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STRENGTHENING SOCIAL AND EMOTIONAL HEALTH

Children's Institute Early Mathematics Kindergarten Parent-Reported Screening Instrument (CI-EMKPSI): A four item parent-reported indicator that predicts academic performance 5 years later.

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Purpose and objectives: The purpose of this brief technical report is to describe the technical psychometric properties of the Children's Institute Early Mathematics Kindergarten Parent-Reported Screening Instrument (CI – EMKPSI). The EMKPSI is a very brief, parent report, a set of four questions that can be used by school districts to identify students entering kindergarten that are likely to need academic intervention in early Mathematics.

The objectives of the project were:

(a) To make the measure as short as possible, so as to reduce district's and parent's costs in obtaining the information.
(b) To ensure that the measure had an alpha reliability above .70, which is typically acceptable for screening measures.
(c) To ensure that the measure could assess the low end of the early Mathematics continuum, thus ceiling effects are expected for this type of construct.
(d) To ensure that the measure is positively correlated with 4th grade Mathematics New York State Assessments for the urban population.

Sample: The sample was obtained from a medium-sized city in upstate New York. At their children's registration prior to entry into kindergarten, parents or caregivers completed the Parent Appraisal of Children's Experiences (K-PACE), a screening instrument that assesses multiple domains. In 2004-05, 1,726 kindergarten PACEs were completed. After removal of forms that could not be matched with school district registration records, e.g., because of malformed identifiers, and duplicated records, 1,649 kindergarten students remained in the sample. In fourth grade, students completed NY State assessments of English Language Arts and Mathematics. Students could take the assessments later (e.g., because of retention) or, in rare cases, earlier, than the rest of the cohort, so test scores were obtained from the 2007-08 (N=7), 2008-09 (N=836), 2009-10 (N=323), and 2010-11 (N=11) school years, yielding 1,177 students who had both PACE and NYS ELA scores and 1,172 who had PACE and NYS Mathematics data. Of these, 30 students took the tests two consecutive years. After the second year's results were dropped, 1,147 students with ELA scores and 1,142 with Mathematics scores remained.

The final sample of students was 48% male, and 66% African-American, 21% Latino/Hispanic, and 15% White/not Hispanic. More than one race/ethnicity category could be selected.

Methods: Classical test analyses were used to identify the smallest collection of uni-dimensional items that targeted early Mathematics. Next, Rasch analyses were performed to ensure that items were well-ordered and fit the model. Predictive validity was estimated against 4th grade NY standardized test scores in Mathematics, English language Arts (ELA), as well as grade retention based on district data.

Results: The measure consisted of four items (in order of difficulty): cut out simple shapes, like a house, with scissors; read numbers up to 12; count 20 things; and write the numbers from 1 to 12. The shapes item was originally intended as a fine motor skill item, yet empirical analyses demonstrated it belongs with the other three math-oriented items, suggesting that difficulty in cutting shapes may occur because of lack of knowledge or comprehension of the concept itself.

- The overall alpha reliability of this 4 item measure was .77.
- All items have good infit and outfit mean square estimates lie in the [.5, 1.5] range and are close to expected values indicating good fit with Rasch Andrich model.
- All items have categories that are progressively ordered.

- A table of norms is provided to convert raw scores from 4-16 to normed scale scores from 278 to 712.
- The measure is moderately correlated with 4th grade NY state Mathematics and English Language Arts scale scores.
- The measure is moderately correlated with having repeated a grade by 4th grade.
- As expected the measure has ceiling effects.
- A cutoff was selected. Students below the cutoff were significantly at higher risk of academic failure five years later:
    - They were 4.4 times more likely to fail the ELA exam five years later.
    - They were 3.4 times more likely to fail mathematics state assessment.
    - They were 5.4 times more likely to score in level 1 in the ELA exam.
    - They were 4.3 times more likely to score in level 1 in the mathematics exam.
    - They were also 2.6 times more likely to repeat a grade in the study period.

