STUDENT Learning in the Metros 2006

How well are our students learning?

Educational INITIATIVES

WIPRO

Prologue

"In regard to education in Brazil, I had a very strange experience. I once attended a lecture which went like this, translated into English: "Two bodies… are considered equivalent… if equal torques… will produce… equal acceleration. Two bodies are considered equivalent if equal torques will produce equal acceleration." The students were all sitting there taking dictation, and when the professor repeated it, they checked it to make sure they wrote it down all right. Then they took down the next sentence and so on and on. I was the only one who knew the professor was talking about objects with the same moment of inertia and it was hard to figure out.

I didn't see how they were going to learn anything from that. Here he was talking about moment of inertia but there was no discussion about how hard it is to push a door open when you put heavy weights on the outside, compared to when you put them near the hinge - nothing!

After the lecture I talked to a student: "You take all these notes - what do you do with them?"

"Oh, we study them," he says. "We'll have an exam."

"What will the exam be like?"

"Very easy. I can tell you now one of the questions." He looks at his notebook and says," 'When are two bodies equivalent?' And the answer is, 'Two bodies are considered equivalent if equal torques will produce equal acceleration.'" So, you see, they could pass the examinations, and "learn" all this stuff, and not know anything at all, except what they had memorized.

After a lot of investigation, I finally figured out that the students had memorized everything, but they didn't know what anything meant. When they heard "when light passes through a medium", they didn't know that it meant a material such as water. Everything was entirely memorized, yet nothing had been translated into meaningful words. So if I asked, "When are two bodies equivalent?" I'm going into the computer with the right keywords. But if I say, "Look at the water," nothing happens - they don't have anything under "Look at the water!"

Surely You're Joking, Mr. Feynman, Richard Feynman, Unwin Paperbacks, 1986

Executive Summary

Public debate in India bemoans the lot of government schools in the country. The implicit assumption is that all's well (or at least almost well) with private schools. In this research study, an attempt has been made to verify that assumption. And instead of looking at private schools in general (which come in a wide variety), an attempt has been made to measure how well students are learning in the 'top' English medium schools (as per public perception) in 5 metros - Mumbai, Kolkata, New Delhi, Chennai and Bangalore.

Over 32,000 students of classes 4, 6 and 8 participated in this study. An analysis of their performance suggests that even in our 'top' schools, students are not learning well and with understanding. Schools seem to be laying disproportionate emphasis on rote and procedural learning and not surprisingly, students tend to be strong in those. To a certain extent this is good - for one, it builds habits of rigour and hard work. But when it starts replacing original thinking and creativity, over-reliance on rote can be extremely counter-productive. This is happening, and we need to be alarmed.

DESIGN OF THE STUDY

An expert panel of educationists and principals guided the survey. About 200 people from different walks of life were surveyed in each metro to identify the best schools in the country. Based on their responses, a list of 50 top schools was drawn for each city. These schools were then invited to participate in the study. Students of classes 4, 6 and 8 of each school were tested for their learning achievement with a special test tailored to their age and ability. The test tried to measure how well students of these classes *understand* the key concepts in English, Mathematics and Science. Apart from the multiple-choice questions, students were also required to write a small paragraph or essay, which would help study their writing competencies.

A *secondary study* was also conducted to understand the progression of learning achievement across the classes. In this study, a *common test* was administered to students of classes 4, 6 and 8, to gather insights on the retention and development of knowledge, as students move to higher classes. Additionally, about 25% of the questions in this paper were taken from an international assessment study (the Trends in International Maths and Science Studies - TIMSS, *http://www.timss.org*) for which performance data of students from over 40 countries is available.

