Summary of Content Knowledge Gains for Math Masters Course 1

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UW-Madison STEM faculty will provide four courses to middle school mathematics teachers from four southern Wisconsin school districts (including MMSD) throughout 2004-05. The four courses will concentrate on key content areas of standards-based mathematics: statistics and probability, algebraic relationships/number operations, geometry, and measurement.

The first Math Masters course on statistics and probability was conducted from August 20-25, 2004. Follow-up professional development on mathematics pedagogy/principles of learning will be provided in the coming months.

Our study of Math Masters will be a joint effort between the SCALE RET targeted studies researchers and MMSD. The two major research questions we will address in this study are:

1. To what extent does each of the four courses increase teachers' mathematical content knowledge?

2. What is the impact of the content and pedagogy courses on participating teachers' implementation of the *Connected Mathematics* curriculum?

In this report, we present findings on teachers' content knowledge from the recently completed Math Masters course on statistics and probability.

Participating Teachers

Thirty-seven teachers participated in the assessment of content knowledge from the first course. Twenty-eight teachers were from MMSD, the remainder from Beloit and Sauk Prairie school districts. Of the 28 MMSD teachers, 24 were math teachers represented nine (of 11) Madison middle schools, and 4 were special education or ESL teacher.

Measuring Content Knowledge

An 8-item pre-test was given to participating teachers at the first session of the course (Appendix A). For the post-test at the last session, half the teachers were randomly given the same test they took for the pre-test, and the other half were given a different post-test (Form B) which paralleled the pre-test in both content and conceptual demands (Appendix B). The tests were developed in conjunction with the UW STEM faculty course instructor to encourage a high degree of correspondence with course content and expectation for in-depth understanding.[1]

[1] The course emphasized six investigations from *Connected Mathematics*, and items for the pre and post-tests were adapted from problems in those investigations.

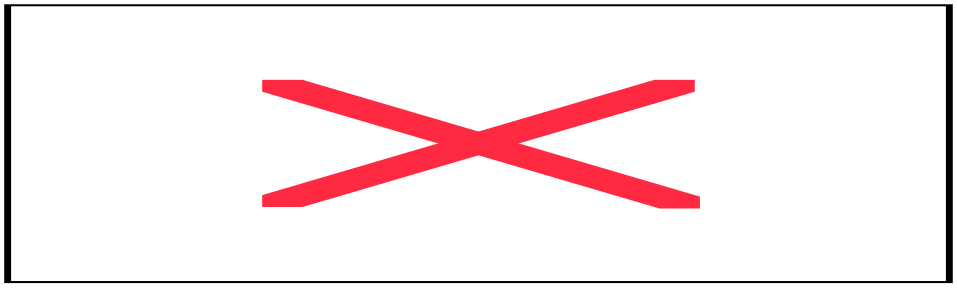
Test items were open-ended and teachers were prompted to demonstrate their work. Given the nature of the items, a rubric was developed to score responses (Appendix C, a similar rubric was used for the alternate post-test). Brian Sniff rated all responses to both pre- and post-tests on a four-point scale, 0-3 (possible range of scores for 8 items was 0-24).

Results

We analyzed the tests of all 37 participants and then analyzed those of the 24 MMSD math teachers, and present the results of each analysis below. The version of the post-test was not a factor since our analysis showed no bias in difficulty level between the two versions.[2]

