VAKIL BROS P. PRESS, BARODA.

STUDIES IN EDUCATION AND PSYCHOLOGY

Achievement Test

in

Arithmetic for Primary Children

Stds. I - VI

N. N. Shah

Faculty of Education & Psychology
JA SAYAJIRAO UNIVERSITY OF BARODA.
Baroda, 1956

INDIAN INSTITUTE OF
ADVANCED STUDY
SIMLA

STUDIES IN EDUCATION AND PSYCHOLOGY

Achievement Test

in

Arithmetic for Primary Children

Stds. I - VI

N. N. Shah

Faculty of Education & Psychology
MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA.
Baroda, 1956

SYNOPSIS OF THE THESIS FOR THE DEGREE OF MASTER OF EDUCATION SUBMITTED TO THE M. S. UNIVERSITY, BARODA

Topic :—

"ACHIEVEMENT TEST IN ARITHMETIC"

for

Primary Children Stds. I – VI.

By

Shri Natvarlal N. Shah.

B. Sc. (Hons.), B. T.

September 1955

THE EDITOR'S NOTE

The need for the construction of Achievement Tests in different school subjects in Indian language cannot be overemphasised. The paucity of standardised literature in this field has hampered the work of school teachers and educators alike in assessing the proficiency of children for various purposes.

The present test aims at discovering the proficiency of children in fundamental skills in Arithmetic. With this object in view the author has tried to construct and standardise 'An Achievement Test in Arithmetic' in Gujarati for primary school children attending Stds. I to VI and to study the common errors made by the pupils and the remedial methods to remove them.

It is hoped that the investigation will serve the purpose for which it was carried out.

T. K. N. Menon

1. INTRODUCTION :

The knowledge and proficiency of four fundamental skills in Arithmetic is one of the most useful aspects of everyday human life. Apart from its practical utility it has got unique mental disciplinary value. Hence it is incumbent on schools that the knowledge should be well imparted.

For schools it is very essential to evaluate the quantity and quality of the knowledge acquired by the children. Hence there is a need for some sort of examination. Great educationists not only have pointed out the defects of the old types of examinations but have suggested the remedies. One of the chief remedies is the method of objective testing by standardised tests, such tests being characterised by (i) objectivity, (ii) validity, (iii) reliability, (iv) sampling, and (v) norms.

2. OBJECT AND SCOPE OF THE INVESTIGATION :

The main object of this investigation was to construct and standardise a consistent "Achievement Test in Arithmetic" in Gujarati for primary school children (Stds. I.–VI) to enable teachers, headmasters, inspectors and guardians to rapidly survey the arithmetical ability of the children. Besides, it was proposed to study (i) common errors made by the pupils and the remedial methods to remove them, and (ii) the difference in the performance of the two sexes.

3. PREPARATION AND FINALISATION OF THE TEST

After a careful study of (a) the syllabus, (b) common text-books, (c) opinions of experienced teachers, and (d) other standardised tests in Arithmetic, a preliminary test of 105 examples of the mechanical and 60 examples of the problem types consistent for Stds. I – IV was prepared. This test was administered on a sample of 300 children and in the light of the

experience gained, a set of (i) 50 examples of Mechanical Types and (ii) 40 examples of Problem Types was drawn up. Again it was administered on another sample of more than 300 children. The mean score for each standard was studied and a further revision was made to bring a finer discrimination among the lower standards.

The final set of 55 examples for (i) Mechanical Types and 45 examples for (ii) Problem Types was fixed up.

The time limit of 40 minutes for each test and the order of difficulty was fixed up.

4. CONTENTS OF THE TESTS :

	No. of Examples Mechanical	No. of Examples Problems
Four Fundamental Operations :		
Addition	6	5
Subtraction	6	5
Addition & Subtraction	–	2
Multiplication	4	4
Division	5	4
Multiplication & Subtraction ...	–	1
Mixed :	–	2
Money, Weights and Measurements :		
Addition	4	1
Subtraction	4	1
Multiplication	4	2
Division	3	1
Multiplication & Division	–	2
Addition & subtraction	–	1
Multiplication & Addition ...	–	1
Mixed :	–	3
Mixed :	–	4
Fractions :		
Addition	2	–
Subtraction	2	–
Multiplication	2	–
Division	2	–
Multiplication & Division	1	–
Addition & Subtraction	1	–
Decimals :		
Addition	3	–
Subtraction	3	–
Square Root :	1	–
Bill Making :	2	–
Proportion :	–	3
Area :	–	2
Interest :	–	1
Total :	55	45

Scoring :—One mark was assigned for each example correctly done. No partial credit was assigned however.

