



TECHNICAL REPORT #23:

Iowa Early Numeracy Indicator Screening Data: 2007-2008

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Abstract

This report presents the findings from an ongoing examination of several Early Numeracy Indicators that were developed by Lembke and Foegen (2005). A new measure (Mixed Numeracy) was developed for use during the current academic year (2007-2008). The Mixed Numeracy measure combines items from each of the three earlier measures: Number Identification, Quantity Discrimination, and Missing Number. The Early Numeracy Indicators were used as benchmarking tools in the fall, winter, and spring in a small Midwestern school district. Mean scores on all of the measures increased over the course of the academic year, as they have in all the previous years. During the 2007-2008 academic year, kindergarten students' scores were slightly lower than previous cohorts for Number Identification, Quantity Discrimination, and Missing Number, while the first grade students had slightly lower scores than earlier cohorts on the Number Identification tasks over the course of the year and very similar scores for the Quantity Discrimination and Missing Number indicators. All four measures had alternate-form reliability coefficients near or above the .80 level, while all of the concurrent validity coefficients were near or above the .50 level and the predictive validity coefficients were at or above the .66 level. The data collected during the 2007-2008 academic year provided strong support for the continued use of the Mixed Numeracy measures, with the possibility that they could be used by themselves as standalone benchmarking tools.

Iowa Early Numeracy Indicator Screening Data: 2007-2008

The purpose of this study was to replicate aspects of three earlier studies (Foegen, Lembke, Klein, Lind, & Jiban, 2006; Impecoven-Lind, Olson, & Foegen, 2009; Lembke & Foegen, 2005) by examining the technical adequacy of three established Early Numeracy Indicators (Number Identification, Quantity Discrimination, and Missing Number) and to collect initial data on a new measure (Mixed Numeracy).

Research Questions

The following research questions guided the data analysis:

1. Are the scores earned by kindergarten and first grade students on the established Early Numeracy Indicators similar to those from the earlier studies for the three screening periods?
2. When compared to the results from previous studies, are similar levels of alternate-form reliability produced by the established Early Numeracy Indicators?
3. Do the Mixed Numeracy measures produce a similar level of alternate-form reliability when compared to the previously studied indicators?
4. When compared to the results from previous studies, are similar levels of concurrent and predictive criterion validity produced by the established Early Numeracy Indicators?
5. Do the Mixed Numeracy measures produce similar levels of concurrent and predictive criterion validity when compared to the measures examined in earlier studies?
6. To what extent are the measures intercorrelated?

Method

Setting and Participants

The study was conducted in an elementary school (grades Pre-K-3) in a small Midwestern school district on the fringe of an urban community. The school district was

composed of four schools. There was one Pre-K through third grade elementary school, one fourth and fifth grade elementary school, one middle school with grades six through eight, and one high school. During the 2007-2008 school year, the district enrolled 1464 students, with 46.4 percent being female, 90 percent white, 5.5 percent Hispanic, 2.7 percent African American, 1.5% Asian, and 0.3 percent Native American. Nearly 49 percent of the students qualified for free or reduced lunch, and 1.8 percent were identified as English Language Learners.

A total of 228 students participated in this study. There were 120 kindergarten students divided among four classes and 108 first grade students who were also divided among four classes. The kindergarten and first grade classes were more diverse than the district as a whole with the kindergarten classes having a student population that was 84.2% white, 8.3% Hispanic, 5.8%, African American, and .8% Asian and the first grade being 88.9% white, 6.5% Hispanic, 3.7% African American, and .9% Native American. More than half of the kindergarten and first grade students (53% and 56%, respectively) received free or reduced price lunch. A greater percentage of kindergarten students were classified as English Language Learners (6.7%) when compared to the first grade students in this study (2.8%). Conversely, there were more students receiving special education students in the first grade (17.6%) as compared to 6.7% of kindergarten students.

Gathering the early numeracy data was a part of the school's typical practices and ongoing commitment to making data driven decisions; therefore, individual consent was not needed for students' participation in the data collection efforts.