Conclusion: The CI-EMKSI is a short (4 item) parent-reported questionnaire that is highly reliable, well ordered and correlated with third party administered official test score data five years after the assessment took place and with grade retention in the five year period of time.

Students below its high-risk cutoff score were two to four times more likely to fail the mathematics and ELA assessments five years later, as well as twice as likely to repeat a grade in the study period.

School districts can use this brief instrument to provide parents with an opportunity to share their views of their child's Mathematics at entrance into kindergarten, and can use the information to screen children who need an aggressive intervention plan to improve academic outcomes in elementary school.

Because the information is obtained from parents, it is anticipated that parents would be happy to have a responsive school contact them about the needs they have expressed. The information in this report indicates that absent successful identification and intervention, students will be likely to fail academically by 4th grade.

Odds Ratios predicting academic failure for students below cutoff:

Table 1 shows the odds ratios and associated 95% confidence intervals.

Table 1. Odds of failing for students below cutoff score.

	n	OR	95% Confidence Interval	
Failing ELA	742	4.37	2.44	7.81
Failing Mathematics	740	3.36	1.90	5.85
ELA level 1	742	5.38	2.45	11.73
Mathematics Level 1	740	4.27	2.10	8.71
Repeating a grade	1005	2.64	1.72	4.03

Note: OR odds ratio. All ORs were stat. significant at p<.01 Computation on ELA and mathematics only for students who did not repeat a grade.

Students who scored below cutoff were 4.4 times more likely to fail the ELA exam five years later, 3.4 times more likely to fail mathematics state assessment, 5.4 times more likely to score in level 1 in the ELA exam, and 4.3 times more likely to score in level 1 in the mathematics exam. They were also 2.6 times more likely to repeat a grade in the study period. Therefore, **these students can be considered to be at substantially higher risk of academic failure.**

Predictive validity:
Raw EMSI score correlations with district academic data (5 years from assessment):

	n	Predictive Validity	Significance
4th ELA scale score*	742	0.31	p<.01
4th Mathematics scale* score	740	0.25	p<.01
Repeat grade in 5 year period	1005	-0.22	p<.01

Note: * Computation on ELA and mathematics only for students who did not repeat a grade.