5. **ADMINISTRATION OF THE TEST :**

The following five centres were selected for the administration of the Test :—

(1) Ahmedabad, (2) Kalol, (3) Mehsana, (4) Siddhpur, (5) Deesa.

From each of the above centres one boys' and one girls' schools were selected and the test was administered on a random sample of 2210 children for the Mechanical Test and 2160 children for the Problem Test from Std. I – VI. The two tests were given on alternate days taking scrupulous care that children on the days were common.

Grade – wise distribution of Children

STD.	Mechanical	Problem
I.	324	311
II.	396	389
III.	392	374
IV.	369	372
V.	389	383
VI.	340	331
Total :	2210	2160

The above table shows that the distribution of subjects is uniform.

6. STANDARDISATION AND RESULTS :

—: GRADEWISE RESULTS :—

MECHANICAL TEST

STD.	NO.	MEAN	S. D.	C. R.	Level in%	Significance	C.V.
			BOYS				
I.	164	2·73	1·96				71·8
				22·3	1	Highly Significant	
II.	204	11·65	5·4				46·3
				10·2	1	Highly Significant	
III.	195	17·15	5·4				31·5
				3·44	1	Highly Significant	
IV.	197	19·25	6·65				34·5
				5·84	1	Highly Significant	
V.	202	23·4	7·65				32·7
				4·46	1	Highly Significant	
VI.	184	27·32	9·40				34·8
			GIRLS				
I.	160	2·42	1·92				79·3
				24·9	1	Highly Significant	
II.	192	9·06	3·04				33·6
				12·75	1	Highly Significant	
III.	197	14·42	5·0				34·7
				10·87	1	Highly Significant	
IV.	172	19·20	6·61				34·4
				2·53	2	Highly Significant	
V.	187	21·5	7·4				34·4
				8·6	1	Highly Significant	
VI.	156	27·5	7·35				26·7
			BOYS AND GIRLS Combined				
I.	324	2·7	1·92				
				27·3	1	Highly Significant	
II.	396	9·8	4·85				
				16·16	1	Highly Significant	
III.	392	15·78	5·5				
				7·50	1	Highly Significant	
IV.	369	19·22	7·20				
				5·6	1	Highly Significant	
V.	389	22·25	8·0				
				8·47	1	Highly Significant	
VI.	340	27·42	8·50				

MECHANICAL TEST

—:

It can be noted from the results shown that (i) there is a gradual increase in the mean scores of boys and girls from Standard to Standard. The difference between the means of I and II Stds is rather large. This may be due to the fact that the children of Std. I are not accustomed to answer such written tests, (ii) the mean scores of boys of Stds. I, II, III, IV and V are more than the mean scores of girls. Only in the case of Std. IV the level of achievement is fairly the same. In the case of Std. VI it can be noticed that the mean scores of girls is higher than the mean scores of boys, (iii) the boys are more variable in Stds. I, III, V., (iv) the difference between the means at successive standards are highly significant, and (v) the combined scores show a better gradation.

GRADEWISE RESULTS (Contd.)

—: PROBLEM TEST :—

STD.	No.	MEAM:	S.D	C.R.:	Level in%	Significance	C.V.
	BOYS :—						
I.	159	2·56	1·54				60·2
				14·3	1	Highly Significant	
II.	198	7·57	4·65				61·4
				9·6	1	Highly Significant	
III.	188	12·63	5·65				44·7
				4·3	1	Highly Significant	
IV.	208	15·15	6·25				41·3
				7·66	1	Highly Significant	
V.	198	19·9	6·3				31·7
				4·64	1	Highly Significant	
VI.	183	23·1	7·25				31·4
	GIRLS :-						
I.	152	2·34	1·66				79·4
				12·58	1	Highly Significant	
II.	191	6·11	3·70				60·5
				8·93	1	Highly Significant	
III.	186	10·23	5·25				51·3
				5·90	1	Highly Significant	
IV.	164	13·51	5·25				38·9
				2·2	2	Highly Significant	
V.	185	14·75	5·5				37·3
				8·2	1	Highly Significant	
VI.	148	20·0	6·04				30·2
	GIRLS & BOYS Combined :-						
I.	311	2·45	1·62				
				18·6	1	Highly Significant	
II.	389	6·85	4·34				
				12·80	1	Highly Significant	
III.	374	11·45	5·6				
				7·02	1	Highly Significant	
IV.	372	14·4	5·95				
				7·14	1	Highly Significant	
V.	383	17·4	5·65				
				11·1	1	Highly Significant	
VI.	331	22·73	6·9				