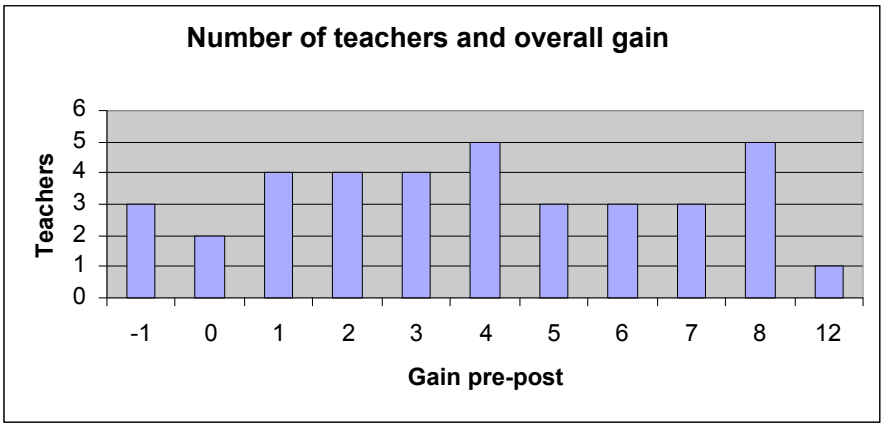
All participants. Pre and post-test results are summarized in Figure 1.

Figure 1. All participants



Pre-test scores ranged from a low of 5 (3 participants) and a high of 24 (1 participant), with a mean score of 13.81 (*SD* = 4.56). Post-test scores ranged from 11 (1 participant) to 24 (2 participants), with a mean of 17.89 (*SD* = 3.60). Average gain for the whole group was 4.08 (*SD* = 3.04). Individual participants showed gains ranging from -1 (3 participants) to 12 (1 participant), as shown in Figure 2. Twenty teachers (54%) showed gains of 4 or more points.

Figure 2. All participants



[2] Analysis showed only two of the eight questions (2 and 3A) with a statistically significant difference between means for the two forms, but this can be attributed to the relatively lower standard deviations for these two questions on Form B. The two items (5A and 5B) that were identical on the pre and post-tests showed similar mean scores and gains for both groups, those who took Form A and those who took Form B as the post-test.

Participants showed increases in average ratings on seven of the eight items and had statistically significant gains on four of the eight items (questions 2, 3A, 4, and 6). Question 3B, asking participants to determine probability, proved to be the most difficult question overall with low means on both the pre (M = .52) and post-tests (M = .88). Question 5A, asking for a calculation to find a percent, had the most scores on the post-test that were lower than scores on the pre-test; that is, 11 participants scored lower on the post-test for this item. Overall, average ratings decreased on this item from pre to post-test (pre, 1.88; post, 1.82).

MMSD math teachers. Our analysis here excluded teachers from districts other than MMSD and the MMSD teachers who taught special education and ESL. Pre and post-test results are summarized in Figure 3.

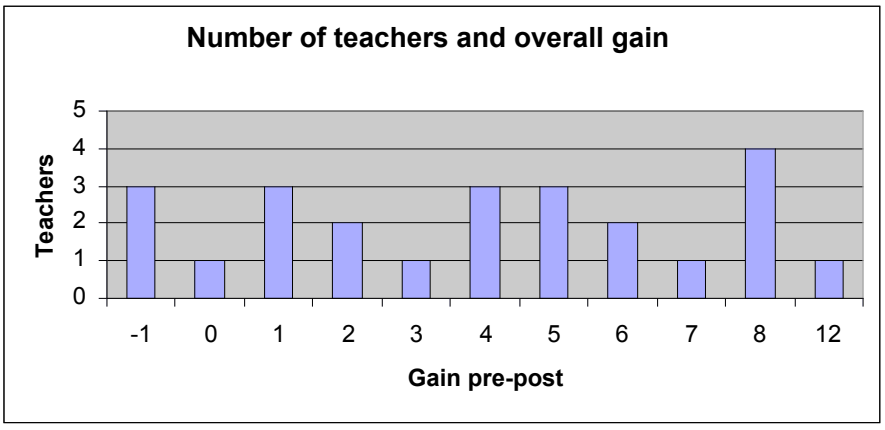
Figure 3. MMSD math teachers

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PRE	24	7	20	13.62	3.819
POST	24	13	24	17.83	3.332
GAIN	24	-1	12	4.21	3.349
Valid N (listwise)	24				

Pre-test scores ranged from a low of 7 (1 participant) and a high of 20 (2 participants), with a mean score of 13.62 (SD = 3.82). Post-test scores ranged from 13 (2 participants) to 24 (2 participants), with a mean of 17.83 (SD = 3.33). Average gain for the whole group was 4.21 (SD = 3.35). Individual participants showed gains ranging from -1 (3 participants) to 12 (1 participant), as shown in Figure 4. Fourteen teachers (58%) showed gains of 4 or more points.

