Comparing Oral and Traditional Assessments in Math Content Courses for Pre-Service Elementary Teachers

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Study Overview

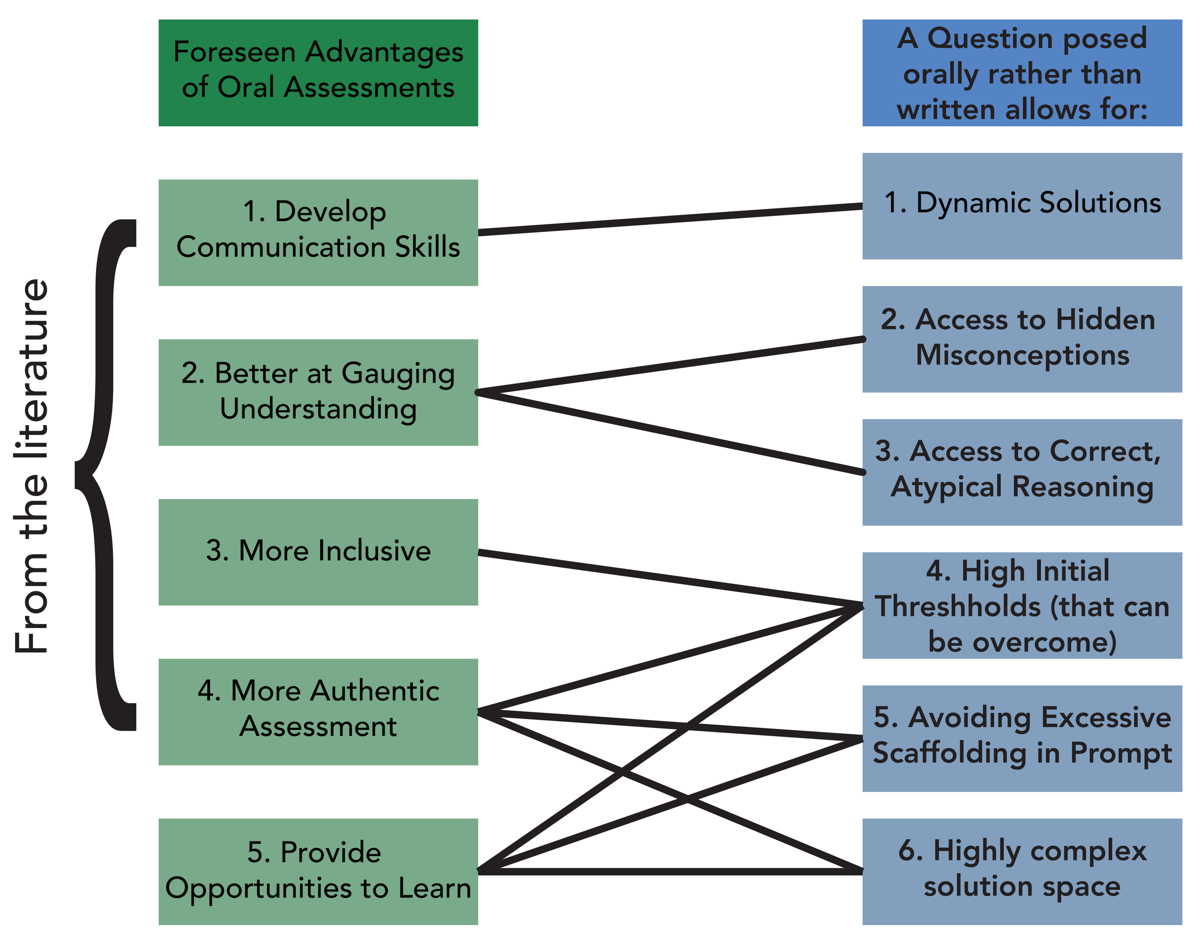
Course Description

¤ First semester math course for pre-service elementary teachers.
¤ Two sections totaling 42 students: all juniors, majority female (95%).
¤ Course content: number and operation from a perspective that emphasizes models, reasoning, problem-solving, and communication.
¤ Course pedagogy: inquiry-based learning.

Problem Space

We were dissatisfied with traditional written assessments. Reasons included:
¤ Did not capture what we saw students demonstrate in class.
¤ Not well-aligned with class format, which values oral communication.
¤ Problems that are challenging to start are necessary, but this effected students disproportionately and did not let us see what some students were capable of.

