Results from the Survey of Mathematics Classes for Elementary Teachers

Raven McCrory, Principal Investigator
517-353-8565, mccrory@msu.edu
Report for Report for MCA12

This report presents results for your section of the *Survey of Mathematics for Elementary Teachers* administered in your mathematics course for prospective elementary teachers. As on the survey, the report includes three parts: 1) mathematics content knowledge, 2) attitudes and beliefs about mathematics, and 3) demographics and mathematical background. The results in this report are from 1304 students who took the pretest and 1046 students who took the posttest. There are 882 students in 52 sections of mathematics classes at 16 institutions in South Carolina, Michigan, and New York included in this analysis. The institutions are a mixture of public and private, large and small, at all levels of Carnegie classification. The criteria for inclusion is that the institution offers courses leading to elementary certification and teaches more than one section per year of a mathematics course taken to fulfill certification requirements.

Results both from your course and from courses at other institutions in the study are included so you can compare your students to students in similar courses. The courses included in this study are mathematics courses required for elementary certification that include number and operations. Usually, this is the first required course, but in some cases, it is the second course in a sequence. At many institutions, there is a prerequisite that must be completed before students can take the elementary mathematics sequence.

Mathematical Content Knowledge Measures

The survey administered to your students included a measure of the mathematical content knowledge necessary for teaching elementary mathematics. In particular, this measure focused on the knowledge of number and operations in elementary mathematics. This measure was developed and extensively tested by a team at the University of Michigan-Ann Arbor specifically to measure the mathematical knowledge of elementary teachers.[1]

Table 1 presents a measure of your students' average pretest scale score where the average score for the entire population is 50 and the standard deviation is 10. This table also reports the average score for all students in the study. The scores were calculated using a two-parameter item response theory (IRT) model. The scores tell a person's ability (or location) on the underlying continuum of the ability being measured, in this case, mathematical content knowledge. Table 2 presents your students' average scale score on the posttest. Gain scores for your class are provided on the same scale based on the post-test results in Table 3. This gives you an opportunity to see your students' gain from the class and to compare your class to other classes and institutions. The advantage of using IRT techniques is that we can equate two different forms of the test so that the

[1] For more information on this measure, see (Hill et al., 2004). For information on how the measure relates to elementary student achievement, see (Hill et al., 2005).

scores are on the same metric. That is, the scale score takes into account the difficulty of the items so that a score of 50 does not mean 50% correct, but rather means that the person who scores 50 has average ability on the scale of knowledge being measured across different forms of the test, compared to the total population being tested. This is similar to what is done on standardized tests such as the SAT, where the score is designed to be a constant measure of ability on the underlying constructs. The table shows scores for your section and for all students in the study.

Table 1. Pretest summary statistics for mathematical content knowledge

	Your Course	All Courses
Count	19	1304
Mean	54.52	50.09
Standard Deviation	11.46	9.98
Minimum	30.56	16.97
Maximum	78.63	95.08

Table 2. Posttest summary statistics for mathematical content knowledge

	Your Course	All Courses
Count	15	1046
Mean	73.14	58.72
Standard Deviation	11.59	11.30
Minimum	54.96	16.97
Maximum	95.08	95.08

Table 3. Gain score summary statistics for mathematical content knowledge

	Your Course	All Courses
Count	19	882
Mean	19.08	8.12
Standard Deviation	9.55	10.41
Minimum	3.14	-35.65
Maximum	42.14	42.15

Released Items

The items in this test are taken from the Learning Mathematics for Teaching (LMT) item bank.[2] To maintain the integrity of the test, items from LMT forms cannot be released publicly. Some sample items have been released, however, four of which were used on this survey.[3] Tables 4 and 5 show the results for your students and for the entire sample on the pre and post tests your students took. The items are shown below, and tables 6 - 9 give detailed responses for each item.

Table 4. Results for released items on the Pretest Form E

	Your students		All students	
Item	N	% Correct	N	% Correct
2	6	31.57	116	23.95
13	11	57.89	169	35.13

Percentages do not include non-responses

Table 5. Results for released items on the Posttest Form G

	Your students		All students	
Item	N	% Correct	N	% Correct
2	12	80	303	63.52
12	9	60	111	22.45

Percentages do not include non-responses

2 The LMT Web site, http://sitemaker.umich.edu/lmt/home, has extensive information about development and use of the items.

3 The complete set of released items is available on the LMT Web site. These measures are copyrighted, 2005, Study of Instructional Improvement (SII)/Learning Mathematics for Teaching/Consortium for Policy Research in Education (CPRE).

Released Item, #2 on Form E

2. Ms. Chambreaux's students are working on the following problem:

Is 371 a prime number?

