Learning Levels of Grade V Students in Mathematics

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Abstract

The Department of Educational Measurement and Evaluation of National Council of Educational Research and Training (NCERT) is an autonomous organisation under the Government of India. This department conducts the National Achievement Surveys (NAS) at different stages of school education under the *Sarva Siksha Abhiyan* (Educational for All), a flagship programme of Government of India. The purpose of the NAS is to know the learning levels of students in different subjects across the states in the country periodically and provide inputs to the policy makers, researchers and others for improving the system.

The present study of grade V was initiated in 2009 and data was collected from 1, 22, 543 students and 6,602 schools covering 35 States and Union Territories. Sample was drawn from government and government aided schools by using Population Proportion Sampling (PPS) and Simple Random Sampling (SRS) methods. Using multiple choice items three forms of test booklets were developed in each subject i.e., Language, Mathematics and Environmental Studies (EVS) using Item Response Theory (IRT).

Moving away from Classical Test Theory (CTT), Item Response Theory (IRT) is used to obtain scaled scores of students. Students' scores were calibrated on a scale of 0-500. For knowing what students can do, students' ability and items difficulty was computed. The research findings in Mathematics indicate that the average achievement across the states varies significantly.

Key words: Achievement Surveys, Learning Achievement, Sarva Shiksha Ahiyan

Introduction

National Achievement Surveys (NAS) are conducted under the Government of India's flagship programme *Sarva Shiksha Abhiyan* (SSA). NAS is designed to provide information about the learning achievement of students in the elementary sector of education in government and government-aided schools. This is achieved by administering standardized tests to students. NAS also collects information about relevant background factors about the school environment, instructional practices, and the home backgrounds of students, teachers' qualification etc. NAS data gives policy makers, curriculum specialists, researchers and, other stake holders a 'snapshot' of what students know and can do in key subjects at a particular point in time. The results also serve as a baseline against which future progress in education may be evaluated.

History of NAS in India

In the year 2000, the programme of NAS, originally conceived by NCERT as an independent project, was incorporated into the Government's flagship project *Sarva Shiksha Abhiyan* (SSA). NCERT is responsible for developing and conducting the surveys whilst funding is provided by the Ministry of Human Resource Development (MHRD), Government of India.

Within SSA, three cycles of NAS were planned. Each cycle was to cover three key grades: Class III, Class V and Class VII/VIII. The first cycle, conducted in the period 2001-2004 was named as the Baseline Achievement Survey (BAS). The second cycle, conducted during the period 2005-2008 was called the Mid-term Achievement Survey (MAS). The third cycle was originally named as the Terminal Achievement Survey (TAS) and presently known as 'Cycle 3' as given in the Table 1.1 below:

Table 1.1: Timeline for NAS under SSA

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Cycle 1 (formerly BAS)				**Cycle 2** (formerly MAS)				**Cycle 3** *(NAS)*			
Class V		Class III		Class V		Class III		*Class V		*Class III*	
	Class VII & VIII					Class VII & VIII			*Class VIII***		

* The findings of the Cycle 3, Class V (NAS) are reported herein. **Cycle 3 (NAS) for Class VIII is in progress while class III is initiated.

It should be noted that whilst each NAS provides achievement scores for the nation, for each participating state and for certain groups (e.g. girl students, students in rural schools, etc.) it does not give scores to individual students or schools.

Methodology

Objectives:

- To study the achievement level of students of Class V in Language, Mathematics and Environmental Studies.
- To study the difference in achievement with regard to area, gender and social groups.

Sample:

The Class V (NAS) was designed to investigate learning achievement in the government system at the State/UT level. Hence, the target population for the survey was all Class V students studying in government schools, local body schools, and government-aided schools.

In general, the sample design for each state/UT involved a three-stage cluster design which used a combination of two probability sampling methods. At the first stage, districts were selected using Probability Proportional to Size (PPS) sampling principle. This means that the probability of selecting a particular district depended on the number of Class V students enrolled in that district. At the second stage, in the chosen districts, the requisite number of schools was selected. Once again, PPS principles were used so that large schools had a higher probability of selection than smaller schools. At the third stage, the required number of students in each school was selected using the Simple Random Sampling (SRS) method. In

schools where Class V had multiple sections, an extra stage of selection was added with one section being sampled at random i.e. using SRS.

