Business Students' Perceptions of Mathematics: Can We Overcome Math Anxiety?

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ABSTRACT

This study seeks to determine student attitudes towards taking quantitative courses. A study was undertaken in sophomore accounting (principles and managerial) and business statistics courses at Texas State University-San Marcos. Respondents were asked to complete 15 questions concerning their attitudes towards math courses. Statistical analysis of the survey results is presented.

An examination of the literature regarding math education is presented. Anxiety and panic are the most quoted reactions by those with serious reservations about working math problems. Theories are examined which explain this behavior and conclusions are drawn about successful strategies in math education. The results of the survey are presented, along with conclusions and suggestions for further study.

INTRODUCTION

In 1980, there were more than 600,000 students enrolled in college remedial or developmental math courses. These courses covered precisely the same math content as high school courses. To aid these students, twice as numerous as they were ten years earlier, virtually all campuses have established basic math programs-sizeable enterprises at those institutions where the mathematically unprepared constitute the majority of students. (Akst, 1)

In the years since that statement by Akst, America has embraced the so-called "high tech" revolution of personal computers, Personal Digital Assistants, etc. Yet, evidence exists that the problem is getting worse instead of better.

> "About six years ago, Wayne State University had to create a separate remedial course to prepare students to get into its remedial math class. When you have a population with an enormous percentage of people hating math, not knowing math, not understanding math,

there's something wrong," according to Wayne State math professor Steve Kahn. (Higgins, 1)

Further, it appears that the problem is not unique to Michigan. The percentage of freshmen needing math remediation in the California State University system is as follows. (Hobel, 2)

Percentage of Freshmen Needing Remediation
in Math at California State Colleges

Year	Percent	Year	Percent
1989	23	1994	48
1990	24	1195	52
1991	26	1996	53
1992	39	1997	54
1993	45	1998	54

The alarming rate of increase, a doubling in ten years of remedial math students, resulted in two landmark books on the subject, *Mind over Math* by Stanley Kogelman and Joseph Warren (1978) and *Overcoming Math Anxiety* by Sheila Tobias (1978). Interestingly, these are still the authoritative books on the subject some 25+ years later. Indeed, the Student Learning Assistance Center at Texas State University-San Marcos, lists the 12 Math Myths listed by Kogelman on its web site. (Kogelman, 30)

Findings by authors in this field indicate again and again that panic and anxiety are prime causes of an inability to work math problems. (Buxton, 1) Interestingly, when these landmark books were written, there was considerable sex bias against math. (Tobias, 13) Tobias notes that this put women at a distinct disadvantage to men when it came to selecting a college major. (Tobias, 26) The dislike of math even extends to perceptions about the people who teach math. (Kogelman, 9) Researchers found that there was early negative re-enforcement by teachers and parents regarding math, usually due to time constraints and the need for an exact answer. (Kogelman, 21) All of these negative ideas have resulted in common myths about math education, as well as the aforementioned twelve myths about math. (Kogelman, 30)

The way problems are solved has been examined (Akst, 14, Buxton, 73, Akst, 21) Researchers have advanced theories to explain math education behavior. (Akst, 48-51)

Finally, we examine remediation that has met with success in math education. The importance of overcoming anxieties using group therapy with a psychologist is noted. The use of interviews and the creation of a math autobiography for those experiencing math anxiety is also examined.

LITERATURE REVIEW

"It would not be surprising if people said they were worried, anxious, or perhaps bored with maths (British term), but the word 'panic,' …suggests purpose and intent in its use." (Buxton, 1) Responses to questions about solving math problems were couched in these terms. 'Whenever I think back to it, it's always that dreadful numbing panic. Now, yes, Good God, straight away

I'm panicking… not straightforward…that makes me panic." (Buxton, 1) It should be noted that Buxton is a British writer describing the reactions of British citizens; i.e., panic about math is not uniquely American. Bonnie Donady of the Wesleyan Math Clinic poses the incomplete the question of 'If I could do math I would…' Individuals will typically answer that they could perform engineering/scientific feats such as car repair or pilot an airplane. "What, me do math? Impossible." (Tobias, 25)

Kogelman reports that negative math experiences most frequently occur between the seventh and tenth grades. However, some people don't remember ever having been comfortable with math and may have had painful experiences in elementary school. (Kogelman, 16-17) Humiliation is another frequent complaint among those with math anxiety. Regarding an elementary school experience, one individual remarked, "If you didn't' get it, they berated you and made you stay in your seat for hours until you got it. They made you sit there and do it until either you did it, or you collapsed on the desk from crying so hard." (Kogelman, 17)

"The most stressful maths situation recalled by my subjects was the mental arithmetic test. The tests did not usually involve working things out, but instead consisted of recalling number facts at speed." (Buxton, 89) Thus, the individuals are subject to both the public humiliation listed above, as well as being required to perform it quickly.

