1971) theory that rote learning, which is derived from procedural teaching, could lead to mathematics anxiety.

The results revealed that the conceptual groups outperformed the procedural groups on the conceptual quiz. The conceptual quiz average score for the conceptual groups (6.81 out of 10) was higher than the one for the procedural (4.54 out of 10). The conceptual quiz questions were not based on problem solving. These questions were designed to test students' knowledge of the subject matter. As the results illustrated, the conceptual groups had a better understanding of the subject matter. The conceptual groups also performed better on the procedural quiz, despite the fact that the procedural groups practiced more procedural problems than the conceptual groups and was exposed to a procedural treatment. The procedural quiz average score for the conceptual group was 7.08/10 and the procedural group's average was 5.85/10. The procedural groups, on average score relatively lower on the procedural quiz. This indicates that the conceptual treatment provided a more flexible understanding of mathematics, which allowed them to utilize the knowledge as a tool to solve problems. In other words, conceptual groups were more able to reason logically, formulate, represent, and solve mathematical problems. This finding supports Brownell's (1973) idea: "the greater the degree of understanding, the less the amount of practice necessary to promote and to fix learning" (p.188). These findings also support the NCTM's reforms (1989) in mathematics education, which argued that teachers should inculcate conceptual understanding before approaching procedural knowledge.

Overall, this study statistically demonstrates that the procedural method of teaching does not overcome mathematics anxiety. Furthermore, procedural methods exacerbate the problem. The rote memorization common in the traditional method of teaching mathematics still remains a concern. This method focuses mainly on mastering rules, while sacrificing attention to concepts. The procedural method, when applied alone, is easy to forget or hard to remember; therefore, it is often associated with pain and frustration for students. While taking the examination, students must recall their lessons and the material they studied, a technique that generates anxiety, disabling students from performing well.

This study reveals that students achieve higher scores in mathematics when they are engaged in exploring and thinking rather than engaging only in rote learning of rules and procedures. In fact, these conceptual and active methods help students build the necessary confidence to learn new mathematical concepts. In other words, conceptual knowledge reduces mathematics anxiety and enhances one's success in the subject. Mathematics in developmental courses needs to be relevant to students' everyday lives. Now the question becomes: In what way can these initiatives and instructional strategies be implemented in remedial mathematics in order to improve these students' mathematics as well as help them to overcome their mathematics anxiety?

Recommendations

This study could be reevaluated, using a quasi-experimental design, with a larger sample size and more lessons plans. Four out of 67 elementary algebra sections were selected in this study. For further study, selecting at least ten sections, for a sample size of 300 participants, would yield results more representative of the population and would limit the influence of outliers or extreme observations. Also, increasing the lesson plans to nearly cover 90% of the course outline will reduce the time spent on procedures by the conceptual groups.

Mixed methods, in which quantitative and qualitative methods are combined, can be used to re-examine this study's questions. A follow-up qualitative component such as interviews could generate more complete data and help examine, in greater depth, the mathematics anxiety of remedial mathematics students in community college.

This study examined the relationship between procedural knowledge, conceptual knowledge, mathematics anxiety and mathematics achievement. It would be useful to examine students' test anxiety using a test anxiety scale. This is to determine whether or not mathematics anxiety, compared to test anxiety, has a more significant impact on mathematics achievement. The relationship between mathematics anxiety, test anxiety, and mathematics achievement could be examined.

A similar study could employ Fennema-Sherman attitudes scales which include, Attitude toward success in mathematics (AS) scale, Mathematics as a male domain (MD) scale, Teacher (T) scale, Confidence in learning mathematics (C) scale, Mathematics anxiety (A) scale, Usefulness of mathematics (U) scale, Effectance motivation (E) scale, father subscale and mother subscale. This would benefit in-depth examination of other factors that contribute to mathematics anxiety as well as students' conceptual knowledge.

Teachers must also make efforts to balance their use of conceptual and procedural teaching. To pass an examination, students must develop both conceptual and procedural understanding (Mary & Heather, 2006). According to NCTM's Principles and Standards for School Mathematics (2000),"Developing fluency requires a balance and connection between conceptual understanding and computational proficiency" (p. 35). However, teachers should focus on the concept first then the procedures.

Reference

Ashcraft, M. H. (2002). *Math anxiety: Personal, educational, and cognitive consequences*. *Current directions Psychological Science, 11(5), 181- 185.*

Bailey, T. (2009). *Challenge and opportunity: Rethinking the role and function of developmental education in community college*. New Directions for Community Colleges,145, 1130.

Beck, A.T., & Emery, G. (1985) Anxiety *Disorders and Phobias: A Cognitive Perspective.* Basic Books, N Y, USA.

Briars, D., & Siegler, R. S. (1984). *A featural analysis of prschoolers' counting knowledge.* Developmental Psychology, 20,607-618.

Brownell, W. A. (1973). *Meaning and skill—Maintaining the balance*. In F. J. Crosswhite, J. L.

Buxton, L. (1981) *Do You Panic About Maths*? Coping with Maths Anxiety. London: Heinemann.

Dreger, R. M., & Aiken, L. R. (1957). *The identification of number anxiety in a college population.* Journal of Educational Psychology, 48, 344–351.

Fennema, E., & Sherman, J. A. (1976). *Fennema-Sherman Mathematics Attitudes Scales: Instruments designed to* *measure attitudes toward the learning of mathematics by males and females.* Catalog of Selected Documents in Psychology, 6(1), 31.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. Journal for Research in Mathematics Education, 21, 33-46.

Mary, M.C., & Heather, J. (2006). *Algebraic equations: Can middle-school students meaningfully translate from words to mathematical symbols? Reading psychology 27*:147-164

National Center for Education Statistics. (2013). *National Postsecondary Aid Study 2007-2008 (NPSAS:2000).* Retrieved January, 2013, from http://nces.ed.gov/pubs2013/2013013.pdf

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

Richardson, F., & Suinn, R. (1972). *The mathematics anxiety rating scale*; Psychometric data. *Journal of Counseling Psychology, 19(6),* 551-554.

Scarpello, G. (2005). *Helping students get past math anxiety*. Retrieved on October 18, 2007; http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/33/58/3f.pdf

Skemp, R. (1971). *The psychology of mathematics*. Baltimore, MD: Penguin Books.

Taylor, L., & Brooks, K. (1986). *Building Math Confidence by Overcoming Math anxiety*. Adult Literacy and basic Education, v10.

Tobias, S. (1993). *Overcoming math anxiety.* New York: W. W. Norton & Company.