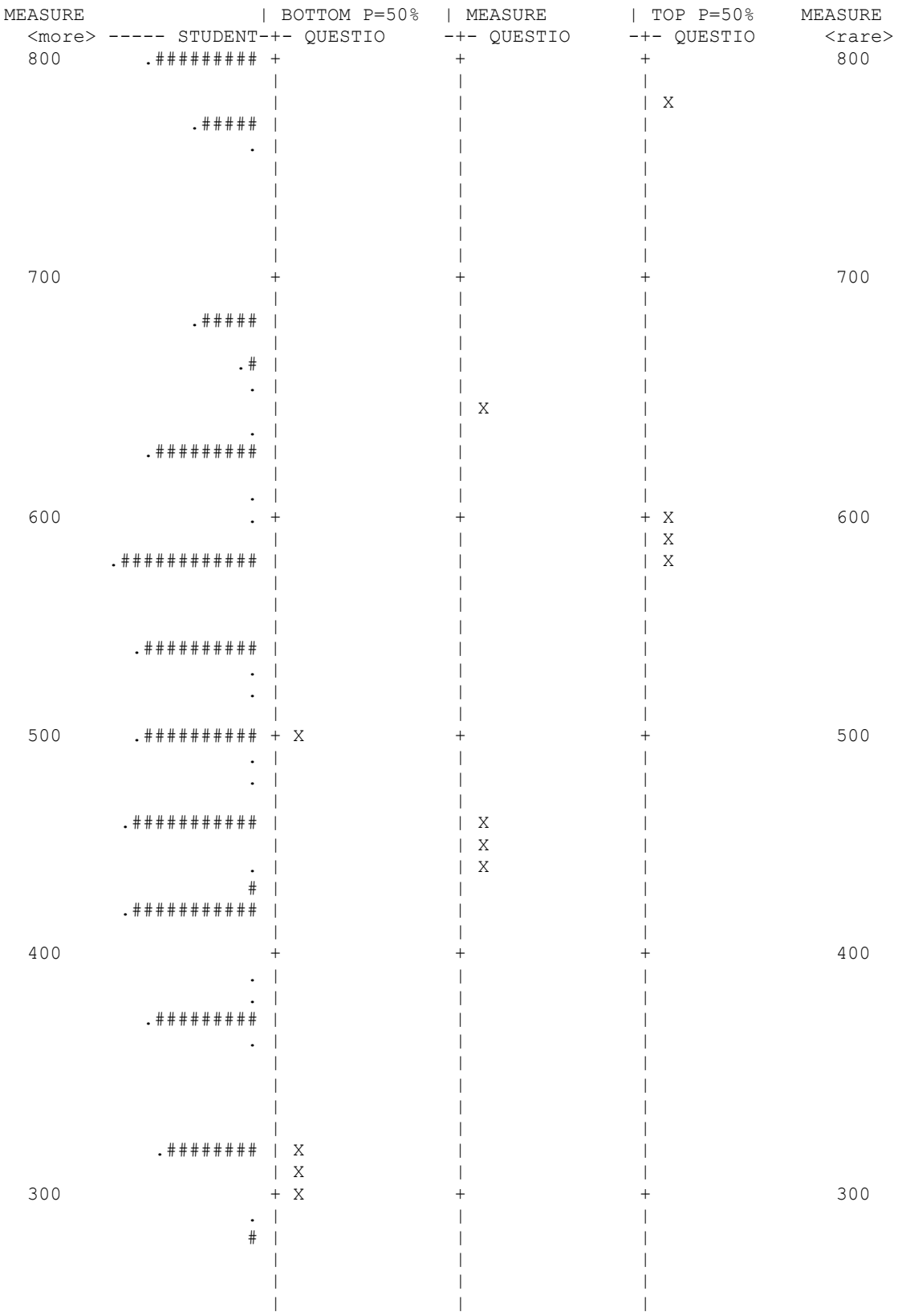
The measure was correlated in the expected direction.

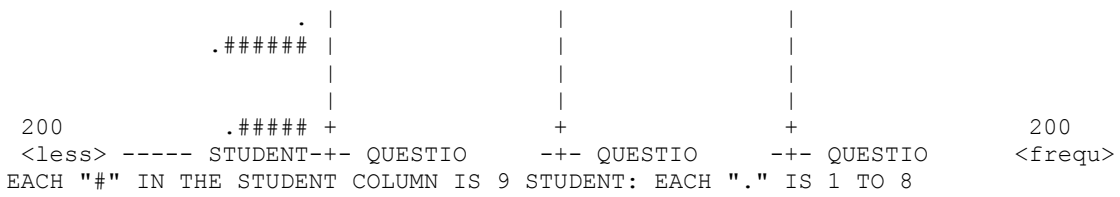
CTT analysis:

