Does Peer Assessment Help Improve Mathematical Writing for Pre-Service Elementary and Middle School Teachers?

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Many Students Experience Difficulty Expressing Mathematics Verbally

- For mathematics teachers, writing ability and the ability to assess mathematical writing are two of the most crucial skills
- Poor writing skills lead to *lack of credibility* as a class leader, leading to a dysfunctional class centered around students' diminished expectations for their own writing
- Many pre-service elementary and middle school teachers are uncomfortable with word problems, so are unlikely to integrate them successfully into their own classroom
- College is typically the last place where pre-service teachers can improve their writing and word problem skills prior to entering the classroom as a teacher

Our Hypothesis

- We suspected that if we asked pre-service teachers assess their peers' word problem solutions, we might accomplish three primary goals
 - Help students become significantly more comfortable with and see the value in word problems
 - Help students improve their own mathematical skills and to become significantly more comfortable writing mathematical sentences
 - Help students become significantly more comfortable grading word problems at the elementary and middle school level

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• And frankly we hoped that they'd be shocked into setting higher standards for their own writing

The Setting

- We decided to test that hypothesis in a study on students in a required Foundations of Mathematics course sequence in which all students are pre-service teachers at Western Oregon University
- In addition to the typical coursework, during each ten-week term all participants completed four Problems of the Week (POWs) which are problems requiring significantly more analysis and synthesis than typical homework problems
- Typical examples of POWs are; "A scale is balanced with a full brick on one side, and a quarter-brick and one pound on the other; find the weight of one brick using a diagram and verify your answer using algebra," or the Tower of Hanoi problem

The Measurement

- Students in designated sections of the courses graded their peers' POWs using the Oregon State Mathematics Problem Solving Official Scoring Guide
- We measured differences in self-responses to a variety of questions about students' perceptions of their mathematical writing skills
 - Important our study measured only differences in attitudes, not differences in abilities or scores

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The Student Groups

- Participants were divided anonymously into "grading group participants" (GGPs; $n_1 = 30$) and "control group participants" (CGPs; $n_2 = 28$); each section of the course was comprised of either all GGPs or all CGPs
- In GGP sections, for each of the four POWs assigned, we distributed two different completed POW's (pseudo-) randomly to each GGP
- The GGPs then used the Scoring Guide to assess their peers' work, students in the control groups did no peer grading

The Instrument

- An entrance survey with seventeen questions, answered using a five-point Likert-type scale
- An exit survey containing the same questions along with three additional follow-up items for GGPs only

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For each item in the survey, we used the Student t-test with unpooled variances (borderline n's and no particular reason to believe the variances were equal) to test

- The null hypothesis that the GGP mean difference between the entrance and exit responses equals the CGP mean difference between the entrance and exit responses against
- The alternative hypothesis that the GGP mean difference between the entrance and exit responses is greater than the CGP mean difference between the entrance and exit responses

The Questions

- Seventeen questions are too many to list or discuss in this forum, but let's take a look at a representative sample of some of the questions in the survey and their respective *p*-values
- We'll consider, in order some survey items which had high *p*-values, then survey items with *p*-values close to *p*=.10, then survey items with very small *p*-values
- (Recall the *p*-value of a hypothesis test is the conditional probability that the null hypothesis is correct, but the data is at least as extreme as that which was obtained)

Survey items for which the peer grading likely had little effect

- I have concerns about teaching mathematics to elementary school students. (*p*=.36)
- I believe mathematics assignments can be graded fairly. (*p*=.37)
- I enjoy writing sentences and paragraphs about mathematical concepts. (*p*=.15)

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Survey items for which the peer grading may have had some significant effect

- I believe I will eventually become comfortable grading/critiquing written math assignments from elementary or middle school children. (*p*=.093)
- I am confident in my mathematical abilities so far. (p=.110)
- Pick a topic in mathematics that you are very comfortable with for example, adding one to a number.
 - I am comfortable explaining this topic to someone else in writing. (*p*=.110)
 - I am comfortable explaining this topic to someone else verbally. (*p*=.110)

Survey items for which the peer grading likely had significant effect

- I believe that by grading mathematics assignments of my peers I can improve my math skills. (*p*=.026)
- I believe that writing sentences and paragraphs about mathematical concepts will help me understand the topic better. (*p*=.024)
- I believe I will eventually become good at writing sentences and paragraphs about mathematical concepts. (*p*=.011)

Follow-Up Questions Asked of GGPs Only

- I believe that grading POWs helped me improve my grading/critiquing abilities (mean ≈ 4.26)
- I believe that grading POWs helped me improve my own skills in writing about mathematics (mean ≈ 4.08)
- I believe that grading POWs helped improve my knowledge and understanding of the topic of the POW (mean ≈ 4.150)

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