Measures

Early Numeracy Indicators. Four measures were used as benchmarking tools in this study: Number Identification (NI), Quantity Discrimination (QD), Missing Number (MN), and

Mixed Numeracy (MX). See Appendix A for sample pages from each type of measure. The Mixed Numeracy measure was used for the first time during the 2007-2008 academic year.

Two different forms of each measure were used during each screening period (fall, winter, and spring) for a total of six forms per measure. The Number Identification tasks had 84 boxes with numerals (ranging from 0 to 100) in them. Each student was to say the names of as many of the numerals as he or she could in the time allotted. All of the 63 items in the Quantity Discrimination measures had a pair of numerals (ranging from 0 to 20). Students were to say the name of the greater number in each pair. For the Missing Number measures, each item was a box with a sequence of three numerals and a blank line. The position of the blank line varied across the four possible positions. Students were to state the name of the missing number in the sequence. Most sequences involved counting by ones; however, some required students to count by fives or tens. The Mixed Numeracy measures included items that were similar to the three earlier measures. It began with a row of four number identification items, followed by a row of four quantity discrimination items, and then a row of four missing number items. This sequence repeated for a total of 84 items.

Criterion measures. The criterion measure used in this study was teachers' ratings of their students' overall math proficiency (see Appendix B for a copy of the rating). Teachers were asked to rate each student's general proficiency in mathematics relative to other students in his/her class, on a Likert scale ranging from 1 to 7, with 1 representing lower proficiency and 7 representing higher proficiency. Teachers were also asked to use the entire scale, not cluster students only in the middle or toward one end. All teachers completed student ratings in the fall and the spring, concurrent with the respective probe administration.

Procedures

Trained data collectors gathered all of the data. Each data collector participated in a small-group training session lasting approximately one hour. The project coordinator delivered this training session using a revised version of the previous year's training materials. During the training session an overview of the study was provided, then the project coordinator modeled how to administer each of the four measures. Data collectors practiced administering each of the tasks and then administered each task to a peer while the trainer observed and completed an 11-item fidelity checklist. All of the data collectors were required to achieve 100% percent accuracy before data collection with students began.

Students participated in three rounds of data collection spread across the academic year. Fall data were collected during the eighth week of school in early October, winter data during the twenty-fifth week of school in mid-February, and spring data during the thirty-fourth week of school in late April. Two forms of each measure were individually administered by trained data collectors during each data collection period (fall, winter, and spring), for a total of six different forms for each probe. Students were given one minute to attempt as many items as they could for each task, with each data collection session lasting approximately ten minutes per child.

Administration of the measures took place at desks or tables in the hallways outside of the students' classrooms. Data collectors provided a brief introduction to each measure and had each student try three sample problems to ensure that the student understood the task before administering the two forms of a measure. Data collectors wrote all of the student's responses in a screening book. All of the measures were hand scored by counting the number of correct responses.

Students who were absent during data collection were assessed if the testing could be completed within the one-week time limit. If this could not be accomplished, that student’s data were omitted for that period, but the student was assessed in subsequent rounds of data collection using standard procedures.

Project staff completed all of the scoring and data entry. Twenty-percent of the measures were rescored to assess inter-scoring agreement. We computed an estimate of agreement by counting the number of items considered agreements (i.e., scored correctly) and the number of items for which there was a disagreement in scoring (i.e., scoring errors) and dividing the number of agreements by the sum of agreements and disagreements. We computed scoring accuracy by measure type for each of the selected scoring booklets and then averaged across all of the booklets to obtain an overall estimate of inter-scoring agreement. Scorers were very consistent with mean agreement rates of at least 99.2% or better (see Table 1).