Two Helpful Frameworks

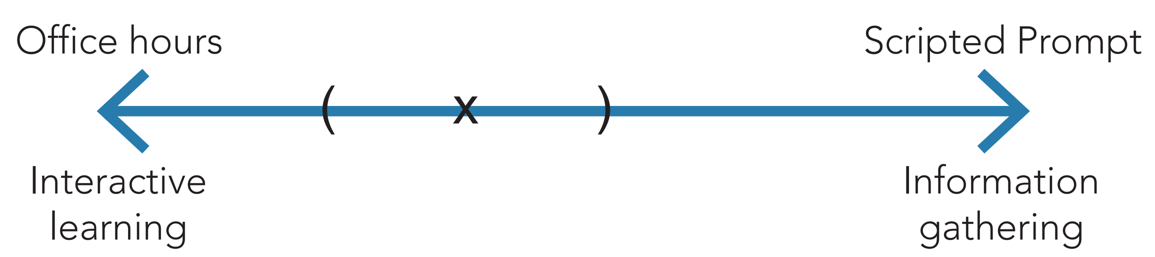


Research Questions

Q1: What characteristics of a student leads her to perform better on an oral vs. written assessment relative to her peers?
Q2: What opportunities for student learning can oral assessments provide?

Exam Logistics and Methods of Study

¤ Three exams: each written with 1-2 oral questions given at a separate time.
¤ Content of oral component coordinated to match items on the written exam.
¤ 15-20 minute video taped individual appointments conducted in 2 day period
¤ Format:



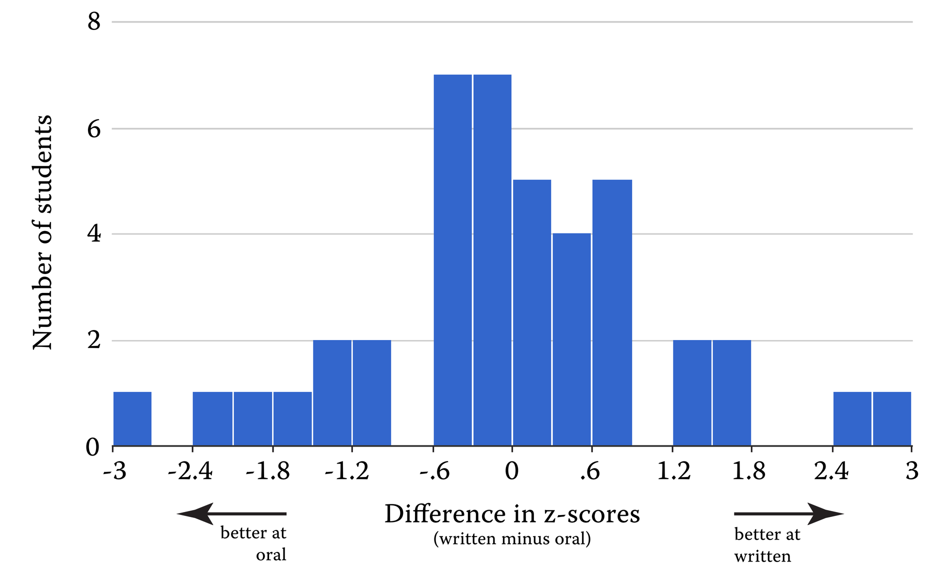
¤ Also administered: Inventory of Learning Styles (ILS), Aberviated Math Anxiety Rating Scale (AMARS), Supplemental AMARS items, student survey.

References

Alexander, L., & Martray, C. (1989). The Development of an Abbreviated Version of the Mathematics Anxiety Rating Scale. *Measurement And Evaluation In Counseling And Development*, 22(3), 143-50.
Huxham, M., Campbell, F., & Westwood, J. (2012). Oral versus written assessments: a test of student performance and attitudes. *Assessment & Evaluation in Higher Education*, 37(1), 125-136.

Written vs. Oral Performance

¤ For each of three exams, we have an oral question o_i and corresponding written question $w_i\,(i=1,2,3)$ assessing the same content.
¤ For each student, we create a written score $\sum w_i$ and oral score $\sum o_i$, and record these in terms of their z-scores (standard deviations from the mean):



Mathematical Anxiety Rating Scale

¤ Original AMARS instrument has 25 items sorted into 3 factors.
¤ We added 7 supplemental items; a new factor analysis shows two additional factors.

From the literature:

1. Math Test Anxiety
   e.g. "Thinking about a math test 1 day before."
2. Numerical Anxiety
   e.g. "Being given a set of subtraction problems to solve."
3. Math Course Anxiety
   e.g. "Watching a teacher work on an algebraic equation on the blackboard."
4. Explanation Anxiety
   e.g. "Explaining my thought process to my math instructor."
5. Problem Solving Anxiety:
   e.g. "Picking up a math textbook to begin working on a homework assignment."

