Formative Assessment: Reducing math phobia and related test anxiety in a geology class for non-science majors

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Abstract

Math and test anxiety are prevalent in society, and tend to be overrepresented in science classes for non-science majors. Students in these classes often excel in other areas but believe they are not able to do math or to do well on science tests. After teaching labs as a TA for Earth, Wind, and Fire, a geology class for non-science majors, I became aware of how disabling math and test anxiety were for many of these students. The next time I taught labs for this course, I used formative assessment to help reduce math and test anxiety. Although many authors have stressed the importance of alternative methods of evaluation, I knew, realistically, that these students would need to be able to take traditional exams. To this end, I gave weekly quizzes that were very challenging, graded harshly, and completely correctable. Students were encouraged to correct their quizzes, and the corrected grade completely replaced the original grade. By the mid term, 100% of the students had mastered rate calculations, and when retested at the final, 80% of the students retained the ability to solve the rate calculations. Students commented feeling less nervous about the midterm exam because they knew they could answer the math questions.

Math and Test Anxiety

- Characterized by feelings of dread and paralysis, inability to complete answers
- Main causes: poor preparation and negative feedback
- Generally math and test anxiety are linked
- Two thirds (Jackson and Leffingwell, 1999) to 93% (Burns, 1998) of Americans have negative associations with math
- an 'I can't' syndrome" (Williams, 1988)
- "Emotional and a cognitive dread of mathematics" (Williams, 1988)
- Math anxiety is isolating (Dodd, 1992)
- Test anxiety may result from poor study skills, the setting of unrealistic goals, hostile test environments, and impromptu testing, such as pop-quizzes (Sogunro, 1998).
- Attributed to the actions, whether overt or covert, of teachers (Williams, 1988), and of parents.
- Teachers run the risk of spreading the "communicable disease of math anxiety" that they themselves are carriers of (Williams, 1988).
- "Habitual, irrelevant, negative thoughts...during a testing situation" (Mealey and Host, 1992) causing distraction
- Women report higher rates of math anxiety (Levine, 1995) even in cases when they outperform men.

How can math and test anxiety be reduced?

Pedagogical:
- Creating positive experiences to replace negative ones which fostered the anxiety
- informal and ongoing assessment (Steele and Arth, 1998)
- "regular and constructive feedback" (Sogunro, 1998)
- Give easier problems to students with known weaknesses, guaranteeing their success (Williams, 1988).

Theraputic:
- Confronting negative experiences
- Bibliotherapy, journaling, and group work, math autobiographies
- Teacher as counselor (Furner and Duffy, 2002), (Eisenberg, 1992)
- Personal stories of success may offer students hope
- "Changing negative beliefs is a slow process" (Dodd, 92)
- Need teachers who are patient and encouraging" (Dodd, 1992)
- Many cases may also require counseling

Formative Assessment

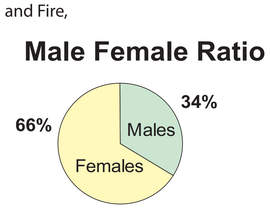
Frequent. low anxiety

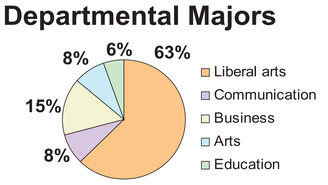
s carried out in Spring 2003 while I was a graduate student in the department of geology at the University of
. It was devised and conducted in response to experiences I had while acting as teaching assistant. In my first
third year, I taught labs for a class called "Earth, Wind, and Fire." This is a class designed to fulfill part of the
ement for non-science majors. Topics in the lab part of the course included the following: Geologic Time;
s, Sea Floor Spreading; Hydrology; Groundwater Flow; Surficial Water; Earthquakes; and Volcanoes. In each of
dents were expected to do simple mathematical calculations. They were asked to calculate rate, length, area, and
ts. Typical problems involved applied math in which students compared rates of sea floor spreading or calculated
a from absolute dating. The labs came from a workbook designed for the course which was based largely upon
ne in the past. Students used real data in some cases, which was a frequent source of frustration for them.
assistant, I had little control over content but a fair amount of control over how I presented the material. The first
abs for Earth, Wind, and Fire, I had certain expectations of the students; these included that students would know

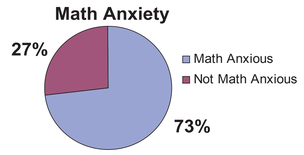
Methods and Interventions

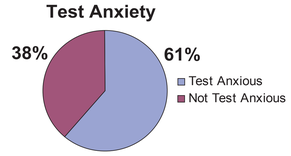
Participants:

Students with fewer than 4 absences who were enrolled in my sections of Earth, Wind, and Fire,





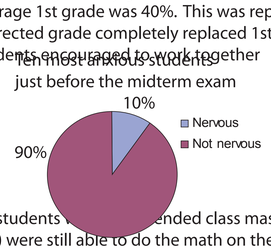


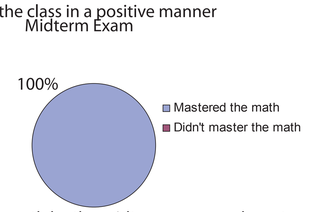


- Students were surveyed at the beginning of the semester and asked if they had math or test anxiety
- I admited that I have personally dealt with math and test anxiety
- Explained importance of math to geology

Results

- Challenging, harshly graded, given weekly with difficult material repeated
- Average 1st grade was 40%. This was reported to the class in a positive manner
- Corrected grade completely replaced 1st grade
- Students encouraged to work together



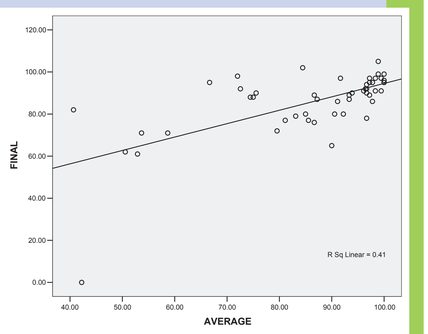


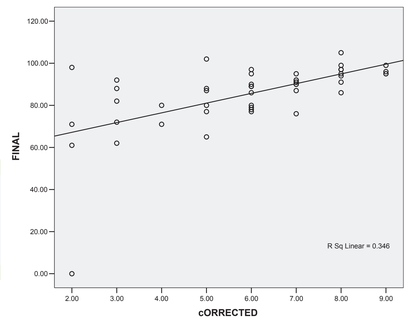
- All students who attended class mastered the math by the midterm exam, and most (80%) were still able to do the math on the final exam.
- Mastery of math in sections taught by other TAs who were not using compassionate quizzes ranged from 40% to 70%
- Students reported feeling less nervous about the exam, compared to how they felt about other exams

Comments from students on course evaluations:
"I really like the policy pf correcting quizzes and having them often"
"She teaches exactly how school should be taught, less emphasis on grades (because she allowed corrections) and more on learning which is what class is all about anyway."

Conclusions

Formative Assessment
Know what your students know
let them know what you expect them to knov
Gte them comfortable with taking tests





Implications, Future work

Students with math anxiety and test anxiety can be retrained by using Formative Assessment. A supportive environment is vital so that the students understand the purpose of the quizzes: to instruct, not just to evaluate. By frankly discussing math anxiety, I was able to create a safe environment and offer hope to those confronting it. By using compassionate quizzes, I interrupted damaging practices common among math anxious students by making them aware that they are not the only ones who struggle and by showing them that they can do the math. This method also relieves test anxiety because students get opportunities to learn the instructors' assessment style, to receive feedback, to take risks in a safe environment, and to assess before major exams what they know and what they still need to study.

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