Figure 4. MMSD math teachers



MMSD math teacher participants showed increases in average ratings on six of the eight items and showed statistically significant gains on five of the eight items (questions 2, 3A, 3B, 4, and 6). As with all participants, question 3B, asking participants to determine probability, proved to

be the most difficult question overall with low means on both the pre (M = .36) and post-tests (M = 1.00), but the gain was statistically significant for MMSD math teachers where it was not for the whole group. As we expected, Question 5A had the most scores on the post-test that were lower than scores on the pre-test (9). Questions 5A (pre, 1.91; post, 1.77) and 5B (pre, 1.91; post, 1.86) showed slight decreases in average ratings.

Overall, these results suggest that teachers benefited from the first Math Masters course on statistics and probability. Close to 90% of all participants showed an increase in content knowledge as measured by pre and post-tests, and gains on four of the eight test items were statistically significant. Those with less content knowledge at the beginning of the course showed more gain than those who came in knowing more, but even among those who scored above the mean on the pre-test, 13 of 17 showed an increase from pre to post (one teacher did score the maximum, 24, on the pre-test and showed no gain or loss on the post-test, again scoring a 24). Madison math teachers were quite similar to the whole group, but for them, gains on five of the eight test items were statistically significant.

Teachers' Reflections

Participants completed a Course Evaluation (Appendix D) on the last day of the course. We summarize here their comments that seemed relevant to learning, or increasing, mathematical content knowledge.

Participants cited a number of positive factors about the course. Those referenced by at least eight participants (over 20%) included:

- the UW STEM faculty instructor's depth of content knowledge (12 participants),
- the instructors' facilitation of class sessions (12),
- addressing important content of *Connected Mathematics* (14),
- group work and discussion (20),
- working with teachers from other schools and districts (10),
- working lunches (22).

Participants also offered some criticisms of, and suggestions for, improving the course, including:

- too much in the schedule (5),
- more challenging problems needed (6),
- more time with UW STEM faculty instructor (6).

Illustrative comments from the evaluation forms included:

- "It was a wonderful blend of CMP (*Connected Mathematics)* and beyond."
- "I really appreciated being able to work with teachers from Beloit and Sauk Prairie."
- "It was good to see what was covered in some of the other grade levels and to talk about what answers students might come up with."
- "I enjoyed listening to (the instructor) posing and discussing questions."

- "I got a lot out of this. It was worth it!"
- "Randomly calling on people with cards kept me accountable."
- "It was nice to have a college professor who was so full of energy and knowledge."

Additional Considerations

In order to preserve confidentiality, data collection from subsequent courses will request the last four digits of teachers' social security numbers rather than names. This will still allow for matching pre and post-tests. A brief survey will be added to the pre-test asking teachers for background characteristics (e.g., degrees held, years of teaching experience) that can be considered in data analysis.

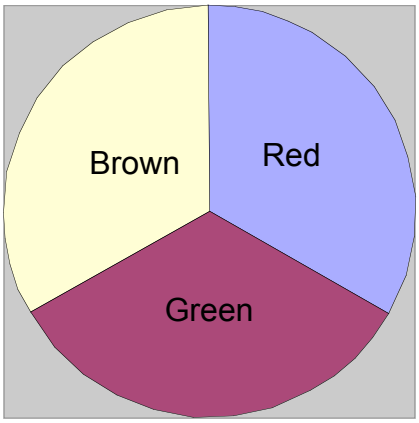
For subsequent courses, we will improve the pre/post-test design. A longer test of at least 20 items will improve reliability and validity for use as the post-test. New scoring rubrics will then be developed. We will also want to have multiple raters of participants' responses on the tests in subsequent courses.