PROBLEM TEST

It can be noted from the results shown that (i) (a) there is a gradual increase in the mean scores of boys and girls from standard to standard, (b) they are comparatively graded in finer way than Mechanical Test scores, (ii) the difference between the scores of boys and girls is significant all throughout showing the superior performance of boys over girls, (iii) the boys are more variable in Stds. I, III, V, (iv) the difference between the means at successive standards are highly significant, and (v) the combined scores show a better gradation.

AGE-WISE RESULTS – MECHANICAL TEST

Age Years:	No.	MEAN:	S.D.:	C.R.:	Level of Significance in%	Significance	C. V.
		BOYS					
6	19	4·3	2·91				67·7
				2·52	1	Highly Significant	
7	64	7·85	6·85				87·3
				1·74	5	Significant	
8	138	9·7	7·5				77·3
				2·85	1	Highly Sinnificant	
9	158	12·35	8·5				68·8
				4·37	1	Highly Significant	
10	137	16·5	7·75				47·0
				2·11	2	Highly Significant	
11	156	18·70	10·2				54·5
				1·40	–	Not Significant	
12	152	20·15	8·25				40·9
				2·24	2	Highly Significant	
13	151	22·47	9·0				40·1
		GIRLS					
6	25	3·0	1·84				61·3
				2·9	5	Significant	
7	75	5·2	4·35				83·7
				4·14	1	Highly Significant	
8	115	8·35	5·62				67·3
				4·17	1	Highly Significant	
9	126	11·90	7·2				60·5
				3·4	1	Highly Significant	
10	156	13·58	5·9				43·5
				5·63	1	Highly Significant	
11	136	18·37	8·25				44·9
				2·50	1	Significant	
12	162	2·8	8·4				40·4
				0·4	–	Not Significant	
13	132	21·2	8·8				41·5
		BOYS & GIRLS Combined					
6	44	3·46	1·66				
				3·56	1	Highly Significant	
7	139	6·44	5·55				
				4·19	1	Highly Significant	
8	251	9·1	6·7				
				4·7	1	Highly Significant	

BOYS & GIRLS Combined

9	282	12·1	8·04			
				4·38	1	Highly Significant
10	293	14·95	7·55			
				5·68	1	Highly Significant
11	292	18·55	7·9			
				2·95	1	Highly Significant
12	314	20·48	8·3			
				2·34	1	Highly Significant
13	283	22·89	16·36			

MECHANICAL TEST

It can be noted from the results shown that (i) there is a gradual increase in the mean scores of boys and girls of various ages. (ii) the difference between the mean scores at successive age levels are significant. It can be noticed that the difference between the mean scores of boys of 11 years and 12 years and between girls of 12 years and 13 years is not significant in Mechanical Test, (iii) the mean scores of boys at various age levels are higher than the mean scores of girls, (iv) the boys of ages 6, 7, 8, 9, 10, 11, 12 are more variable. Only the girls of 13 years age are more variable than boys, (v) the combined results show better results.

—: AGE-WISE RESULTS - PROBLEM TEST :—

Age Years:	No.	MEAN:	S.D.:	C.R.:	Level of Significance in%	Significance	C. V.
	BOYS :-						
6	22	1·6	1·16				72·5
				4·24	1	Highly Significant	
7	59	5·2	4·2				80·8
				1·9	5	Significant	
8	136	7·0	6·0				85·7
				3·70	1	Highly Significant	
9	152	9·7	6·5				67·0
				4·25	1	Highly Significant	
10	133	12·85	6·7				52·1
				2·30	2	Highly Significant	
11	160	14·7	7·95				54·1
				2·7	1	Highly Significant	
12	144	17·0	7·25				42·7
				3·64	1	Highly Significant	
13	145	19·5	7·8				40·0
	GIRLS :-						
6	34	1·92	1·5				78·1
				2·55	2	Highly Significant	
7	69	4·4	3·2				72·7
				2·70	1	Highly Significant	
8	110	5·85	4·5				76·9
				2·90	1	Highly Significant	
9	120	7·75	5·4				69·7
				1·91	5	Significant	
10	152	9·30	6·75				72·6
				4·16	1	Highly Significant	
11	123	13·04	6·25				48·0
				2·02	5	Significant	
12	148	14·70	7·25				49·3
				0·91	–	Not Significant	
13	121	15·5	7·0				45·2
	BOYS & GIRLS Combined :-						
6	46	1·76	1·52				
				6·98	1	Highly Significant	
7	128	4·37	3·39				
				4·91	1	Highly Significant	
8	246	6·46	5·3				
				4·76	1	Highly Significant	
9	273	8·85	6·1				
				3·37	1	Highly Significant	