Table 1

Mean Agreement, Range and Number of Probes Examined for Inter-scoring Agreement

	Number Identification			Quantity Discrimination		
	Mean Agreement	Range	# Probes Rescored	Mean Agreement	Range	# Probes Rescored
Fall	99.6%	92-100%	72	99.5%	92-100%	72
Winter	100%	100%	75	99.9%	97-100%	76
Spring	99.2%	92-100%	78	99.5%	94-100%	78
	Missing Number			Mixed Numeracy		
	Mean Agreement	Range	# Probes Rescored	Mean Agreement	Range	# Probes Rescored
Fall	100%	100%	72	99.6%	91-100%	72
Winter	99.9%	92-100%	76	99.9%	94-100%	76
Spring	99.9%	94-100%	78	99.7%	95-100%	78

Scoring and Data Analyses

Data analyses were conducted using number correct scores for each of the four early numeracy indicators. Alternate-form reliability was computed by correlating scores from the two forms of each type during each data collection period. For the criterion measures, teacher ratings were standardized by classroom and the resulting z -scores were used in the analyses. We examined concurrent criterion validity by correlating the mean of the scores from the two forms of each measure and the standardized teacher ratings, comparing fall scores with fall ratings, and then comparing spring scores with spring ratings. To determine predictive validity we compared fall mean scores on the Early Numeracy Indicators with spring teacher ratings.

Results

The results section begins with descriptive statistics for all four of the early numeracy indicators. These statistics are followed by analyses specific to each of the research questions. Table 2 includes the means and standard deviations for each of the individually administered indicators for kindergarten students, and Table 3 includes the same information for first grade students. Tests of skewness and kurtosis were conducted for all study variables. The only statistics that fell out of the commonly acceptable range were for Number Identification and Quantity Discrimination data from kindergarten students during the fall.

We examined the distributions produced on each of the measures, noting possible floor or ceiling effects, as well as the magnitude of the standard deviations. For floor effects, we noted the number of zeroes during each administration. As expected, kindergarten students earned many zeroes during the fall administration, with the number dropping for subsequent administrations. The fewest zeroes occurred on Number Identification and the most on Missing Number. For first grade students, scores of zero only occurred during the fall administration.

Table 2

Descriptive Statistics for Early Numeracy Indicators for Kindergarten Students

<u>Measure</u>	<u>Date</u>	<u>Form</u>	<u>Kindergarten</u>					
			<u>n</u>	<u>Min</u>	<u># of Zeroes</u>	<u>Max</u>	<u>M</u>	<u>SD</u>
Number Identification	Fall	1	108	0	2	45	11.85	7.80
		2	108	0	5	43	10.70	7.53
		Mean	108	0	1	44	11.29	7.49
	Winter	1	104	2	0	52	20.33	9.53
		2	104	0	1	54	19.82	9.85
		Mean	104	1	0	53	20.07	9.54
	Spring	1	104	0	1	55	23.02	12.99
		2	104	3	0	54	21.58	11.23
		Mean	104	5	0	54	22.30	11.68
Quantity Discrimination	Fall	1	108	0	10	37	7.87	6.73
		2	108	0	11	32	7.64	6.42
		Mean	108	0	7	34	7.75	6.43
	Winter	1	104	0	1	41	15.95	8.87
		2	104	0	2	41	16.18	8.28
		Mean	104	0	1	39	16.07	8.44
	Spring	1	104	0	1	43	18.12	8.99
		2	104	0	1	39	17.84	8.44
		Mean	104	0	1	40.5	17.98	8.52
Missing Number	Fall	1	108	0	15	17	5.29	3.87
		2	108	0	21	18	5.94	4.60
		Mean	108	0	14	17.5	5.62	4.10
	Winter	1	104	0	5	21	9.07	4.59
		2	104	0	5	19	8.52	4.79
		Mean	104	0	3	19	8.79	4.45
	Spring	1	104	2	0	22	11.21	4.44
		2	104	0	1	22	10.69	4.31
		Mean	104	2	0	22	10.95	4.17
Mixed Numeracy	Fall	1	108	0	6	22	9.50	5.50
		2	108	0	7	29	10.26	6.02
		Mean	108	0	4	25	9.88	5.64
	Winter	1	104	0	1	29	16.08	5.71
		2	104	0	2	32	16.78	6.63
		Mean	104	0	1	30	16.43	6.00
	Spring	1	104	2	0	33	18.91	6.15
		2	104	2	0	37	20.16	6.93
		Mean	104	7	0	35	19.54	6.18

