A Tale of How Oral Reviews Morphed into Active Learning Classes

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Formative Oral Assessments: Engaging Students in Articulating their Thinking

- Ungraded, voluntary
- Often cited by students as most important aid to learning
- Small groups of 5–6 students for an hour
- All students at white boards

- Emphasis on conceptual questions
  - Why would you use linearization?
  - What does it look like on a graph?
  - From the graph, what kind of functions will give the best results?
  - Does it matter where you center the linearization?
How Do Orals Work?

Voluntary and ungraded
Outside of regular class time
5-6 students is ideal
Students write their names on the boards
Emphasis is on conceptual understanding
Not how many radians is 180 degrees, but why?
Not find a derivative, but if the derivative is -6 at x=4, what does that tell you about the graph at x=4
Benefits of Oral Assessments

- Students negotiate meaning and make mathematical connections
- Students learn to be far more metacognitive about their own learning
- Students feel more confident in their mathematical ability
- Students display more expert views on the nature of mathematics. (CLASS survey)
Problems to be Addressed

- Orals popular with students
- We would start with about 30% for Test 1
- sometimes more than 70% by test 3
- BUT the logistics are very time consuming

- PROBLEMS:
- RETENTION in STEM majors/college
- Students who are not fully prepared for the one semester Calculus I course
- Students who earn 3 on the AP
Supporting STEM Students

- summer camps,
- a two-semester Calculus I course,
- revised active learning recitations
- a pathway for students who earned an AP3
- drop down course
- supported by Learning Assistants (LAs).
Summer “Prep” camps
Math Readiness and Bootcamp

- **Math Readiness**
  - 5 days / residential
  - intensive prep for math placement test
  - students divided into groups of 10–12 with instructor/two LAs (use Noyce scholars)

- **Boot Camp**
  - week long residential
  - bio/chem or math/physics/engineering
  - common meals + meal cards
  - study habits / yoga / time management / research project with presentation (carbon footprint of Mason (trees/cars/etc))
Two-semester Course

- Smaller: 36–44 students versus 72–90
- Advantages over pre-calculus
  - students are less resistive
  - students see reasons e.g. “factoring”
- Students at white boards 50–75% of time
- Students have concepts broken down into smaller chunks – 8 tests versus 4
- Mason is phasing out Pre-calculus
Students who earn 3 on AP

- Given three credits for 1st semester of the two-semester course
- Enroll in 2nd semester (review entire course)
- At conclusion: 4 credits for regular Calculus 1 class / 2 elective math credits
- Almost all earn a B or better
- Some went on to honors Calculus 2, again earning an A or B
What about Students in Regular Calculus classes?

- Experimented with sharing an Active Learning Classroom

- drop-down class provided for students failing the first test in Calculus I
Revised Recitations

- 45 students instead of 30
- One TA and 2 LAs
- Students at white boards/working in groups
- Asked to work problems
- Must explain their reasoning
- Run like oral assessments
Learning Assistants Critical

- Undergraduates
- Take Teaching and Learning Seminar
- Facilitate authentic group learning
- Meet weekly with their “instructor”
- LAs are often students from previous classes that we observe helping fellow students
- In 72 person ALC and recitations, 2 LAs
- In 36 person ALC, 1 LA
- *LAs build a strong foundation in their major
QUESTIONS?

Contact:

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DATA?
CLASS Results: 7 items had significant pre/post differences

Students agreement increased significantly on:

- Item 8 – I am not satisfied until I understand why something works the way it does. (p=.042)
- Item 11 – I study math to learn things that will be useful in my life outside of school. (p=.012)
- Item 16 – To understand math I talk about it with friends and other students. (p=.002)
- Item 23 – Mathematical formulas express meaningful relationships among measurable things or amounts. (p=.001)
- Item 36 – When studying something new in math, I compare it to what I already know rather than just memorizing the way it was presented. (p=.028)
Students disagreed more strongly

- Item 7 – There is usually only one correct way to solve a math problem. (p=.037)
- Item 18 – If I don't remember a mathematical method needed to solve a problem on a test, there's nothing else I can do. (p=.007)

*Students answers to all other questions were not significantly different pre/post*
Looking at control vs. treatment in Calculus I for each exam unit exam

<table>
<thead>
<tr>
<th>Compare Exam Scores</th>
<th>N</th>
<th>Average</th>
<th>St. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Orals Exam 1</td>
<td>333</td>
<td>75.1</td>
<td>15.0</td>
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<tr>
<td>Orals Exam 1</td>
<td>134</td>
<td>81.6</td>
<td>10.4</td>
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<tr>
<td>No Orals Exam 2</td>
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<td>74.5</td>
<td>15.4</td>
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<tr>
<td>Orals Exam 2</td>
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<td>79.8</td>
<td>12.6</td>
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<tr>
<td>No Orals Exam 3</td>
<td>318</td>
<td>64.4</td>
<td>19.1</td>
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<tr>
<td>Orals Exam 3</td>
<td>138</td>
<td>73.9</td>
<td>15.7</td>
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</tbody>
</table>
Average Grades by placement score and number of orals

Course Grades in APPM 1350 for students participating in 0 vs 3 orals in Fall 2008
Decline in Failure Rates

- **Calculus I**
- **Calculus 2**

- 9 year AVG, Calc1 and 2
- 2007-2008
Effects of Orals

- Students learn the importance of understanding the basic concepts in order to be able to apply those concepts to novel situations
- Students become more metacognitive about their learning
- Students learn better ways of studying
- *Students work harder because they believe their instructors are invested in their success.*
- Students attend class and office hours more and do more homework
- All of the above improvements increase with the number of orals in which students participate
Students’ Reactions

- Helps me understand the hard concepts
- Helps me determine what I know and don’t know for the upcoming test
- It clarifies things I was unclear about
- It gives me confidence before the written test
- It helps to hear how other students think about some of the important ideas
Research Results

EXAM1

Mean: 76.96
Std.Dev: 14.15
n: 400 (100.00%)
Predicted: 76.96

ASSESSME

P-value=0.0000; F=14.2686; df=4.451

(19,21)

Mean: 70.81
Std.Dev: 15.86
n: 72 (15.45%)
Predicted: 70.81

(21,24)

Mean: 76.54
Std.Dev: 12.06
n: 134 (28.76%)
Predicted: 76.54

ORALS1

P-value=0.0049; F=8.4361; df=1.70

No Oral Exam 1

Mean: 67.38
Std.Dev: 16.98
n: 50 (10.73%)
Predicted: 67.38

Yes Oral Exam 1

Mean: 78.59
Std.Dev: 9.27
n: 22 (4.72%)
Predicted: 78.59

ORALS1

P-value=0.0388; F=4.3506; df=1,132

No Oral Exam 1

Mean: 75.19
Std.Dev: 12.00
n: 196 (20.80%)
Predicted: 75.19

Yes Oral Exam 1

Mean: 79.95
Std.Dev: 11.66
n: 38 (8.15%)
Predicted: 79.95
Benefits of Oral Assessments

- Students negotiate meaning and make mathematical connections
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- Students display more expert views on the nature of mathematics.
Great Calculus Experiment –Fall 07

<table>
<thead>
<tr>
<th>TEST</th>
<th>ORALS Failure Rate</th>
<th>NO ORALS Failure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10%</td>
<td>12.5%</td>
</tr>
<tr>
<td>2</td>
<td>9%</td>
<td>13%</td>
</tr>
<tr>
<td>3</td>
<td>8.5%</td>
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