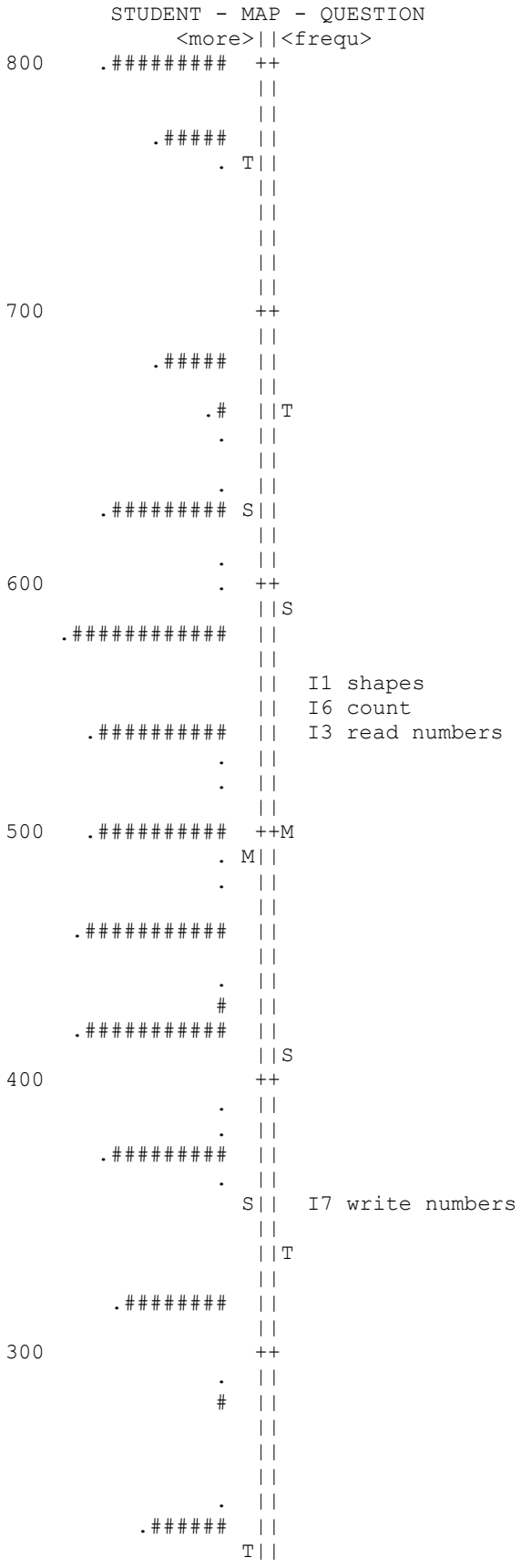
Alpha reliability =.77

Factor structure: 1 factor.

Rasch analysis:







```
                    ||
 200         .#####  ++
               <less>||<rare>
EACH "#" IS 9. EACH "." IS 1 TO 8
```

```
EXPECTED SCORE: MEAN   (Rasch-score-point threshold, ":" indicates Rasch-half-point
threshold) (ILLUSTRATED BY AN OBSERVED CATEGORY)
100  200    300    400    500    600    700    800    900
|------+------+------+------+------+------+------+------|  NUM   QUESTION
1                   1     :      2    :   3     :     44    7  I7 write numbers
|                                                        |
|                                                        |
1       1    :      2    :    3     :     4             4    3  I3 read numbers
1      1     :      2    :    3     :    4              4    6  I6 count
1     1      :      2    :    3     :    4              4    1  I1 shapes
|------+------+------+------+------+------+------+------|  NUM   QUESTION
100  200    300    400    500    600    700    800    900

                      1  1        1
4        5     7   9  0  0  9 19  11 8  15     5        7
1 241    91 46 3   16 7922 44406  01141513   1302      37  STUDENT
   T            S           M            S           T
0           10    20 30 40 50 60 70 80        90       99  PERCENTILE
```

```
50%  CUMULATIVE  PROBABILITY:  MEDIAN  (equal-cumulative-probability  Rasch-Thurstone
thresholds) (ILLUSTRATED BY AN OBSERVED CATEGORY)
100  200    300    400    500    600    700    800    900
|------+------+------+------+------+------+------+------|  NUM   QUESTION
1                           2          3       4        4    7  I7 write numbers
|                                                        |
|                                                        |
1              2          3       4                     4    3  I3 read numbers
1              2          3       4                     4    6  I6 count
1             2          3       4                      4    1  I1 shapes
|------+------+------+------+------+------+------+------|  NUM   QUESTION
100  200    300    400    500    600    700    800    900

                      1  1        1
4        5     7   9  0  0  9 19  11 8  15     5        7
1 241    91 46 3   16 7922 44406  01141513   1302      37  STUDENT
   T            S           M            S           T
0           10    20 30 40 50 60 70 80        90       99  PERCENTILE
```

```
OBSERVED AVERAGE MEASURES FOR STUDENT (unscored) (BY OBSERVED CATEGORY)
200     300       400       500       600       700       800
|---------+---------+---------+---------+---------+---------|  NUM   QUESTION
|                  1          m   2        3                4    7  I7 write numbers
|                                                             |
|                                                             |
|       1              2    m    3              4            |    3  I3 read numbers
|        1             2      m 3              4             |    6  I6 count
|      1               2    m     3            4             |    1  I1 shapes
|---------+---------+---------+---------+---------+---------|  NUM   QUESTION
200     300       400       500       600       700       800
  Code for unidentified missing data: m

                       1   1           1
4  5        7    8    0   0   9   9   1 1  8   1 5       5  8
8  91  46   3    485  783 2 332 776   0 11 41 51 3    1 302 0  STUDENT
            S                  M                S
0      10       20   30  40  50  60  70   80            90 99  PERCENTILE

     SUMMARY OF 1128 MEASURED (EXTREME AND NON-EXTREME) STUDENT
-------------------------------------------------------------------------------
|          TOTAL                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN       9.7       3.9         507      88                                |
| S.D.       3.5        .5         185      39                                |
| MAX.      16.0       4.0         900     198                                |
| MIN.       1.0       1.0          97      62       .00   -3.7    .00   -3.7 |
|-----------------------------------------------------------------------------|
| REAL RMSE    103 TRUE SD     154  SEPARATION  1.49  STUDEN RELIABILITY  .69 |
|MODEL RMSE     97 TRUE SD     158  SEPARATION  1.64  STUDEN RELIABILITY  .73 |
| S.E. OF STUDENT MEAN = 6                                                    |
-------------------------------------------------------------------------------
STUDENT RAW SCORE-TO-MEASURE CORRELATION = .93
CRONBACH ALPHA (KR-20) STUDENT RAW SCORE "TEST" RELIABILITY = .81
```