As she walks around the room looking at their papers, she sees many different ways to solve this problem. Which solution method is correct? (Mark ONE answer.)

A) Check to see whether 371 is divisible by 2, 3, 4, 5, 6, 7, 8, or 9.
B) Break 371 into 3 and 71; they are both prime, so 371 must also be prime.
C) Check to see whether 371 is divisible by any prime number less than 20.
D) Break 371 into 37 and 1; they are both prime, so 371 must also be prime.

Table 6. Response frequency by option, Form E, Item 2

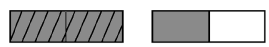
	Percent	
Answer	Your students	All students
a	63.15	55.44
b	5.26	20.76
c	**31.57**	**23.95**
d	0	5.76

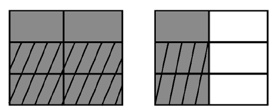
Correct response c (in bold).
Percentages do not include non-responses.

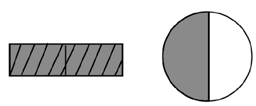
Released Item, #13 on Form E

13. At a professional development workshop, teachers were learning about different ways to represent multiplication of fractions problems. The leader also helped them to become aware of examples that do not represent multiplication of fractions appropriately.

Which model below cannot be used to show that $1\frac{1}{2} \times \frac{2}{3} = 1$? (Mark ONE answer.)

A) 

B) 

C) 

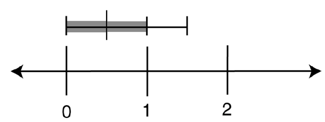
D) 

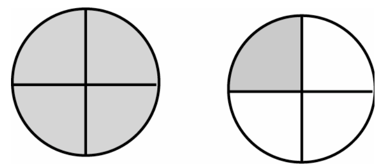
Table 7. Response frequency by option, Form E, Item 13

	Percent	
Answer	Your students	All students
a	0	6.01
b	5.26	11.46
c	**57.89**	**35.13**
d	31.57	35.59

Correct response c (in bold).
Percentages do not include non-responses.

Released Item, #2 on Form G

Mrs. Johnson thinks it is important to vary the whole when she teaches fractions. For example, she might use five dollars to be the whole, or ten students, or a single rectangle. On one particular day, she uses as the whole a picture of two pizzas. What fraction of the two pizzas is she illustrating below? (Mark ONE answer.)



A) 5/4

B) 5/3

C) 5/8

D) 1/4

Table 8. Response frequency by option, Form G, Item 2

	Percent	
Answer	Your students	All students
a	20	27.76
b	0	1.21
c	**80**	**63.52**
d	0	4.30

Correct response c (in bold).
Percentages do not include non-responses.

Released Item, #12 on Form G

Ms. Harris was working with her class on divisibility rules. She told her class that a number is divisible by 4 if and only if the last two digits of the number are divisible by 4. One of her students asked her why the rule for 4 worked. She asked the other students if they could come up with a reason, and several possible reasons were proposed. Which of the following statements comes closest to explaining the reason for the divisibility rule for 4? (Mark ONE answer.)

A) Four is an even number, and odd numbers are not divisible by even numbers.

B) The number 100 is divisible by 4 (and also 1000, 10,000, etc.).

C) Every other even number is divisible by 4, for example, 24 and 28 but not 26.

D) It only works when the sum of the last two digits is an even number.

Table 9. Response frequency by option, Form G, Item 12

	Percent	
Answer	Your students	All students
a	6.66	16.80
b	60	22.49
c	**20**	**29.87**
d	13.33	26.68

Correct response c (in bold).
Percentages do not include non-responses.

Attitudes and Beliefs Measures

There were 28 items on attitudes and beliefs about mathematics on the survey. The items were on a five point scale with 1=strongly disagree and 5=strongly agree. The items grouped into two factors with reliabilities (Cronbach's alpha) shown in table 10, determined in statistical analyses using the data from this study. The two factors measure beliefs about 1) usefulness of mathematics (Usefulness) and 2) whether there are or are not multiple ways of doing mathematics (One Correct Way). Pilot data suggested four factors, but two of the factors proved to be unreliable and are not included

Table 10. Attitudes and beliefs factors, all students (scale for each item is 1-5)

	Your Students			All Students			
	N	Mean	Std. Dev	N	Mean	Std. Dev	Cronbach's Alpha
Usefulness	19	3.67	0.38	1206	3.65	0.57	0.81
One Correct Way	19	2.01	0.36	1234	1.99	0.57	0.72

All items that make up the factors are shown in the Appendix. The first factor, "Usefulness", consists of ten items and refers to the belief that mathematics is a useful enterprise. The mean score of 3.65 indicates that respondents overall tend to agree with the view that mathematics is useful. The second factor, "One Correct Way," is composed of four items and indicates a belief that mathematics problems can be solved only one way. The mean score of 1.99 indicates that responding students think of mathematics as having more than one way of solving a problem. That is, they tend to disagree with statements that characterize mathematics as fixed and having a single correct approach.