Regression Analysis

¤ Observations: each student at three points in time (Exams 1, 2, 3).
¤ Outcome variable: difference in z-scores between oral exam and corresponding content in written exam.
¤ Model: linear regression with mixed effects.
¤ Control variables: Test Anxiety, Explanation Anxiety, Problem Solving Anxiety

	Estimate	p-value
1. Test Anxiety	0.2824	0.0908
4. Explanation Anxiety	0.1057	0.4887
5. Problem Solving Anxiety	-0.3323	0.0744

Interpretation

¤ (Controlling for Explanation Anxiety) Test Anxiety and Problem Solving Anxiety have a significant effect on oral v. written exam performance ($p < 0.1$).
¤ One point higher in TA predicts **written score** 0.28 SDs higher than oral.
¤ One points higher in PSA predicts **oral score** 0.33 SDs higher than written.

Discussion

¤ Students scoring high in Problem Solving Anxiety might particularly struggle with the intimidation of getting started on a problem with a high entry threshhold. Supports available in this format of oral assessment seemed to remediate that. By remediating this anxiety, oral assessments allowed us to better gauge the understanding of these students.
¤ Students with higher Test Anxiety may have benefitted from having less time pressure and less personal confrontation pressure that a written exam affords.

Learning during Oral Assessments

What is Learning?

¤ Our evidence of student **understanding** is based on their verbal descriptions.
¤ Student **learning** is qualitative change in students' understanding.

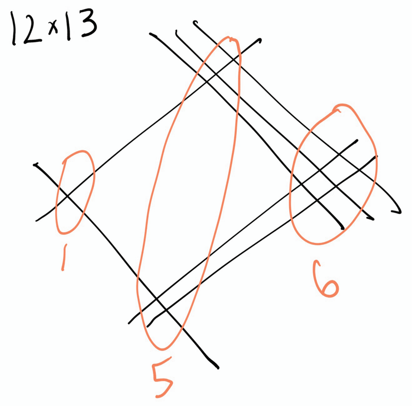
Case Study

Segment 1

Description:
Starts by demonstrating the algorithm on a product of 2-digit numbers. Checks with the standard algorithm.

Student Demonstrates:
Procedural knowledge of line algorithm.

12×13

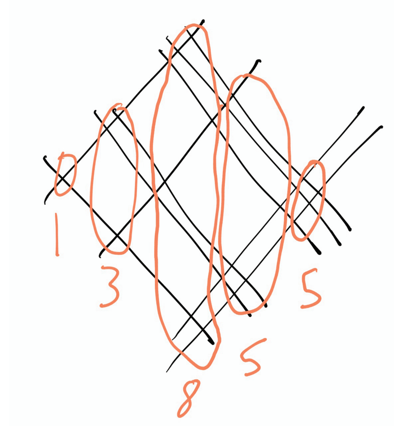


Segment 2

Description:
Demonstrates the algorithm on a product of 3-digit numbers. Place value in the diagram is not clear and circling is a mostly incorrect.

Student Demonstrates:
Lack of understanding of the organizing principles behind the procedural steps.

112 × 123



Segment 3

Description:
When asked to justify algorithm in 2-digit case, justification seems based on procedural similarity to standard algorithm.

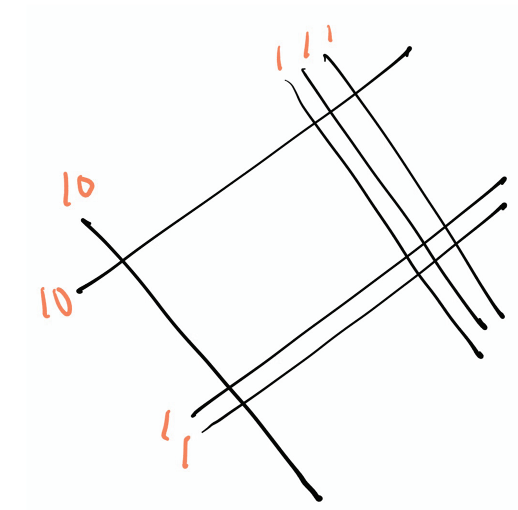
Student Demonstrates:
Understanding of a connection between steps in line algorithm and standard algorithm

$$\begin{array}{r} 12 \\ \times\, 13 \\ \hline 36 \\ 120 \\ \hline 156 \end{array}$$

Segment 4

Description:
Instructor asks: "Why is that 1 in the hundreds place, other than it happens to be on the left?"
In response, student starts to explicitly refer to the value of the lines in her diagram.

Student Demonstrates:
Understanding of the value of different lines in the algorithm and its role in finding partial products.



Segment 5

Description:
When instructor asks what properties of multiplication this is using, student goes through detailed algebraic justification of the multiplication and connects the steps to pieces of her line diagram.

Student Demonstrates:
Understanding of the connection between using algebraic properties and the line algorithm in terms of both place value and the distributive property.

$$13 \times 12$$
$$= \underbrace{(10+3)}_{a}(\underbrace{10}_{b}+\underbrace{2}_{c})$$
$$= 10(10+3) + 2(10+3)$$
$$= 100 + 30 + 20 + 6$$