TEST ADMINISTRATION AND DATA ANALYSIS

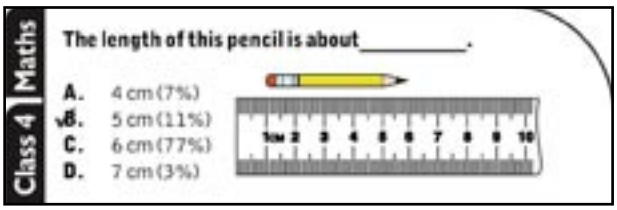
About 32,000 students from 142 schools participated in the tests which were conducted between February and April 2006. Trained invigilators from Educational Initiatives supervised every test. The participation ranged from 23 schools in Kolkata to 37 schools in Chennai. Some background information on issues like class size, fees and school facilities were also collected through a questionnaire from the participating schools to look for any influence of these factors on student achievement. 89 out of the 142 schools filled and returned the background questionnaire.

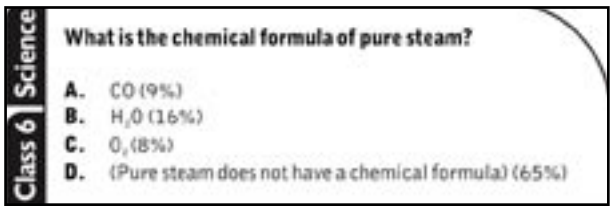
THE FINDINGS

The results do not present a happy picture of the state of student learning even in the 'top' schools of the metros. Students seem to be learning mechanically, and are able to answer questions based on recall or standard procedures quite well. However, their performance on questions testing understanding or application is far below what we consider to be acceptable levels.

The student performance suggests that they are unable to tackle questions that appear to be a little different from what they typically find in textbooks or in the class. Their ability to apply what they have learnt to new, unfamiliar problems - so important in today's world - is not very high.

The results also show that students tend to slot learning into artificial compartments. They may learn something, but are able to answer it only in the same context, in which the learning first occurred. They





Students seem to falter when questions are asked in even a slightly unfamiliar form. The question on the left suggests that practical competencies like measurement are not being developed well. In the question on the right students know the formula of water and about physical and chemical changes but are unable to link the two facts. (Figures in brackets indicate the percentage of students who chose that option.)

may be using an aspect of what they have learnt in their day-to-day lives, but be completely unaware of that connection. Another finding is that students tend to be weak in certain real-life competencies like practical measurements and problem solving, which can and should be developed through the formal school curriculum.

Many of these findings were corroborated through the secondary study in which learning levels across classes were compared. While learning clearly improved from class 4 to 6 to 8, a number of students seem to be learning class 3 and 4 concepts only around class 6 or later.

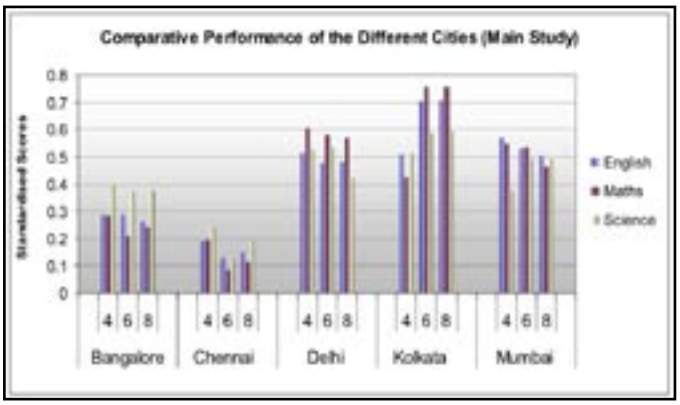


Exhibit 1 *- Surprisingly, a statistically significant difference was found in the performance of students in the different cities.*

A number of specific misconceptions in English, Mathematics and Science were also identified, and these are illustrated with a large number of examples in the detailed report.

COMPARATIVE ANALYSIS

One of the most significant findings of the study was the poor performance of the students compared with the average performance of students from 43 countries. Across the sample of 11 questions in Maths and Science, our class 4 students performed *below international average on all of them* (***Exhibit 2).***

A comparative analysis of the performance of the 5 metros again threw up a surprise. It was found that the performance of the cities fell into two categories, with Kolkata, Mumbai and Delhi clearly outperforming Bangalore and Chennai (***Exhibit 1).*** It was also found that schools affiliated to the CISCE (ICSE) board out-performed the CBSE board which in turn out-performed the state boards.