With experiences like these, it is no wonder many people experience math anxiety. Given this negative experience, it is not surprising that the dislike of math also extends to the dislike of people who teach it. "I remember my high school geometry teacher. He was gray all over. I was given this little immigrant teacher…he didn't understand us…I certainly didn't' understand him." (Kogelman, 16) Kogelman describes the vision one math anxious person had about a mathematician coming to interview her. "I expected you to be unattractive, cold, and to have absolutely no sense of humor. Basically, you would be boring! I expected there to be huge differences between us because we wouldn't be able to speak the same language." (Kogelman, 8-9)

This fear of math leads to anxieties and unreasoning fears. The result can be that people make great leaps in their assumptions. As Tobias puts it, "people who don't know what math is don't know what math isn't. (Tobias, 25) Individuals suffering math anxiety believe working math to be a near supernatural task, and if one could do it, an array of technical proficiencies would be possible.

The next step in analyzing math anxiety is to ask students to describe exactly how they solved problems. Akst reports that "by studying students' self-reports, we have become convinced that many of our students make painfully slow progress, not because they attach mistaken interpretations to algebra symbols...but rather because they attach essentially none." (Akst, 14) How then do we analyze such information?

Karl Popper distinguished between three worlds. The first is the external physical world which we recognize through our senses. The second is that mental world which each of us has within ourselves. World three is the world of statements, those utterances in whatever form that we have externalized. (Buxton, 73) Someone in world one (generally a teacher) thrusts some

mathematical material into the student's world two, with the demand that it be worked upon. The students ask, 'what is the use of it?' It is the student's experiences with world one that occasions his anxiety. (Buxton, 74)

Kerry and Lang, in their profile of remedial math students, make these observations about problem solving. They note that students feel that learning will take place if they just sit back and watch the professor show them what they need to know. The major difference between the unsuccessful and successful problem solvers in their extent of thought about the problem was in the degree to which their approach to the problem might be characterized as active or passive. (Bloom, 25-29) Poor problem solvers are less active because they do not believe there is anything for them to do. Their view of problem solving and learning; you know the answer or you do not, places them in the passive role of absorbing information and repeating it back. Instruction whether by textbook, lecture, or cookbook laboratory places students in the role of copiers. Rarely are they asked to generate their own knowledge. (Akst, 22)

If that is the case, is there hope that such students can learn math? The third of three theories on the subject suggest a new way of looking at this problem. The traditional view (Bloom, 1976) is that intelligence and achievement are viewed as a flat normal curve. This view permeates the entire educational establishment; indeed, accelerated classes are set up for those in the right tail while those in the left tail are discouraged from taking the more difficult classes. Bloom reports that cognitive entry skill, which is the knowledge that a student possesses at the beginning of a unit, account for half of the student's variance from the norm of course achievement. This means that students tend to maintain their relative positions within the group. Weak students remain weak and strong students remain strong. Another 15-20 percent of the variation in course achievement is accounted for by affective entry skills. This is simply the student's initial attitude toward the course. Thus, the cognitive and affective entry skills play a major role in determining the performance of a student. This means that 65-70 percent of student end-of-course achievement is predictably aimed at failure. (Akst, 50)

John Carroll, a North Carolina professor of education, is credited with developing an assumption that places this emphasis on achievement. Whereas the traditional assumption views the spread of intelligence and achievement in the population as wide, the Carroll assumption sees far less variation. A consequence of this position for development educators is that remedial students can be expected to overcome them under appropriate conditions. That condition is individualized or self-paced instruction. Under the Carroll assumption, the normal curve of achievement is relatively narrow and sharp-peaked. (Akst, 05-51, Carroll)

Benjamin Bloom of the University of Chicago formulates a third assumption. He asserts that 95 percent of students can achieve mastery of 90 percent of the instructional objectives, when provided with quality instruction. The key element in quality instruction is the "mastery testing requirement." The rule of the mastery testing requirement is that no student is allowed to begin instruction in a unit until he or she has first mastered, at the 90 percent level, the cognitive entry skills for that unit. This requires an assessment of entry skills and then a strategy to overcome deficiencies. Now known as Personalized System of Instruction, PSI has had impressive results. PSI students had far better end-of-course achievement, moving to the 70^{th} percentile instead of the 50^{th} percentile under conventional instruction. (Kulik, Kulik, and Cohen, 79)