Table 3

Descriptive Statistics for Early Numeracy Indicators for First Grade Students

<u>Measure</u>	<u>Date</u>	<u>Form</u>	<u>Grade 1</u>					
			<u>n</u>	<u>Min</u>	<u># of Zeroes</u>	<u>Max</u>	<u>M</u>	<u>SD</u>
Number Identification	Fall	1	91	4	0	64	32.48	13.77
		2	91	0	1	60	28.44	13.02
		Mean	91	2	0	61.5	30.46	13.12
	Winter	1	91	19	0	84	46.73	13.50
		2	90	12	0	80	44.26	13.37
		Mean	91	16	0	78	45.55	13.04
	Spring	1	93	17	0	82	52.11	13.44
		2	93	14	0	83	48.84	13.01
		Mean	93	18	0	82.5	50.47	12.99
Quantity Discrimination	Fall	1	91	0	1	48	26.22	10.21
		2	91	0	1	46	25.62	9.94
		Mean	91	0	1	47	25.92	9.83
	Winter	1	90	16	0	51	36.41	7.57
		2	90	12	0	54	35.07	7.92
		Mean	90	14	0	52	35.74	7.53
	Spring	1	93	10	0	61	38.41	8.90
		2	93	16	0	57	36.03	8.64
		Mean	93	13	0	59	37.22	8.42
Missing Number	Fall	1	91	0	1	23	12.98	4.82
		2	91	0	2	27	14.46	5.18
		Mean	91	0	1	25	13.72	4.79
	Winter	1	91	3	0	28	17.10	5.31
		2	91	5	0	27	16.60	4.54
		Mean	91	4	0	26.5	16.85	4.61
	Spring	1	93	7	0	31	19.69	4.80
		2	93	8	0	34	19.48	5.21
		Mean	93	8		32	19.59	4.77
Mixed Numeracy	Fall	1	91	0	1	38	21.36	6.45
		2	91	0	1	41	21.77	6.93
		Mean	91	0	1	39.5	21.57	6.45
	Winter	1	91	9	0	48	28.26	6.75
		2	91	16	0	48	29.66	6.66
		Mean	91	12	0	48	28.96	6.36
	Spring	1	93	19	0	51	33.58	6.71
		2	93	18	0	57	34.28	7.08
		Mean	93	19	0	54	33.93	6.66

When we examined the data for ceiling effects, we did not find any for kindergarten students; however, there were some very high scores for first graders on the Number Identification and Quantity Discrimination measures. For the Number Identification measures, one student scored 84/84 in winter, three students scored 82/84 or 83/84 in the spring. For the Quantity Discrimination measures, there was one student who scored 61/63 during the spring administration period.

As we considered the distribution of scores for each of the measures, we found the same pattern for both grades across all the three administration periods. Number Identification had the largest standard deviations, followed by Quantity Discrimination, Mixed Numeracy, and then Missing Number.

The descriptive statistics for the criterion measures appear in Table 4. Teachers were asked to use the full range of ratings, and the data show that they did. Nevertheless, we calculated z -scores for the teacher ratings by classroom to control for possible variability in the teachers' application of the rating scale.

Table 4

Descriptive Statistics for Criterion Measures

<u>Measure</u>	<u><i>n</i></u>	<u>Min</u>	<u>Max</u>	<u><i>M</i></u>	<u><i>SD</i></u>
<u>Kindergarten</u>					
Teacher Rating, Fall	108	1	7	4.16	1.92
Teacher Rating, Spring	104	1	7	4.43	1.97
Teacher Rating z Score, Fall	108	-2.04	1.67	-.0051	.99
Teacher Rating z Score, Spring	104	-1.92	1.47	-.0081	.99
<u>Grade 1</u>					
Teacher Rating, Fall	91	1	7	4.25	1.67
Teacher Rating, Spring	92	1	7	4.21	1.72
Teacher Rating z Score, Fall	91	-2.02	2.03	-.0130	.98
Teacher Rating z Score, Spring	92	-2.90	1.82	-.0105	.98

Research Question 1: Are the scores earned by kindergarten and first grade students similar to those from the earlier studies for the three screening periods?