In the survey, PPS sampling was based on Class V enrolment data from the District Information System for Education (DISE) 2007/08. SRS sampling was conducted according to the class registers available in sampled schools. Although the DISE data was not free from criticism, it was used because it was considered to be the most complete and up to date enrolment data available at the time of sampling. Unfortunately, due to discrepancies in the DISE data, limitations in the sampling method and loss of information at the sampling and administration stages of the survey, it was impossible to estimate sample weights for the survey.

In this survey, information gathered through tests and questionnaires administered to a sample comprising 1,22,543 students in 6,602 schools across 31 States and Union Territories (UT). The subjects covered were Mathematics, Language (including Reading Comprehension) and Environmental Studies (EVS).

Survey Instruments

Development of instruments is one of the most important activities of the survey. This includes test booklets and questionnaires. For Class V, there are three main subjects on which the learning is focussed: Language, Mathematics and Environmental Studies. In this paper only Mathematics is covered.

Tests

Before developing the tests, assessment frameworks were developed in each subject. The frameworks describe the competencies to be covered in the tests, the type of items to be used, the number of items to be used for testing each competency, the structure of the test forms and number of tests.

A large number of test items were prepared in each subject and translated into the fifteen regional languages necessary for testing across the different states of India. These were then piloted in each state to see how the items worked in different languages. The difficulty level and discrimination index were computed for each item. This and other evidence allowed suitable items to be selected for the final tests.

In an important development from earlier surveys, instead of one booklet, three booklets for each subject were prepared. Further steps were taken to ensure that the different test booklets in a particular subject could be linked together. This was done by including a block of common items in each booklet. These are the 'anchor items' which, through the application of Item Response Theory, allow us to place the scores from all three booklets on the same scale.

Analysis and Interpretation of Data:

For the Class V (NAS), each test form of Mathematics consisted of 40 multiple-choice items. Of these, 20 were anchor items which appeared in all the test forms. Thus overall 80 unique items were used to measure learning achievement.

The responses of students to the various tasks were analysed using Item Response Theory. The three test forms were then aligned using the anchor items thereby placing all items on a

single scale comprising scores from 0 to 500. On this scale, the mean score was set at 250 with a standard deviation of 50.

The 20 states and UTs represented in Table 1.2 are those in which Class V students were tested and where the sample covered at least 80% of the target population. The average score for this group was 251 (with a standard error of 0.7). The results reveal substantial differences in Mathematics achievement between the highest performing states (298 for Uttar Pradesh and 279 for Tamil Nadu) and the lowest performing states/UTs (217 for Puducherry and 226 for the Andaman and Nicobar islands). In Mathematics, seven states had average scores significantly above that of the group; nine states had average scores significantly below that of the group; four states had average scores that were not significantly different from that of the group.

Table 1.2: Average Mathematics scores for States and Union Territories where Class V students were tested and the population coverage was >80%

State or Union Territory	Average Score	Standard Error	Significant Difference
A & N Islands	226	2.8	⬮
Andhra Pradesh	238	2.2	⬮
Bihar	242	3.4	⬮
Chandigarh	229	2.0	⬮
Chhattisgarh	232	3.4	⬮
Delhi	260	3.4	⬯
Gujarat	256	3.2	●
Haryana	240	2.5	⬮
Himachal Pradesh	243	2.4	⬮
Jammu & Kashmir	262	2.9	⬯
Karnataka	269	2.9	⬯
Madhya Pradesh	265	3.5	⬯
Orissa	257	3.0	●
Puducherry	217	3.6	⬮
Punjab	252	2.6	●
Rajasthan	257	3.2	●
Tamil Nadu	279	2.8	⬯
Tripura	260	3.0	⬯
Uttar Pradesh	298	3.1	⬯
Uttarakhand	241	2.7	⬮
Group Average	**251**	**0.7**	

● The state's average score is not significantly different to that of the group.

⬯ The state's average score is significantly above that of the group.

⬮ The state's average score is significantly below that of the group.

The five States and UTs represented in Table 1.3 are those in which Class V students were tested but where the sample covered less than 80% of the target population. For this group, great care should be taken when considering an average score or comparing it with that of other states as it may not be a reliable measure for the whole State/UT.

Table 1.3: Average Mathematics scores for States and Union Territories where Class V students were tested and the population coverage was <80%

State or Union Territory	Average Score	Standard Error	Significant Difference
Assam	241	2.3	⬮
Daman & Diu	259	5.7	●
Goa	241	3.9	⬮
Kerala	244	1.5	⬮
Maharashtra	264	3.1	⬯
Group Average	250	1.6	

● The state's average score is not significantly different to that of the group.
⬯ The state's average score is significantly above that of the group.
⬮ The state's average score is significantly below that of the group.