Cronbach's Alpha measures the reliability of each scale. That is, it measures how well the items in the scale correlate with each other, internal to the scale, and thus how closely the items in the scale are all measuring the same thing. An alpha of 1.0 would mean that the items were perfectly correlated and were measuring exactly the same thing; 0 would mean no correlation at all, suggesting that they measured entirely different things. The correlations for each of these two factors are reasonable, and suggest that there is an underlying trait or belief that each is measuring.

Table 11 reports Pearson's correlations among six variables: the two attitudes and beliefs factors, performance on the mathematics items, and the converted ACT scores (as explained below, all SAT scores were put on an ACT score scale to create a new variable, CACT). For each factor, the first row reports correlation coefficients, and the second row reports probability to two significant digits that the correlation would have occurred even if there were no relationship between the two factors. For example, in the fourth row comparing "Usefulness" factor to ACT score, the probability of 0.00 means that there is almost no chance that the correlation of 0.27 would happen when there was no relationship between ACT scores and students beliefs about "Usefulness." This is a low probability and we can conclude (statistically) that the correlation of 0.27 is real. In this table, we have marked in bold the correlations with probabilities less than 0.05. This value means it is very unlikely that the correlation happened by chance, and thus the correlation between the two items is statistically significant. Significance does not mean that the correlation is strong or weak – that is indicated by the value of the correlation coefficient. The sign of the coefficient – positive or negative – indicates the direction of the correlation. A positive coefficient means that as one value goes up, the other goes up as well. A negative coefficient means that as one value goes up, the other goes down.

Table 11. Pearson Correlations of Attitudes and Beliefs Factors and Math Achievements

		Pretest Score	Posttest Score	Gain	Usefulness	One Correct Way	Converted ACT Score
Pretest Score	Pearson Correlation	1.00	**0.52**	**-0.38**	**0.18**	**-0.10**	**0.51**
	Sig. (2-tailed)		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	N		882	882	1206	1234	759
Posttest Score	Pearson Correlation		1.00	**0.59**	**0.23**	**-0.12**	**0.43**
	Sig. (2-tailed)			**0.00**	**0.00**	**0.00**	**0.00**
	N			882	821	838	544
Gain	Pearson Correlation			1.00	**0.08**	-0.04	-0.02
	Sig. (2-tailed)				**0.02**	0.30	0.62
	N				821	838	544
Usefulness	Pearson Correlation				1.00	**-0.36**	**0.27**
	Sig. (2-tailed)					**0.00**	**0.00**
	N					1188	706
One Correct Way	Pearson Correlation					1.00	**-0.12**
	Sig. (2-tailed)						**0.00**
	N						726

Bold **Correlation is significant at the 0.05 level (2-tailed).**
N Number of students used to calculate this correlation

As shown in Table 11, “Usefulness” and “One Correct Way” have a moderate negative correlation (r = - 0.36) indicating that students who think of mathematics as having one correct solution tend not to think mathematics is useful and vice versa. Interestingly, “One Correct Way” is negatively correlated with all the measures including test score and SAT. This suggests that believing that doing math means knowing the single correct way to solve a problem is related to lower scores on this test as well as the SAT and ACT.

Score on the content measure (Pretest and Posttest) has significant positive correlations with 'Usefulness' (r = 0.18, r=.23 respectively) and a negative correlation with "One Correct Way" (r = - 0.10, 1-12). This suggests that students with more content knowledge tend to like mathematics and view it as useful and as having multiple ways of solving a problem. Interestingly, the relationship with "One Correct Way" disappears for gain scores. This is an interesting finding that needs verification through additional research.

Background Information

This section reports the demographic and mathematical background characteristics of students in your course and all students in the study. Table 12 gives basic demographic data. Not surprisingly, a large proportion of the students are female. Sophomores make up the largest group by year. Nearly all the students in the sample are education majors.

