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 provide students with the training to succeed in such an environment, 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 Laffingwell, 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)
- Anxiety anxiety may result from poor study skills, the setting of unrealistic goals, hostile test environments, and improptu 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 (Stevel and Artth, 1998)
  - “Regular and constructive feedback” (Sogunro, 1998)
  - Give easier problems to students with known weaknesses, guaranteeing their success (Williams, 1988).
- Therapeutic
  - 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
Feedback provided, followed by time to revise thinking
- Promote learning, not as a measure of success/failure
- Improves learning considerably (Black and William, 1998)

Methods and Interventions
Participants: 92% of students with regular attendance (fewer than 5 absences) enrolled in my spring 2003 sections of Earth, Wind, and Fire, a geology class for non-science majors, grades 16-50
- Surveyed about math/test anxiety and reason for taking course
- Male Female Ratio
Departmental Majors
<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
<th>Total</th>
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<tbody>
<tr>
<td>54%</td>
<td>46%</td>
<td>100%</td>
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Methods:
- Quizzes given weekly, graded harshly, with new topics added
- Explained the purpose of formative assessment
- Students could correct the quizzes
- New grade completely replaced original grade
- Tactics for correcting quizzes:
  - Feedback would be immediate
  - Knowing what your students know
  - Positive correlation between number of quizzes corrected and midterm and final exam grades

Results
- All students who had attended class mastered the math by the midterm exam, and most (90%) 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

Implications and Suggestions
Students with math anxiety and test anxiety can be retained by using Formative Assessment. A supportive environment is vital so that 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 formative assessment, 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 reduces 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.

Classroom Response Systems
This technique could be employed in a large class
- Feedback would be immediate
- Would allow the instructor to know what was not understood by the class and to act on that knowledge

References
Stevel, D., Artth, A. (1998, Jan-Feb). Math Instruction and Assessment: Preventing Anxiety. Promoting Confidence. Schools in the Middle. 7(2), 44-46.
Williams, W. (1998 Feb.). Changing negative beliefs is a slow process” (Dodd, 92)

Comments from students on course evaluations:
- "I really like the policy of 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."

Correlation
- Positive correlation between number of quizzes corrected and midterm and final exam grade (significant at .01 level)
- Positive correlation between quiz grade and midterm and final exam grade (significant at .01 level)