The six states represented in Table 1.4 are those in which, due to local circumstances, Class VI students had to be tested. For this group, the average Mathematics score was 246 (Standard Error 1.1). West Bengal performed significantly better than the group average whereas the average scores of Sikkim and Mizoram were significantly below the group average.

Table 1.4: Average Mathematics scores for States where Class VI students were tested

State or Union Territory	Average Score	Standard Error	Significant Difference
Jharkhand	247	3.0	●
Meghalaya	244	2.9	●
Mizoram	233	1.0	⬮
Nagaland	251	3.5	●
Sikkim	234	1.8	⬮
West Bengal	267	2.4	⬯
Group Average	**246**	**1.1**	

● The state's average score is not significantly different to that of the group.
⬯ The state's average score is significantly above that of the group.
⬮ The state's average score is significantly below that of the group.

Table 1.5 illustrates the range of achievement within states and across groups of states. The tables list the scores achieved by students at key *percentiles*. For example, the score at the

25th percentile is the score which 75% of students achieve or surpass: the score at the 90th percentile is the score that 10% of students achieve or surpass.

The range between the 25th and 75th percentiles (the inter-quartile range) represents the performance of the middle 50% of students. Hence, this is a good indicator of the state's degree of homogeneity in terms of the Mathematics achievement of its students.

Table 1.5: Percentile scores in Mathematics for States where Class V students were tested and the population coverage was >80%

State or Union Territory	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile	Range 75-25	Range 90-10
A & N Islands	182	200	224	237	276	37	94
Andhra Pradesh	185	212	228	271	291	59	107
Bihar	178	204	230	275	321	71	143
Chandigarh	185	212	226	248	273	36	88
Chhattisgarh	165	200	226	269	316	69	151
Delhi	201	226	262	292	325	66	124
Gujarat	194	224	255	287	320	63	126
Haryana	183	212	229	271	305	59	122
Himachal Pradesh	187	220	233	273	301	52	114
Jammu & Kashmir	189	225	268	303	333	78	144
Karnataka	206	228	273	308	331	81	125
Madhya Pradesh	202	227	270	302	329	75	126
Orissa	186	222	253	298	329	75	143
Puducherry	179	187	216	227	265	40	86
Punjab	191	225	250	276	314	51	123
Rajasthan	190	224	257	288	324	64	133
Tamil Nadu	224	234	275	318	342	84	118
Tripura	184	225	268	305	336	80	151
Uttar Pradesh	223	261	310	346	377	85	154
Uttarakhand	182	212	230	273	306	62	124
Group Distribution	**191**	**219**	**249**	**283**	**316**	**64**	**125**

Note: Ranges may not agree due to rounding.

The inter-quartile range (i.e. the range between the 75th and 25th percentiles) is highly variable. For example, Chandigarh has an inter-quartile range of just 36 whilst Uttar Pradesh has a corresponding value of 85. These values suggest that, in terms of Mathematics achievement, the Class V population in Chandigarh is far more homogeneous than that of Uttar Pradesh. In most states, the range of performance for the middle group was between 50 and 80 scale-score points. Performance at the 10th and 90th percentiles respectively shows

extremes in low and high achievement. The range between these two points, which includes 90 percent of the population, is highly variable ranging from 86 (Puducherry) to 154 (Uttar Pradesh).

The percentiles provide additional information when comparing Mathematics performance amongst states. For example, when the states are arranged in order of average score, the differences between adjacent states tend to be small. However, the range of scores may not be similar. For example, there is no significant difference between the average score of Bihar (242) and Andhra Pradesh (238). However, the score ranges between the 25th and 75th percentiles are very different: Bihar's range is 71 compared with Andhra Pradesh's range of 59. This indicates that whilst average performance in the two states is approximately the same, the Class V cohort in Bihar is more diverse in its mathematical achievement.