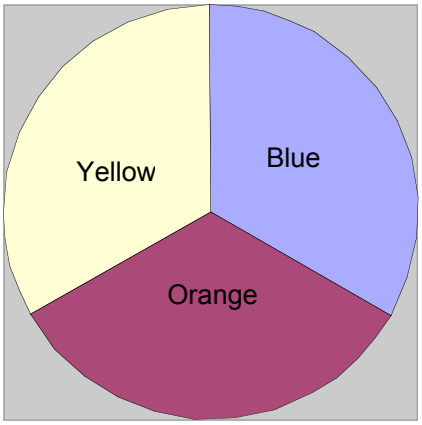
Appendix A

Pretest (Form A) for Statistics and Probability Course Name_____

This test is intended to demonstrate growth through this course. Make sure that you demonstrate you work on each problem so we can effectively see your strategies for solving the following problems.

1. The Beloit High School is hosting a carnival to raise money for a trip to the national science fair in San Diego, CA. They will have a game called Making Purple at the carnival. The game involves the two spinners below. A player spins spinner A and spinner B. If the player gets red on spinner A and blue on spinner B, the player wins, because red and blue make purple.





The science club will charge $1.00 per play. A player who makes purple gets $5.00 back. If 100 people play, how much money would you expect the club to make?

2. A store carries nine different brands of granola bars. Give an example of possible prices for each of the nine brands of granola bars if the mean price is $1.33? Explain how you determined the values for each of the nine brands.

3. Bob Lindmeier from Channel 27 said there was a 30% chance of rain on Saturday during the Friday evening news. On the Saturday evening news, he again said there would be a 30% chance of rain on Sunday. It rained both days, and Bob's station manager is wondering if Bob really knows how to predict weather.

A. Suppose Bob had done all of the calculations correctly, and according to his data there really was a 30% chance of rain each day. What was the probability there would be rain both days?

B. What is the probability that it would rain at least one day?

4. Compare the given measurements in two ways, and tell which of the two comparisons you think is better.

The United States has an estimated population of 255,600,000 and a land area of 9,363,109 km^2. Haiti has an estimated population of 6,400,000 and a land area of 27,739 km^2.

5. Polls conducted for the presidential elections commonly use samples of about 1000 eligible voters.

A. There are about 190 million eligible voters in the US. What percent of eligible voters are in a sample of 1000?

B. How do you think this small sample is chosen so that results will predict the winner with reasonable accuracy?

6. Kyle just bought a new car. His friends Alexis, Bob, Carlos, David, and Emile all want to ride with him to the Brewer game, but he can take only three people with him.

Kyle decides to write all their names down and draw them from a hat. In how many ways can he choose three of the five friends?

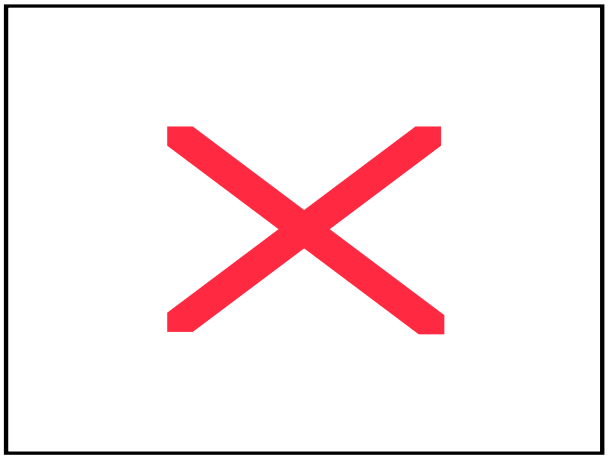
What is the probability that he will choose Alexis, Carlos, and Emile?