It is not surprising that several researchers point to the importance of interviews to determine a diagnosis of the anxiety. The counselor asks about past experiences in math. This forms the mathematics autobiography. Tobias feels that this talking process is at the heart of the treatment of math anxiety. It helps people to know they are not alone in their fear. The process of recollection can remove old obstacles to learning and insight into what is blocking learning now. The eventual goal is to understand how phobias get in the way of working math problems. Once those phobias or unreasoning fears are identified, we can start persisting and get down to learning math. (Tobias, 248) Kogelman reports a similar result. The first step in freeing yourself from all your past attitudes toward math is to come to grips with your feelings and reactions when confronted with it. With that discovery, you will become acutely sensitive to your own patterns of reacting and will be able to catch yourself and begin to change. (Kogelman, 126) Buxton gives a detailed account of her interview with a lady she names Elaine in Chapter 11 of her book. By the eighth interview, Elaine is astonished to discover that she can work a math problem. (Buxton, 159)

So, in the 25+ years since these landmark books were written, has the situation improved? As was noted earlier, increased remediation exists at Wayne State and in the California University System. It does not seem to be much better in Texas. The recent round of TAKS (Texas Assessment of Knowledge and Skills) tests suggest that students are still having difficulty with math and science. Students in most grades struggled with math and science. Indeed, Tom Gaul, superintendent of Round Rock school district, notes that, "we did some restructuring of our class days, double-blocking algebra classes and making more time for studying those things our students need to know for the TAKS." Last year, only 49% of Texas juniors passed all sections of TAKS. (Martinez) The fact that these landmark studies are still the guiding light was suggested when this researcher's Google search located the 12 Myths of Math Education at a 1999 website of his former school, Texas State University. (Southwest Texas State University)

RESULTS OF THE STUDY

The survey questionnaire consists of ten questions about attitudes towards math. There are five demographic questions to profile the respondents. Questionnaires were distributed to 266 first semester accounting students, 175 second semester accounting students, and 206 students in first semester statistics. All classes were at Texas State University-San Marcos. The first eight questions and question ten were posed on a Likert scale from one to five. Questions eight and nine were multiple choice. The lower end of the scale was designed to model a negative response. Conversely the upper end of the scale for these questions was modeled to be a positive response.

Question Number One *My earliest memory of solving math problems is*
(1 unsuccessful / 5 successful)

Value	*Frequency*	*Cum Frequency*	*Percent*	*Cum Percent*
1	16	16	2.43	2.43
2	42	58	6.37	8.80
3	131	189	19.88	28.68
4	199	388	30.20	58.88
5	271	659	41.12	100

The average response was 4.01 for this question. This suggests that most of the respondents had positive early experiences with math.

Question Number Two *I would rate my early success in math as*
(1 unsuccessful / 5 unsuccessful)

Value	*Frequency*	*Cum Frequency*	*Percent*	*Cum Percent*
1	12	12	1.81	1.81
2	34	46	5.14	6.95
3	116	162	17.52	24.47
4	217	379	32.78	57.25
5	283	662	42.75	100

The average response was 4.11 for this question. Again, this suggests early success by the respondent.

Question Number Three *I would rate my later success in math, such as fractions, arithmetic expressions, and algebraic manipulation as*
(1 unsuccessful / 5 successful)

Value	*Frequency*	*Cum Frequency*	*Percent*	*Cum Percent*
1	15	15	2.27	2.27
2	47	62	7.10	9.37
3	149	211	22.51	31.87
4	250	461	37.76	69.64
5	201	662	30.36	100

The average response was 3.86 for this question. This is a lower average than the first two questions elicited, suggesting that the respondents were having more difficulty as they progressed through school.

Question Number Four *I find math relevant to the problems I will face in life*
(1 disagree / 5 agree)

Value	*Frequency*	*Cum Frequency*	*Percent*	*Cum Percent*
1	31	31	4.69	4.69
2	108	139	16.34	21.03
3	234	373	35.40	56.43
4	173	546	26.17	82.60
5	115	661	17.4	100

The average response dropped to 3.35 for this question. This suggests that after early successful experiences, more respondents were starting to question the benefit of mathematics.

Question Number Five *As an elective, I would take a course which uses analytical problem solving skills, such as statistics, computer programming, and/or accounting.*
(1 disagree / 5 agree)

Value	*Frequency*	*Cum Frequency*	*Percent*	*Cum Percent*
1	194	194	29.31	29.31
2	143	337	21.60	50.91
3	165	502	24.92	75.83
4	94	596	14.20	90.03
5	66	662	9.97	100

The average response dropped to 2.54 for this question. This suggests that over half of the students would not take such a course.

Question Number Six *In comparison with qualitative courses such as management and marketing, I find courses requiring analytical problem solving skills to be*
(1 unpleasant / 5 pleasant)

Value	*Frequency*	*Cum Frequency*	*Percent*	*Cum Percent*
1	61	61	9.21	9.21
2	115	176	17.37	26.59
3	285	461	43.05	69.64
4	156	617	23.56	93.20
5	45	662	6.80	100

The average response was 3.01 for this question. Students are ambivalent about taking a qualitative or quantitative course.