Table 1.6: Percentile scores in Mathematics for States where Class V students were tested and the population coverage was <80%

State or Union Territory	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile	Range 75-25	Range 90-10
Assam	182	212	228	273	312	62	130
Daman & Diu	206	225	256	291	324	65	118
Goa	189	219	230	269	291	51	101
Kerala	198	224	234	272	288	48	90
Maharashtra	203	226	268	299	331	72	128
Group Distribution	**195**	**221**	**243**	**281**	**309**	**60**	**113**

Table 1.7: Percentile scores in Mathematics for States where Class VI students were tested

State or Union Territory	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile	Range 75-25	Range 90-10
Jharkhand	180	215	234	279	324	64	143
Meghalaya	194	222	230	272	310	50	117
Mizoram	196	221	227	248	273	27	76
Nagaland	187	219	236	282	324	62	138
Sikkim	197	223	228	256	273	33	76
West Bengal	211	227	270	299	332	71	122
Group Distribution	**194**	**221**	**238**	**272**	**306**	**51**	**112**

The inter-quartile range for the states where Class VI students were tested varied considerably from about 27 scale-points in Mizoram to 71 points in West Bengal. The range of scale-points covering the population from the 10th to the 90th percentile (i.e. the range which includes 90 percent of the population) varied dramatically from the highly diverse state of Jharkhand (143) to Sikkim (76) where relatively little difference between high and low performing student was detected.

Interestingly, the data shows that whilst West Bengal has by far the highest median performance (270) in this group, Nagaland and Jharkhand have scores at the 90th percentile which are comparable to that of West Bengal (324 *cf.* 332). This suggests that high achieving students in Nagaland and Jharkhand are not lagging behind their peers in West Bengal.

How did Various Groups Perform in Mathematics?

Performance is compared by gender, by school location, and by social category. (The quoted scores were calculated for the 20 States and UTs where students were tested in Class V and coverage of the population was at least 80% since this group gives the most reliable picture.)

Are there any gender related-differences in Mathematics achievement?

The average Mathematics scores achieved by boys and girls shows that, within this group of states, no significant difference was detected in the average achievement levels of the two groups. In general, the general result, i.e. no significant difference between the average achievement of boys and girls holds for all states and UTs.

Are there any differences in Mathematics achievement related to school location?

The average Mathematics scores achieved by students in rural and urban schools shows that within this group of states, no significant difference was detected in the average achievement levels of the two groups.

In general, no significant difference between rural and urban students holds for all states and UTs. However, two exceptional cases were detected: in A & N Islands, the rural students outperformed the urban students whereas in Tripura the urban students outperformed the rural students by a margin which is statistically significant.

Are there any differences in Mathematics achievement related to caste category?

Table 1.8 below compares the average mathematics scores achieved by students in different social categories. It shows that students in the general category achieved significantly higher average scores than those in other categories. Students classified as being in the OBC group significantly outperformed those in the ST group. No significant difference was detected in the average achievement levels of students in the SC and ST categories.

Table 1.8: Average Mathematics scores for groups by social category (Class V)

Category	Average (SE)	SC	ST	OBC	General
SC	247 (1.2)	-	●	🡻	🡻
ST	245 (1.5)	●	-	🡻	🡻
OBC	251 (1.0)	🡹	🡹	-	🡻
General	257 (1.2)	🡹	🡹	🡹	-

● The average scores of the two categories being compared are not significantly different.

🡹 The average scores of the category given in the first column is significantly higher than that of the category with which it is being compared.

🡻 The average score of the category given in the first column is significantly lower than that of the category with which it is being compared.

Conclusion

The average mathematical achievement of students varies greatly across the states and UTs of India. There is a great difference in outcomes in the group of high scoring states such as Uttar Pradesh (298) Tamil Nadu (279) and Karnataka (269) and the low scoring states/UTs such as Puducherry (217), Andaman & Nicobar Islands (226) and Chandigarh (229).

States also vary greatly in the range between their lowest and highest achieving students as revealed by their inter-quartile score ranges. Some states/UTs, e.g. Chandigarh (36), Andaman & Nicobar Islands (37) and Puducherry (40) have relatively homogeneous cohorts whilst others have far more diverse outcomes e.g. Uttar Pradesh (85), Tamil Nadu (84) and Karnataka (81). Therefore, when looking at Mathematics performance within a state/UT, it is important to consider not only the average score, but also the distribution of percentile scores.

Overall, the survey found no significant difference in the average achievement of Class V girls and boys studying Mathematics in Government and Government-aided schools. Some readers may be surprised by this finding. However, the large sample size (>55.000) and the consistency of results across states suggest that this is a robust conclusion.

Similarly, with a few exceptions, no significant difference was detected between the average achievement level in Mathematics of rural and urban students. In cases such as Tripura (favouring rural) and the Andaman & Nicobar Islands (favouring urban), further investigations may be necessary at the local level to explain these exceptional outcomes.

Data from the survey confirms that students from the general category outperform their peers in the SC, ST and OBC categories by a statistically significant margin.

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