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MODEL MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	QUESTION
1	3049	1092	442	4	1.16	3.4	1.32	5.7	A .69	.75	47.7	50.2	I1 shapes
7	2015	1076	645	5	1.00	.0	.93	-1.0	B .78	.76	60.1	59.4	I7 write numbers
6	2952	1086	456	4	.98	-.4	.94	-1.2	b .77	.76	54.2	50.7	I6 count
3	2955	1089	457	4	.86	-3.4	.82	-3.9	a .79	.76	53.4	50.8	I3 read numbers
MEAN	2742.8	1085.8	500	5	1.00	-.1	1.00	-.1			53.9	52.8	
S.D.	422.0	6.0	84	0	.11	2.4	.19	3.5			4.4	3.8	

ENTRY NUMBER	DATA CODE	SCORE VALUE	DATA COUNT	DATA %	AVERAGE ABILITY	S.E. MEAN	OUTF MNSQ	PTMEA CORR.	QUESTION
1	A	1	131	12	270.64	12.64	1.3	-.48	I1 shapes
		2	312	29	417.94	6.22	1.3	-.31	
		3	302	28	533.34	6.41	1.6	.08	
		4	347	32	657.34	8.62	1.3	.55	
		MISSING ***	49	4#	467.74	36.86		-.04	
7	B	1	550	51	386.75	5.69	.9	-.66	I7 write numbers
		2	257	24	539.72	5.46	.7	.10	
		3	125	12	626.47	7.67	.8	.23	
		4	144	13	806.53	10.35	1.5	.63	
		MISSING ***	65	6#	499.66	18.80		-.01	
6	b	1	206	19	285.58	9.03	1.0	-.57	I6 count
		2	271	25	428.71	5.36	.8	-.24	
		3	232	21	523.96	5.79	.8	.05	
		4	377	35	674.84	7.57	1.0	.65	
		MISSING ***	55	5#	496.85	21.87		-.01	
3	a	1	219	20	279.14	7.82	.8	-.62	I3 read numbers
		2	256	24	431.36	5.07	.7	-.23	
		3	232	21	532.00	5.50	.8	.07	
		4	382	35	675.83	7.34	.9	.66	
		MISSING ***	52	5#	479.50	22.82		-.03	