Boys outperformed girls by a margin that was statistically significant in Mathematics (in all classes) and Science in class 8. In Mathematics, the gap widens even more among better-performing students and in the case of difficult questions. We believe that these differences are not because boys are inherently better in Mathematics than girls, but due to social messages encouraging boys to do better in Mathematics and probably discouraging girls.

As stated earlier the exhibit 2 shows that the average performance of the student in the metro schools was below the international average on all the common questions taken from the TIMSS.

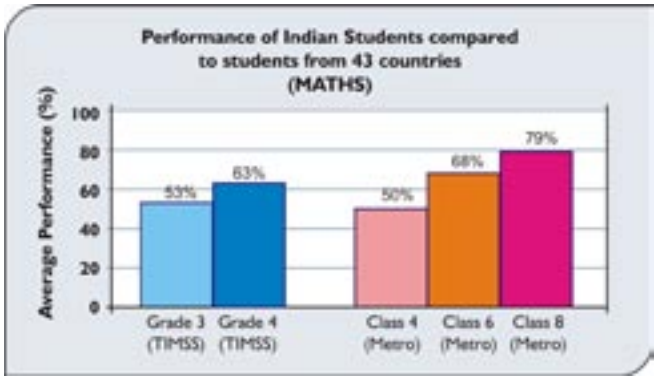


Exhibit 2 *- Some of the questions used in the study were taken from TIMSS, an international study across 43 countries. TIMSS tested students of classes 3 and 4, while students of 4, 6 and 8 were tested in this study. As the graph shows, students representing the 'top' schools of our metros scored lower than the international average.*

None of the factors like class size or school facilities seemed to be strongly and clearly correlated to the student performances in the tests. Our hypothesis is that the teaching-learning processes and the quality of leadership play an important part in determining the effectiveness of student learning.

NEXT STEPS

All the data, including the question papers and detailed analysis will be made available in the public domain. This should allow the issue of quality of learning to be more widely debated on a foundation of hard data, rather than subjective "opinions". It is planned to expand this study to more cities in the coming year, and also enhance the study in other ways. It seems clear that it is in our power to improve the quality of learning in our schools, but that will happen only if we choose to make that commitment to the next generation, by way of focusing on real learning. The current focus on valuing high scores in the board exams or fancy facilities in our schools is unlikely to take us far, as far as real learning is concerned. Our tests should be such that they measure real learning.

Many of the questions asked in the study test understanding of concepts covered in textbooks and classrooms of a lower class. Of course, the questions are of a form that are slightly different from what is typically done in the class. In many such questions, it was found that basic understanding seemed to be weak among a significant proportion of the students.

Textbook case study - 1

A non-zero decimal number lies between two whole numbers.

The concept of non-zero decimal fractions is treated in a fair amount of detail in classes 4 and 5 of different states. Excerpts from 3 textbooks are presented here.

What the textbooks of classes 4 & 5 says...

Board	Class	What's in the textbook
NCERT	Class 5 *Page 96,* *Example 1,*	Example 1: Write the following decimals in the place value table: 27.45, 9.07, 76.305 Solution: The given decimals can be written in the place value table as shown below: Hundreds (100) | Tens (10) | Ones (1) | Tenths (1/10) | Hundredths (1/100) | Thousandths (1/1000) 27.45 → 2 | 7 | 4 | 5 9.07 → 9 | 0 | 7 76.305 → 7 | 6 | 3 | 0 | 5
Maharashtra state board	'Decimals' Class 4 *Page 67, section 3,* *'Decimal fractions'* Class 5 *Page 35,* *sum number 4.5.14*	In a fill-up, "As you go from left to right, the place value of each digit ____ part of its place value in the preceding place." Arrange the following decimals in the ascending and descending order: (i) 3.700, 3.701, 5.731, 7.214, 4.120 (ii) 4.125, 4.205, 4.025, 4.502
Karnataka state board	Class 4 *Page 31,* *'The place value of decimal digits'*	For the number 754.32, the value of each place is described. i.e. place value of 7 is 700, 5 is 50, 2 is 23 is 3/10 and so on.