Table 12. Personal information

		Your course		All courses	
		Number	Percent	Number	Percent
Gender	Male	2	10.52	129	10.28
	Female	17	89.47	1213	96.62
College Year	Freshman	0	0	337	22.61
	Sophomore	14	73.68	539	43.89
	Junior	5	26.31	317	26.92
	Senior	0	0	111	9.97
	Post BA	0	0	35	3.36
Major Field of Study	Education	19	100	1192	92.99
	Mathematics	0	0	8	<1
	Other	0	0	128	11.9
Number of college mathematics courses to date*	0	0	0	10	1.14
	1	9	47.36	358	29.15
	2	9	47.36	382	26.72
	3	1	5.26	304	24.68
	4 or more	0	0	281	24.58

*Includes courses in statistics and computer sciences

Achievement in Mathematics

Table 13 reports distribution of ACT mathematics scores. The ACT is the score most often reported by students in your class, although in other sections, the SAT is the predominant test reported. Across the entire population, 712 students reported ACT scores and 303 reported SAT scores. Using the concordance tables found in Dorans (1999), all SAT scores were converted to equivalent ACT scores, labeled CACT in this report. Table 14 shows that the average CACT score across all students who reported scores was 23 as well as the average of your students. Table 14 shows the average of your students' scores as well as the average CACT score across all students.

Table 13. Converted ACT score statistics

	Your Course	All Courses
Count	17	909
Mean	23.64	23
Standard Deviation	4.16	4.4
Minimum	14	11
Maximum	31	39

Table 14 reports Pearson's correlations between the students' CACT mathematics score, pretest scores, posttest scores, and gain scores. It is interesting to note that while there is a relationship between CACT scores and the pretest (.53) and the posttest (.43), the relationship disappears when comparing test scores to gain scores. This may be because something other than current mathematical knowledge that occurs in the classroom accounts for the gain. In our research, we hope to figure out what other factors influence gain.

Table 14. Pearson correlation coefficients

		Pretest	Posttest	Gain
CACT	Correlations	0.52	0.43	-0.02
	Significance	0.00	0.00	0.62
	Number in Analysis	544	544	544

* only those students that had both pre and post test results were included in this analysis

High School Mathematics Courses

Table 15 reports the mathematics courses taken by your students in high school. The frequency reports the number of students who took that course in at least one grade in high school. As shown on the table, across all courses, most students took algebra I (93%), algebra II (83%), and geometry (92%). 48% of the respondents took pre-calculus, and 14% took calculus. Because these percentages are calculated based on the entire sample, they include students who did not respond, either yes or no, to some or all of the questions about the courses they took. We have treated a non-response as "no" in these calculations.

Table 15. High school mathematics courses

	Your course		All courses	
High School Math Courses	**Number**	**Percent**	**Number**	**Percent**
Basic or general mathematics	10	52.63	958	76.86
Tech-prep, business, consumer, or other applied mathematics	3	15.78	245	18.52
Introduction to algebra or pre-algebra	12	63.15	999	79.77
Algebra I	14	73.68	1109	87.62
Geometry	14	73.68	994	78.02
Algebra II with or without trigonometry	11	57.89	1089	85.29
Trigonometry (as a separate course)	3	15.78	253	22.41
Pre-calculus	7	36.84	564	44.69
Unified, integrated, or sequential mathematics	3	15.78	74	6.66
Probability or statistics	7	36.84	273	20.27
Calculus	2	10.52	161	13.83
Discrete or finite mathematics	1	5.26	57	4.52
Other mathematics courses	1	5.26	117	8.68
Computer programming	2	10.52	160	11.45

The Next Step

At this point, we have descriptive statistics about students from courses in the sample. Our aim is to eventually have a more complete model of how the variables in this report relate to each other and to student outcomes. We hope to be able to say things like "students who took calculus in high school (showed/did not show) significant gains compared to students who did not take calculus." Or, "Students who report a strong positive attitude toward mathematics..." Probably the most important kinds of results we will have will relate to items from the instructor survey, where we plan to investigate the impact of the particular textbook used and the coverage within that textbook and other variables related to what you specifically teach in your class.

Please contact the project Principal Investigator, Raven McCrory (mccrory@msu.edu), if you have any questions or comments about this report or about the project. We welcome your thoughts and input as we proceed with the project.

References

Dorans, N.J. (1999). Correspondence between ACT and SAT I Scores. *College Board Research Report 99-1*. New York, NY: The College Board.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406.

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' mathematics knowledge for teaching. *Elementary School Journal, 105*, 11-30.

Appendix: Attitudes and Beliefs Items

Factor 1: Usefulness

1. I like math.
2. Mathematics is useful for solving everyday problems.
3. I'm good at math.
4. Almost all people use mathematics in their jobs.
5. Mathematics is useful for every profession
6. Mathematics entails a fundamental benefit for society if one engages in mathematical tasks, one can discover new things (connections, rules, concepts).
7. If one engages in math tasks, one can discover new things.
8. In math you can be creative.
9. In math many things can be discovered and tried out by oneself.

Factor 2: One Correct Way

1. There is only one correct way to solve a mathematics problem.
2. Math problems can be done correctly in only one way.
3. Usually there is more than one way to solve mathematical tasks and problems.
4. Everything important about mathematics is already known by mathematicians.