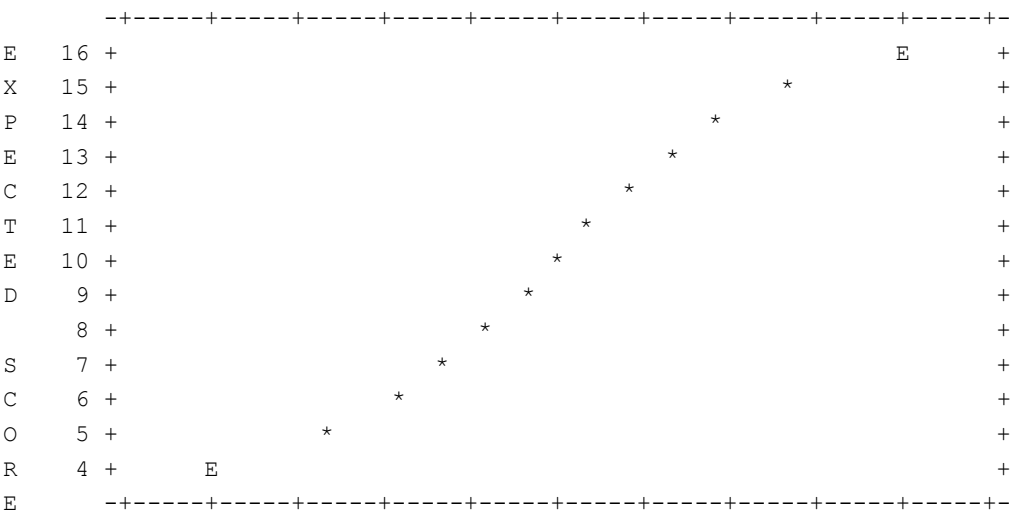
Missing % includes all categories. Scored % only of scored categories

TABLE OF MEASURES ON TEST OF 4 QUESTION

SCORE	MEASURE	S.E.	SCORE	MEASURE	S.E.	SCORE	MEASURE	S.E.
4	96E	187	9	461	62	14	686	83
5	229	108	10	499	62	15	772	107
6	316	82	11	538	63	16	900E	185
7	374	71	12	579	66			
8	420	65	13	627	72			

CURRENT VALUES, UMEAN=500.0000 USCALE=100.0000
TO SET MEASURE RANGE AS 0-100, UMEAN=50.2093 USCALE=12.4399
TO SET MEASURE RANGE TO MATCH RAW SCORE RANGE, UMEAN=10.0251 USCALE=1.4928
Predicting Score from Measure: Score = Measure * .0173 + -2.6675
Predicting Measure from Score: Measure = Score * 55.9067 + 164.4778

RAW SCORE-MEASURE OGIVE FOR COMPLETE TEST




```
                                  1  1   1  1
             4       6    7  81 01 0 9 0  11 8 15    5       7
STUDEN       1 25    0 46 3  43 71 24473  0115243  1302     37
               T          S          M           S          T
%TILE        0         10   20 30 40 50 60 70 80    90      99

QUESTI                            3           1
                             T    S    M    S    T
%TILE                           0 70       99
```

TABLE OF SAMPLE NORMS (500/100) AND FREQUENCIES CORRESPONDING TO COMPLETE TEST

SCORE	MEASURE	S.E.	NORMED	S.E.	FREQUENCY	%	CUM.FREQ.	%	PERCENTILE
4	96E	187	278	101	48	4.3	48	4.3	2
5	229	108	350	59	60	5.3	108	9.6	7
6	316	82	397	44	83	7.4	191	16.9	13
7	374	71	428	38	97	8.6	288	25.5	21
8	420	65	453	35	118	10.5	406	36.0	31
9	461	62	475	34	102	9.0	508	45.0	41
10	499	62	496	33	102	9.0	610	54.1	50
11	538	63	517	34	106	9.4	716	63.5	59
12	579	66	539	36	121	10.7	837	74.2	69
13	627	72	565	39	86	7.6	923	81.8	78
14	686	83	597	45	69	6.1	992	87.9	85
15	772	107	643	58	56	5.0	1048	92.9	90
16	900E	185	712	100	80	7.1	1128	100.0	96

THE NORMED SCALE IS EQUIVALENT TO UIMEAN= 226.4254 USCALE= .5396