We asked Class 6...

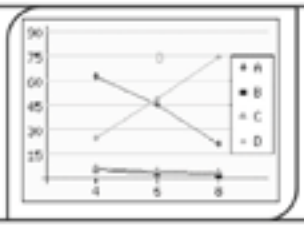
...Which number is closest to '423.1'.

Class 4 & 6

Maths

Which of these numbers is ALMOST equal to 423.1?

	Class 4	Class 6	Class 8
A. 4231	61.5%	44.3%	20.6%
B. 4.23	5.0%	2.4%	1.8%
C. 42.3	5.3%	4.1%	3.1%
✓ D. 423	24.4%	48%	73.5%



Option A (the most incorrect option in the sense that 4231 is the farthest from 423.1!) is chosen by a signficant percentage of class 4 and 6 students! They are probably misguided by the fact that 4231 has all the digits of the original number in the same order. Students simply seem to ignore the decimal point. Even in class 8, a fourth of the students answer wrongly.

Contents

Contents

Appendices

Design of the Study

1.1 NEED FOR THE STUDY

Mainstream public discourse on education seems to assume that poor quality is an issue largely confined to government schooling[1]. But how well are students in our 'top' schools learning? In order to try and understand this, Educational Initiatives (EI) and Wipro Ltd. conducted a research study in the 5 metros – Mumbai, Kolkata, Chennai, Delhi and Bangalore.

These 'top' schools in our largest cities arguably represent the best education that is available in the country. These schools are likely to be the least constrained for different types of resources. Facilities like libraries, computers, playgrounds as well as access to resources (being located in the metros) are the best in the country.

Partly for these reasons, these schools, in general, are the most coveted among parents and serve as role models to other schools. Often they are the thought leaders and their ideas and practices set the tone for others. It is therefore interesting to study how these 'role models' are faring.

Since 2001, Educational Initiatives (EI) has been engaged in the task of measuring learning in school students. While EI works with a large number of students in rural and municipal schools also, EI's work with students of urban English medium schools has provided the foundation for this study. Over 2.5 lakh students of classes 3 to 12 have taken a test called ASSET which EI conducts. These tests provide a unique snapshot of what students understand, and what their misconceptions are. However, ASSET is a paid test and thus the schools or students who write ASSET are a self-selected group. Only a systematically sampled group can help reach any conclusion about the state of student learning. That was attempted in this study.

A clarification: Many of the terms being used here – like *learning*, *quality* and even the reference to *'top' schools* – are complex and potentially controversial. This study is based on the notion that true learning is much more than rote learning; rather, the abilities to apply learning, think originally and solve unfamiliar problems, for example, are more effective measures of 'true learning'[2] Similarly, the term 'top' schools always refers to a set of schools identified through a clearly defined process, and does not represent a value judgement of any kind.

1.2 SALIENT FEATURES OF THE STUDY

Expert Panel: A group of eminent educationists and school principals formed an expert panel that oversaw and was consulted on various aspects of the study.

Selection of Top English Medium Schools: The 'top' 40 schools were identified through a popular survey in each metro and invited to participate in the study.

Specially Assembled Test Paper: Students of classes 4, 6 and 8 from these schools were assessed through a test. The test consisted of objective, multiple-choice questions in English, Mathematics, and Science as well as a writing task. The questions were carefully selected from a pool of ASSET items which have already been extensively tested with thousands of students.

A Secondary Study: A 'Secondary Study on Progress in Student Learning' (henceforth referred to as simply the *secondary study*) was also conducted to help understand how student learning develops across classes. Some questions from an international test, the TIMSS[3], were also included in this to provide a comparison with the performance of international students.

A Writing Task: All students were administered a writing test, where they had to write a paragraph, story or report. This revealed insights about the writing competencies of students in these top schools.

Completely Invigilated Tests: All the tests were invigilated by EI representatives, to ensure that the processes were standardised and possibilities of copying or collusion were minimised.