BOYS & GIRLS Combined :-

10	281	10·9	6·15			
				5·26	1	Highly Significant
11	274	13·95	7·45			
				3·87	1	Highly Significant
12	292	16·31	7·4			
				2·16	5	Highly Significant
13	266	17·62	7·6			

PROBLEM TEST

It can be noted from the results shown that, (i) there is a gradual increase in the mean scores of boys and girls of various ages, (ii) the difference between the mean scores at successive age levels are significant. It can be noticed that the difference between the mean scores of girls of 12 years and 13 years is not significant in the problem test, (iii) the mean scores of boys of various age levels are higher than the mean scores of girls, except in the case of 6 years, where the sample tested is very small and hence the difference can not be taken as important, (iv) the boys of ages 7 8, 11 are more variable and the girls of 6, 9, 10, 12, 13 years age are more variable, and (v) the combined results show better results.

7- RELIABILITY OF THE TEST:

The reliability of the test was established by the following methods, (i) Test-Retest Method, (ii) Split-Half Method, (iii) in absence of a parallel form the test scores of the Mechanical Test and the test scores of the Problem Test were correlated. The results are given bslow :—

—: CORRELATION BY TEST RE-TEST METHOD :—

	Number of BOYS-GIRLS:	r.	P.Er.
MECHANICAL	374	+ 0·87	± 0·008
PROBLEM	345	+ 0·80	± 0·013

—: CORRELATION BY SPLIT-HALF METHOD :—

	Number	r.	P.Er.
MECHANICAL:			
BOYS	1146	+ 0·90	± 0·004
GIRLS	1064	+ 0·87	± 0·005
BOYS & GIRLS	2210	+ 0·88	± 0·003
PROBLEM:			
BOYS	1134	+ 0·87	± 0·005
GIRLS	1026	+ 0·80	± 0·007
BOYS & GIRLS	2160	+ 0·83	± 0·005

CORRELATION BETWEEN MECHANICAL & PROBLEM TESTS' SCORES

	Number	r	P. Er.
BOYS :	1055	+ 0·87	± 0·005
GIRLS :	903	+ 0·85	± 0·006
BOYS & GIRLS :	1958	+ 0·86	± 0·004

The above results show that the test is highly reliable.

8. VALIDITY OF THE TEST :

The validity of the test was found out by (i) correlating the test scores with the annual marks obtained by the children in the subject of Arithmetic, and (ii) by correlating the test scores with carefully obtained Teachers' estimates on seven point scale.

A	B	C	D	E	F	G
Very Good :	Good :	More than Average :	Average :	Below Average :	Bad :	Very Bad :

CORRELATION BETWEEN ANNUAL MARKS IN ARITHMETIC AND TEST SCORES

MECHANICAL

BOYS

STD.	Number	r.	P. Er.
I.	158	+ 0·48	± 0·041
II.	189	+ 0·55	± 0·034
III.	188	+ 0·44	± 0·039
IV.	186	+ 0·50	± 0·037
V.	189	+ 0·43	± 0·039
VI.	178	+ 0·47	± 0·039
	GIRLS		
I.	110	+ 0·63	± 0·038
II.	142	+ 0·64	± 0·033
III.	165	+ 0·63	± 0·02
IV.	163	+ 0·59	± 0·033
V.	165	+ 0·32	± 0·046
VI.	142	+ 0·40	± 0·047
	BOYS & GIRLS		
I.	268	+ 0·39	± 0·035
II.	331	+ 0·34	± 0·033
III.	353	+ 0·67	± 0·02
IV.	349	+ 0·42	± 0·035
V.	354	+ 0·41	± 0·029
VI.	320	+ 0·46	± 0·073