During earlier studies (Foegen et al., 2006; Impecoven-Lind et al, 2009), mean scores on all of the indicators increased over the course of the academic year. The same was true for the 2007-2008 academic year. The current year's kindergarten students earned slightly lower scores than the previous two cohorts on all of the previously studied measures (Number Identification, Quantity Discrimination, and Missing Number) throughout the year, while this was only the case for first graders during the fall data collection. The current year's first graders earned slightly lower scores on the Number Identification measures during the winter and spring than earlier cohorts, but they had very similar scores for the Quantity Discrimination and Missing Number tasks during these data collection periods.

Research Question 2: When compared to the results from previous studies, are similar levels of alternate-form reliability produced by the established Early Numeracy Indicators?

The data in Table 5 show that all of the alternate-form reliability coefficients between the two forms of each type of probe were greater than .80 except for two instances (Winter Missing Number in Grade 1 and Spring Mixed Numeracy in kindergarten). The coefficients for the Number Identification, Quantity Discrimination, and Missing Number measures were higher for all but three of the comparisons when compared to earlier cohorts (Foegen et al., 2006; Impecoven-Lind et al, 2009). On the whole, the Number Identification tasks had the greatest alternate-form reliability, followed by the Quantity Discrimination measures. The Missing Number probes had the lowest alternate-form reliability overall.

Table 5

Alternate-form Reliability

	<u>Kindergarten</u>			<u>Grade 1</u>		
	Fall	Winter	Spring	Fall	Winter	Spring
NI Means	.91	.94	.86	.93	.89	.93
QD Means	.91	.94	.91	.91	.89	.84
MN Means	.88	.80	.82	.84	.75	.81
MX Means	.92	.89	.79	.86	.80	.87

Note. All correlations are significant at the $p < 0.01$ level.

Research Question 3: Do the Mixed Numeracy measures produce a similar level of alternate-form reliability when compared to the previously studied indicators?

All but one of the alternate-form reliability coefficients for the Mixed Numeracy measures were at the .80 level or higher. Compared to the other measures, the Mixed Numeracy measures had higher reliability coefficients than the Missing Number tasks during every data collection period except for kindergarten students in the spring. For the most part, the Mixed Numeracy measures had lower alternate-form reliability coefficients than Number Identification and Quantity Discrimination.

Research Question 4: When compared to the results from previous studies, are similar levels of concurrent and predictive criterion validity produced by the established Early Numeracy Indicators?

To calculate concurrent validity coefficients, we correlated fall teacher ratings with students' fall mean scores for the two forms of each measure and spring mean scores with spring teacher ratings (see Table 6). The concurrent validity coefficients for kindergarten students were greater in the spring than in the fall; however, the opposite was true for first grade students. The

concurrent validity coefficients for three of the fall correlations were at least .65 or higher (Number Identification, Quantity Discrimination, and Mixed Numeracy) for kindergarten students, while the coefficients for Quantity Discrimination, Missing Number and Mixed Numeracy were .71 or better during the spring. Three of the fall correlations for grade 1 students reached .72 or above (Number Identification, Quantity Discrimination, and Mixed Numeracy), and the highest coefficients for the spring correlations ranged from .52 to .58 (Number Identification, Mixed Numeracy, and Quantity Discrimination, respectively). We were surprised by the drop in the concurrent validity levels for the first grade students in the spring; consequently, we decided to disaggregate the data by teacher. Two of the first grade teachers had much lower concurrent validity levels near the end of the school year than they had in the fall with coefficients ranging from .40 to .50 in the spring as compared to .60 to .80 for the fall. These teachers' spring coefficients were also lower than those for their peers during the same time period (.60 to .70).

Table 6

Concurrent Validity Coefficients for Kindergarten and Grade 1 Students

	<u>Kindergarten</u>		<u>Grade 1</u>	
	Fall Teacher Rating	Spring Teacher Rating	Fall Teacher Rating	Spring Teacher Rating
NI	.65	.66	.72	.52
QD	.66	.73	.78	.58
MN	.58	.72	.62	.49
MX	.67	.71	.76	.53

Note. All correlations are significant at the $p < 0.01$ level.