Background Questionnaires: The test papers given to the students include 4 questions seeking information about student preferences and interests. School principals were also asked to fill a questionnaire seeking information about the school and its facilities.

Analysis: Different types of analysis were carried out on the collected data to extract patterns in performances and to understand differences in learning levels across different groups. Advanced statistical methods and Item Response Theory were used to confirm patterns. Analysis was also done to check if copying had occurred.

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[1] *This assumption is visible in public debates on reservations in private schools or even the voucher system. See http://www.deccanherald.com/deccanherald/mar042004/edu1.asp or http://www.financialexpress.com/fe_full_story.php?content_id=108443 for example.*

[2] *A counter view, sometimes expressed, is that good rote learning is a good foundation for building 'learning with understanding' after that, and that this strategy has worked for thousands of Indian students till today. This is discussed briefly in Section 3. Similarly, it is sometimes argued that aspects like teacher quality, school facilities, classroom processes and even the nature of power relationships in schools must be measured if quality is sought to be measured. This is true. However, if student learning is seen as a key outcome of education, it is justified to be used as a surrogate.*

[3] *The* Trends in International Maths and Science Studies, *http://www.timss.org*

1.3 HOW THE STUDY WAS CARRIED OUT

The 'top' 40-50 schools in the 5 metros were identified based on popular perception. Test papers were specially assembled for classes 4, 6 and 8 with class appropriate questions in English, Maths and Science for the main study. For the secondary study, a *common test paper* (pitched mainly at the class 4-5 level) was prepared for these classes. Both tests also had specially developed English writing tasks. The questions for both the study papers were drawn mostly from past ASSET papers, based on known difficulty and discrimination values. Some questions were taken from questions released from the TIMSS tests. In all about 32,000 students of classes 4, 6 and 8 from 142 schools took these tests.

1.3.1 Selection of Schools

It was intended that two approaches would be used to identify the top English medium schools of each metro. Firstly, the list of top-performing schools in the Board Exams would be drawn up; and secondly, a popular survey would be conducted in each city. However, it was found that Boards provide, at most, details of the pass percentage of schools: none of them release the *average Board exam performance* of schools. In the absence of this data the selection of the schools was done purely on popular perception.

A survey of about 200 people was conducted in each of the cities. The survey was conducted by an EI representative in each city who served as the city coordinator for the project.

For the survey, 20 people were interviewed in each of these categories in each city:

1. housewives
2. school teachers
3. college teachers
4. school students
5. college students
6. scientists and research scholars
7. professionals - engineers, architects, doctors, etc.
8. artists - artists, writers, painters, beauticians
9. journalists (print and electronic)
10. government officials

Each person was asked to name what he or she considered to be the *5 leading schools* in the city, though not in any particular order. The responses were systematically noted and the frequency of naming was calculated for each school.

For each person called or met, the name, phone number and area of residence were noted. The phone numbers were used to make random verifications. In Delhi, for example, the entire exercise was redone by a different team after the verification exercise indicated an error rate of over 20%.

Two criteria were used while selecting the people – 1) areas from geographically different parts of the city were selected and 2) not more than 3 people from each category were to be from any one geographical area. Similarly, not more than 3 people were to be from any one school, institution, company or organisation. In Kolkata the survey yielded much fewer schools than in other cities; in Chennai, the number of areas was fewer than in the other cities – in both these cases, about 30 more people were surveyed.

Some people were unable to name 5 schools; this reduced the total number of responses. The data required a fair amount of cleaning: for example, some people named specific branches (like DPS RK Puram), while others named a school group (DPS). Many people were unaware of specific branches and occasionally wrong branches were also named[4].

The total number of schools named in each city varied from 86 in Kolkata to almost 201 in Bangalore.

1.3.2 Expert Panel

A panel of experts consisting of principals, educationists subject specialists and assessment experts from various parts of the country guided the entire project. Their inputs were sought on the overall design of the study as well as the design of the test papers, though not on the actual choice of questions. Expert panel members also provided a lot of ground level help – for example in obtaining school lists and securing permissions from specific schools. The list of the expert panel members appears in Appendix A.