—: CORRELATION BETWEEN ANNUAL MARKS IN ARITHMETIC AND TEST SCORES :—

—: PROBLEMS :—

STD.	Number	r.	P. Er.
		BOYS	
I.	104	+ 0·71	± 0·033
II.	157	+ 0·59	± 0·035
III.	166	+ 0·48	± 0·04
IV.	150	+ 0·63	± 0·033
V.	180	+ 0·45	± 0·04
VI.	168	+ 0·51	± 0·039
		GIRLS	
I.	102	+ 0·66	± 0·038
II.	155	+ 0·56	± 0·036
III.	172	+ 0·43	± 0·042
IV.	155	+ 0·45	± 0·043
V.	159	+ 0·25	± 0·027
VI.	143	+ 0·39	± 0·047
		GIRLS AND BOYS Combined	
I.	206	+ 0·66	± 0·026
II.	312	+ 0·52	± 0·028
III.	338	+ 0·53	± 0·026
IV.	305	+ 0·59	± 0·025
V.	339	+ 0·44	± 0·029
VI.	311	+ 0·37	± 0·033

On observing the results in the tables it is found that majority of the correlations (r) are more than + 0·4 and onwards upto + 0·71 ± 0·33. This shows that the test has fairly high validity.

CORRELATION BETWEEN TEACHERS' ESTIMATES AND TEST SCORE RESULTS

—: MECHANICAL :—			—: PROBLEM :—		
STD.	Number :	r. P. Er.	STD.	Number :	r. P. Er.
	—: BOYS :—			—: BOYS :—	
I.	69	+ 0·65 ± 0·045	I.	89	+ 0·47 ± 0·055
II.	162	+ 0·53 ± 0·038	II.	140	+ 0·72 ± 0·027
III.	111	+ 0·48 ± 0·048	III.	99	+ 0·61 ± 0·042
IV.	125	+ 0·66 ± 0·034	IV.	120	+ 0· 6 ± 0·039
V.	202	+ 0·59 ± 0·03	V.	184	+ 0·57 ± 0·033
VI.	184	+ 0·64 ± 0·03	VI.	180	+ 0·62 ± 0·0 3
	—: GIRLS :—			—: GIRLS :—	
I.	88	+ 0·52 ± 0·05	I.	118	+ 0·49 ± 0·046
II.	107	+ 0·69 ± 0·034	II.	137	+ 0·55 ± 0·040
III.	160	+ 0·45 ± 0·042	III.	137	+ 0·61 ± 0·036
IV.	101	+ 0·58 ± 0·044	IV.	73	+ 0·81 ± 0· 02
V.	173	+ 0·55 ± 0·036	V.	156	+ 0· 6 ± 0·034
VI.	156	+ 0·43 ± 0·04	VI.	144	+ 0·52 ± 0·041
	–: BOYS & GIRLS Combined :–			–: BOYS & GIRLS Combined :–	
I.	157	+ 0·5 ± 0·026	I.	207	+ 0·57 ± 0·078
II.	269	+ 0·57 ± 0·027	II.	277	+ 0·28 ± 0·037
III.	271	+ 0·45 ± 0·048	III.	236	+ 0· 6 ± 0·029
IV.	226	+ 0·61 ± 0·028	IV.	193	+ 0·66 ± 0·028
V.	375	+ 0·53 ± 0·025	V.	340	+ 0·36 ± 0·032
VI.	340	+ 0·63 ± 0·022	VI.	324	+ 0·53 ± 0·04

On observing the results in above tables it is found that majority of Correlations (r) are found to be more than + 0·5 and onwards upto + 0·81 ± 0·02, showing a comparatively high correlation for almost every class.

9 COMMON MISTAKES AND REMEDIES :

On scrutinising the answers given by more than 2000 children it was found that many glaring mistakes are done by them, in the four fundamental operations like addition, subtraction multiplication, division and their various combinations. The mistakes have been analysed and classified. Probable reasons are discussed and remedial measures have been suggested.

10.- CONCLUSIONS AND FINDINGS :—

More stress should be laid on individual attention to the children by the teachers from the very early stages. The number in each class should not be more than 30 so as to enable teachers to pay more personal attention.

The importance of mental training in Arithmetic and the mastery over number tables should not be neglected. Mechanisation in the process of calculations in Arithmetic is one of the important aspects of its practical utility in day-to-day life.

On the whole the performance of the boys is superior to the performance of the girls. There is less difference in the case of Mechanical Test, but significant differnce is found especially in the case of Problem Test where the boys are found to be quite superior to girls. This may be due to the environmental differences between the two sexes.