Concurrent criterion validity measures were not given during the 2006-2007 academic year (Impecoven-Lind et al., 2009); therefore, we could only compare the coefficients for the Quantity Discrimination and Missing Number measures for the current study with those obtained during the 2005-2006 academic year (Foegen et al., 2006). We found very similar results for these two measures for kindergarten students; however, the fall concurrent validity coefficient was considerably higher for the current first grade students on the Quantity Discrimination measures (.78 as compared to .57) and the spring coefficient was lower for these students on the Missing Number measures (.49 as compared to .60).

Table 7 includes the predictive validity coefficients for each of the measures. We compared students' fall mean scores for the two forms of each measure with spring teacher ratings to calculate the predictive validity of each measure for this study. All of the predictive validity coefficients were at the .65 level or higher with the Mixed Numeracy having the highest predictive validity coefficient in kindergarten and Quantity Discrimination having the highest coefficient in Grade 1.

Table 7

Predictive Validity Coefficients for Kindergarten and Grade 1 Students

	<u>Kindergarten</u>	<u>Grade 1</u>
	Spring Teacher Rating	Spring Teacher Rating
NI	.66	.72
QD	.67	.82
MN	.67	.65
MX	.72	.78

Note. All correlations are significant at the $p < 0.01$ level.

The predictive validity coefficients for the Quantity Discrimination and Missing Number were greater for both kindergarten and first grade students when compared to earlier cohorts (Foegen et al., 2006; Impecoven-Lind et al, 2009). The predictive validity coefficient for the Quantity Discrimination measures in the first grade reflected the greatest increases over previous results; it was to .82 in the current study as compared to .62 in 2005-2006.

Research Question 5: Do the Mixed Numeracy measures produce similar levels of concurrent and predictive criterion validity when compared to the measures examined in earlier studies?

An examination of the data presented in Tables 6 and 7 shows that the Mixed Numeracy measures produced very similar levels of concurrent and predictive criterion validity when compared to the other established Early Numeracy Indicators. All of the validity coefficients for the Mixed Numeracy measures were .53 or higher. Compared to the Early Numeracy Indicators examined in earlier years, the Mixed Numeracy measures had the highest predictive validity coefficient for kindergarten students and the second highest for first grade students.

Research Question 6: To what extent are the measures intercorrelated?

Table 8 displays the intercorrelations between the four Early Numeracy Indicators over the course of the academic year in Kindergarten. When we examined the intercorrelation coefficients for kindergarten students for each administration period, we found that the Mixed Numeracy measures had the highest rate of intercorrelation with the other three measures with all but one of the coefficients at the .80 level (Number Identification and Missing Number) and several close to the .90 level (Quantity Discrimination). This is not surprising as the Mixed Numeracy probes contain rows of items that are similar to each of the other measures. All of the intercorrelation coefficients for the Number Identification and Quantity Discrimination measures were .80 and above, while these coefficients ranged from the .60 to the .70 level for the Number

Identification and the Missing Number tasks. The intercorrelations between the Quantity Discrimination and the Missing Number measures were close to or above the .70 level.

The intercorrelation data for first grade students is presented in Table 9. The data for the Mixed Numeracy measures is similar to that from the kindergarten students, with this measure having the highest intercorrelation coefficients for eight of the nine combinations across the three other measures during the three administration periods (close to or above the .80 level). While the intercorrelations between the Mixed Numeracy and Quantity Discrimination measures were the highest for the kindergarten students, this was not the case for first grade students. All of the coefficients were very similar across the different combinations. The intercorrelation coefficients for the Number Identification and the Quantity Discrimination tasks ranged from .70 to .80, while the coefficients for Number Identification and Missing Number were closer to the .70 level. Finally, the intercorrelations between the Quantity Discrimination and Missing Number indicators also ranged from about .70 to nearly .80.

Considering all of the reliability and validity data from the 2007-2008 academic year, there is strong support for the continued use of the Mixed Numeracy measures. It may be that they can be used as a standalone Early Numeracy Indicator, which would definitely decrease the amount of time needed to screen kindergarten and first grade students.