1.3.3 Inviting Schools to Participate

The target was to test up to 40 schools from the list of 'top' schools of each city. Invitations were sent to the top 40, and as some schools refused, others down the list were invited. The invitation letter was signed by Educational Initiatives and Wipro and mentioned the purpose of the study, its research nature, the details of the expert panel, and also clarified that no fees were applicable and that the results of individual schools would remain confidential. The letter appears in Appendix B.

Challenges Faced: The tests were conducted between February 20th and April 25th, 2006. Schools were busy for a substantial part of this time with final exams and (in some cases) holidays, though the actual dates differed regionally. In cities where the students had already been promoted to the next class, the test was conducted for students of the higher class – 5th, 7th and 9th. Many schools – especially those that were Board centres – had genuine problems but the long window allowed most schools to choose a convenient date. Some schools initially agreed but dropped out at the last minute due to changes in their time table, or other unavoidable or unplanned circumstances (e.g. elections in Kolkata). But, some schools

[4] *Where a specific branch was named by a substantial number of people, it was kept that way. In other cases, the list was consolidated, and the oldest or best-known school of that group was selected.*

	Bangalore	Chennai	Delhi	Kolkata	Mumbai	TOTAL
Schools tested	26	37	24	23	32	142
Students tested (Main study)	3286	4738	2814	2555	3845	17238
Students tested (Secondary Study)	2996	4424	2610	2529	3889	16448

***Table 1**: The number of schools and students who took the tests in the different cities. (For some analysis, not all the schools were considered as is explained in the appropriate places.)*

Affiliation Boards	Schools		Students	
Central Board of Secondary Education (CBSE)	57	40.1%	12807	38.0%
Council for the Indian School Certificate Examination (CISCE)	46	32.4%	10256	30.4%
Matriculation Board (Tamil Nadu)	17	12.0%	4609	13.7%
Maharashtra State Board	13	9.2%	3930	11.7%
Karnataka State Board	7	4.9%	1922	5.7%
West Bengal State Board	1	0.7%	131	0.4%
IGCSE ('Cambridge')	1	0.7%	31	0.1%
Total	142	100%	33686	100%

***Table 2**: The number of schools and students who participated, boardwise.*

were very inaccessible (literally or metaphorically) and refused to participate without citing any reason.

The number of students actually tested city-wise and board-wise are shown in Tables 1 and 2.[5]

1.3.4 Administration of the Test

Every school that agreed to participate was asked to select 2 sections (or 3 sections if the number of students per section was less than 35) from each of classes 4, 6 and 8. Schools were specifically requested not to break sections or select particular students. If they had sections grouped by ability, average ability sections were to be selected. Later analysis suggests that schools have stuck to these criteria.[6] Also invigilators did not report any cases where students seemed to have been rearranged for the sake of the test.

Although the plan was to test 3 sections from a school, some schools agreed to participate only if all their students could write the test! In such cases the additional sections were given the Secondary Study paper, with students being asked to mark the answer in the question booklet itself. These extra papers were thus not used in the analysis.

Invigilation: *All the tests were monitored by invigilators selected by Educational Initiatives.* About 35-40 invigilators were selected in each city to supervise the tests. One invigilator was present in each classroom during the testing. A city coordinator supervised all the testing for a city.

Invigilators were given instructions on what they were to tell the class at the start of the test – although they were not given a script. A check list of tasks to be done before, during and after the tests was also given to each of the city coordinators.[7] City coordinators conducted training sessions for groups of invigilators before the tests. In the training sessions, the aim of the study as well as the processes of distribution of the papers, collection of the test papers and answer sheets and storage and despatch of the papers were discussed. The test booklets were colour-coded and students had to mark their answers on OMR (Optical Mark Recognition) sheets.

Invigilators were given strict instructions not to help students with any questions. If students sought clarifications they were to ask them to 'read the questions carefully as they were self explanatory, and in case something was still unclear, to move on to the next question.' A school information form was used to keep track of the number of test papers, answer sheets and essay sheets that were used per school.