Appendix B

Post-test (Form B) for Statistics and Probability Course Name_____

This test is intended to demonstrate growth through this course. Make sure that you demonstrate you work on each problem so we can effectively see your strategies for solving the following problems.

1. The Sauk Prairie Middle School is hosting a carnival to raise money for new books in the library. They hosted a casino night at middle school and one of the games is shown below. In order to win, both spinners need to land on a win.



The book club will charge $2.00 per play. A player who wins gets $8.00 back. If 100 people play, how much money would you expect the club to make?

2. David has been doing pretty well in math class so far this year. His quiz scores for the first quarter have been 82%, 93%, 86% and 87%. He has one last quiz and he wants to know if he can still get above a 90% for a quiz average for the quarter (assume all scores are equally weighted and the maximum score on a quiz is 100%). How can David solve his problem?

3. Bob Lindmeier from Channel 27 said there was a 20% chance of rain on Saturday during the Friday evening news. On the Saturday evening news, he again said there would be a 40% chance of rain on Sunday. It rained both days, and Bob's station manager is wondering if Bob really knows how to predict weather.

A. What was the probability there would be rain both days?

B. What is the probability that it would rain at least one day?

4. Compare the given measurements in two ways, and tell which of the two comparisons you think is better.

Madison's total population is 203,219 people, the African American population is 12,155 people. Beloit has a population of 34,757 people and the African American population is 5,497 people.

5. Polls conducted for the presidential elections commonly use samples of about 1000 eligible voters.

A. There are about 190 million eligible voters in the US. What percent of eligible voters are in a sample of 1000?

B. How do you think this small sample is chosen so that results will predict the winner with reasonable accuracy?

6. Jared just bought a new car. His friends Alice, Brenda, Cindy, David, Erica and Janine all want to ride with him to the Brewer game, but he can take only three people with him.

Jared decides to write all their names down and draw them from a hat. In how many ways can he choose three of the six friends?

What is the probability that he will choose Alice, Cindy, and Erica?

Appendix C

Scoring Rubric for Pre-Test	0	1	2	3
Item #1 Spinners	No answer or incorrect answer with no work or explanations	Incorrect strategy, with incorrect response	Correct strategy for probability with incorrect amount of money made	Correct strategy for probability with correct amount of money made.
Item #2 Granola Bars	No answer or incorrect answer with no work or explanations	List was incorrect but provided a good explanation	Correct list however lacking sufficient explanation	Made list and provided complete description for strategy
Item #3 Weather Forecast Part A Both days	No answer or incorrect answer with no work or explanations	Incorrect answer with work shown	Correct strategy but incorrect response	Correct strategy with correct response
Item #3 Weather Forecast Part B At least one day	No answer or incorrect answer with no work or explanations	Incorrect answer with work shown	Correct strategy but incorrect response	Correct strategy with correct response
Item #4 Measurement Comparison	No answer or incorrect answer with no work or explanations	Making only one comparison	Making two unique comparisons without a summary statement	Using two unique comparisons with good comparison of strategies
Item #5 Polls Part A	No answer or incorrect answer with no work or explanations	Incorrect calculation chosen and shown	Used simple division but made a percent error	Used a simple division to get accurate answer
Item #5 Polls Part B	No answer or incorrect answer with no work or explanations	Giving a basic answer such as “randomly”		Good explanation demonstrating understanding of polling goals
Item #6 Combinations	No answer or incorrect answer with no work or explanations	Incorrect strategy, but work is shown	Correct strategy with calculation errors	Correct strategy with correct responses

Appendix D

Course Evaluation

Please help us improve this course and the future Content Knowledge courses by sharing some of your thoughts with us.

1. What did you feel worked well for your growth in Statistics and Probability?

2. What suggestions do you feel could have improved your growth in this class?

3. What other comments about the course do you have that we have not already discussed?