Question Number Seven *Rate your level of dislike/like for math (1 dislike / 5 like)*

Value	*Frequency*	*Cum Frequency*	*Percent*	*Cum Percent*
1	70	70	10.59	10.59
2	97	167	14.67	25.26
3	172	339	26.02	51.29
4	209	548	31.62	82.90
5	113	661	17.10	100

The average response was 3.08 for this question. Students, by a small margin, were more apt to like than dislike math.

Question Number Eight *Generally you consider yourself as disliking math because (multiple choice*

Value	*Frequency*	*Percent*
1	*74*	*29.48*
2	*33*	*13.15*
3	*33*	*13.15*
4	*103*	*41.04*
5	*8*	*3.18*

The calculation of an average response is not relevant to this question because four responses were offered and all could be selected. Two hundred and fifty-one responded to this question which was for those disliking math. Responses were as follows.

Number	Response
1	I am poor at mathematics
2	Math is not relevant to my life.
3	Math is not relevant to solving business problems I will face.
4	Calculators and computers can solve these problems better than I can.

The most frequent response was that machines can perform math better than the respondent. The second most frequent response was that the respondent was poor at math.

Question Number Nine *Generally, you consider yourself as liking math because (multiple choice)*

Value	*Frequency*	*Percent*
1	127	41.37
2	40	13.03
3	107	34.85
4	23	7.49
5	10	3.26

This was the positive alternative to question number eight.
Answers were chosen as follows.

Number	Response
1	I had early success in math.
2	Math is relevant to my life.
3	Math is relevant to solving the business problems I will face.
4	Computer and calculators don't think the same way that people do.

Three hundred and seven respondents answered this question which was the positive view of math. The most frequent response was early success and the second most frequent response was that it is relevant to business problems.

Question Number Ten *I believe that math ability can/cannot be taught*
(1 cannot be taught / 5 can be taught)

Value	*Frequency*	*Cum Frequency*	*Percent*	*Cum Percent*
1	10	10	1.54	1.54
2	33	43	5.69	6.63
3	144	187	22.22	28.85
4	260	447	40.12	68.97
5	201	648	31.03	100.00

The average response was 3.94. This indicates that most respondents thought math could be taught.

Demographic Analysis

Question Number Eleven *My major is*

Major	Responses	Percent
Accounting / Computer Information Systems	131	19.91
Finance / Economics	107	16.26
Marketing	123	18.69
Management	151	22.95
Other	146	22.19
Total	658	100.00

The majors of the respondents were approximately uniformly distributed, with no clustering in a particular major.

Question Number Twelve *My overall Grade Point Average is*

Responses to this question was

GPA Range	# Responses	Percent
Below 2.00	11	1.68
2.00-2.50	75	11.45
2.51-3.00	265	40.46
3.01-3.50	215	32.82
3.51-4.00	89	13.59
Total	655	100.00

Approximately three-fourths of the respondents had a GPA between 2.51 and 3.50.

Question Number Thirteen *This survey is being administered in*

Class	# Responses	Percent
1st Semester Accounting	266	41.11
2nd Semester Accounting	175	27.05
Intro to Statistics	206	31.84
Total	647	100.00

This table shows a wide distribution of respondents in the three courses. Respondents were not surveyed in more than one course.

Question Number Fourteen *How many hours of college level math have you completed*

# Hours	# Responses	Percent
Three	94	14.48
Six	219	33.74
Nine	178	27.43
> Nine	158	24.35
Total	649	100.00

Thus, approximately 85% of the respondents have completed two or more math classes in college.

Question Number Fifteen *Gender*

Gender	# Responses	Percent
Male	367	57.61
Female	270	42.39
Total	637	100.00

This table shows a good mix between male and female among the respondents.

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Students indicated early success in solving math problems. Yet, that success and enthusiasm for math waned later in their life. The largest of the five responses to the relevance of math to problems in later life was neutral. Half the respondents would not take an elective class in a quantitative field. Among the respondents that did not like math, the greatest responses were that the computers and calculators could solve the problems more easily and that they themselves were poor at math. Among the respondents that did like math, the most frequent response was that they had early success at math and that they believed math is relevant to solving the business problems they will face.

This study indicates that a substantial portion of students either doubt their own abilities or fail to see the relevance of math to business problems. This doubt is occurring in the basic courses taught in a college of business. This suggests that more surveying should be done to identify such students as soon as they arrive on the college campus. In that way, the methods known to overcome math anxiety could be utilized as quickly as possible.

The authors recognize that only one university was utilized for the survey. However, the authors believe that the perceptions of the students that were surveyed are typical for business students, regardless of the geographic location. Texas State University-San Marcos is a broad-based, regional university, possessing bachelors, masters, and doctoral programs. The overall enrollment is approximately 26,000 students. Approximately 20% of the student population are business majors. Nevertheless, extending the research to other states and universities could prove beneficial.

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