Table 8:

Intercorrelations Between Early Numeracy Indicators for Kindergarten Students

	FNI Mean	FQD Mean	FMN Mean	FMX Mean	WNI Mean	WQD Mean	WMN Mean	WMX Mean	SNI Mean	SQD Mean	SMN Mean
FNI Mean	--										
FQD Mean	.82	--									
FMN Mean	.72	.71	--								
FMX Mean	.86	.89	.83	--							
WNI Mean	.86	.82	.68	.81	--						
WQD Mean	.76	.80	.70	.83	.85	--					
WMN Mean	.61	.56	.60	.63	.64	.68	--				
WMX Mean	.76	.76	.67	.80	.87	.88	.79	--			
SNI Mean	.79	.76	.63	.77	.88	.83	.62	.82	--		
SQD Mean	.76	.79	.66	.81	.82	.88	.70	.87	.81	--	
SMN Mean	.65	.59	.64	.67	.71	.71	.77	.76	.64	.76	--
SMX Mean	.70	.71	.64	.73	.80	.78	.70	.83	.75	.85	.80

Note. All correlations are significant at the $p < 0.01$ level.

Table 9

Intercorrelations Between Early Numeracy Indicators for First Grade Students

	FNI Mean	FQD Mean	FMN Mean	FMX Mean	WNI Mean	WQD Mean	WMN Mean	WMX Mean	SNI Mean	SQD Mean	SMN Mean
FNI Mean	--										
FQD Mean	.84	--									
FMN Mean	.71	.77	--								
FMX Mean	.86	.90	.83	--							
WNI Mean	.75	.66	.59	.74	--						
WQD Mean	.62	.76	.56	.70	.75	--					
WMN Mean	.68	.74	.75	.78	.70	.74	--				
WMX Mean	.69	.77	.70	.79	.81	.78	.82	--			
SNI Mean	.71	.65	.53	.68	.87	.71	.70	.78	--		
SQD Mean	.61	.67	.55	.68	.66	.80	.62	.74	.76	--	
SMN Mean	.57	.57	.53	.63	.63	.68	.76	.71	.69	.70	--
SMX Mean	.64	.64	.57	.71	.74	.73	.72	.78	.80	.82	.83

Note. All correlations are significant at the $p < 0.01$ level.

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Appendix A

Early Numeracy Indicators

Number Identification

Sample Number Identification Measure Page

Quantity Discrimination

Sample Quantity Discrimination Measure Page

Missing Number

Sample Missing Number Measure Page

Mixed Numeracy

Sample Mixed Numeracy Page

Number Identification, page 1—Student copy

6

4

2

9

16

5

18

8

39

8

26

0

18

30

16

2

18

94

17

22

7

64

47

9

1

34

24

97

Quantity Discrimination, page 1—student copy

5	2
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7	1
---	---

8	3
---	---

1	18
---	----

8	10
---	----

7	8
---	---

16	8
----	---

9	1
---	---

10	7
----	---

2	6
---	---

6	14
---	----

9	4
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12	5
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9	15
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10	8
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17	11
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0	6
---	---

8	10
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15	14
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6	1
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5	1
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Missing Number, page 1—Student copy

7 8 ___ 10

3 4 5 ___

4 ___ 6 7

30 40 50 ___

1 2 3 ___

4 5 ___ 7

___ 3 4 5

5 10 15 ___

7 8 ___ 10

___ 4 5 6

7 8 ___ 10

6 ___ 8 9

10 15 20 ___

6 7 ___ 9

___ 2 3 4

3 4 5 ___

4 ___ 6 7

5 6 7 ___

0 1 ___ 3

___ 1 2 3

30 40 50 ___

Mixed Numeracy, page 1 - Student Copy

4	7	2	1
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12 9	6 1	3 8	10 7
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2 3 ___ 5	4 5 6 ___	1 ___ 3 4	7 8 9 ___
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41	8	21	11
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18 9	6 10	20 15	1 7
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5 10 15 ___	___ 5 6 7	3 4 ___ 6	20 30 40 ___
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14	81	21	50
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OSEP Award #H324H030003

Appendix B

Teacher Rating Scale