Question booklets were colour-coded and OMR answer sheets were used.

[5] *Please refer to Appendix H for more details on the number of schools that were used for different types of analysis.*

[6] *An ability section is likely to be characterised by a high ave*

[7] *Appendix C has copies of all the formats used in the study*

Only one part of the test, i.e. the writing task (essay) sheet was to be answered on the question booklet (all other answers were recorded on the OMR sheet). Since these sheets were to be separated, students were also asked to write their name, class and the answer (OMR) sheet number on the essay response sheet in the place provided for the purpose.

Question papers and answer sheets: For each class (4,6 and 8) participating in the main study, there were 2 distinct sets of papers[8]. The invigilators were instructed to distribute the sets ensuring that *adjacent students (column-wise) got different paper codes*. For the Secondary Study, there was one common paper for all the 3 classes.

Each OMR sheet (answer sheet) was numbered. Students were given time to practice using the OMR sheets if required before the start of the test. Partly due to this, there were few instances of students having problems with the answer sheets.

At the end of the test all question papers and answer sheets were collected and counted. It was important to ensure that no question paper remained on the premises or was copied as the test dates were different across schools. City co-ordinators maintained records of the number of question papers sent to each school and verified it with the number of question papers returned. In spite of these precautions, one incident was reported where one question paper was missing in a school.

1.3.5 Background Questionnaire

A background questionnaire was prepared to seek details from the school like the number of teachers and facilities available. Appendix F has a copy of the questionnaire. This questionnaire was personally administered except in cases where schools said that they would fill it themselves. Out of the 142 schools to whom the questionnaire was given, 89 filled and returned them.

1.3.6 Handling of Question Booklets and Answer Sheets

As mentioned, both question booklets and answer sheets were counted and collected after each test and the details updated in the 'School Details Form'. A copy can be found in Appendix D. The answer sheets were packed and sent to the EI office in Ahmedabad where the OMR scanning and analysis were done.

For the essay sheets, city coordinators detached the sheet containing the essays, packed them and shipped them to Ahmedabad. The remaining parts of the papers were destroyed after the tests were completed. 2 essay sheets from the secondary study papers were randomly selected from each class and school and these approximately 750 papers were scored and analysed.

1.3.7 Analysis

The analysis was geared to answer basic questions like:

- *How well are students learning in these schools?*
- *Are students learning concepts in the same class that they are taught them in or later?*
- *Approximately how much time do students take to internalize a concept?*
- *How well-developed are students' writing and expression competencies?*
- *Is the performance of any city better (or worse) than the others?*
- *Do students of a particular board do better than those of other boards?*
- *Where do students of these schools stand compared to their international counterparts?*
- *Is there a difference between the performance of boys and girls?*

The primary analysis involved looking at averages and standard deviations at the level of school, city, class, subject and overall. For comparative analysis (between cities, genders, Indian and international averages) performance scores for each category were calculated and the appropriate statistical test (t-test or a z-test) was employed to check for statistical significance between the differences.

Following this, detailed analysis was performed at the question level. Individual questions were studied as were questions on certain subjects areas or competencies. For instance, how do students do questions on estimation? Do they do better on questions which are 'straightforward'? To go deeper into interesting patterns, Item Response Theory (IRT) was employed and special computers programs were written. This helped get a lot of in-depth information even on factors like which students (high performing or low performing) were choosing which options on specific questions, or on how learning was increasing from lower to higher classes.

The analysis of the writing task which provided insights into student proficiency in written English, proceeded parallely, and the analysis process is described in chapter 2.3.

Though the papers were developed carefully balancing various competencies (as described in the next section), a competency-wise analysis was consciously avoided. A minimum of 3 questions were included per competency, however, it was felt that this was insufficient to reach a conclusion about student learning competency-wise.

Finally, the information collected through the background questionnaire was analysed in two ways. For certain parameters - like the number of schools that have football grounds - simple counts and percentages were calculated. For certain other parameters correlations were calculated with student perrformance to check if these factors influenced overall learning.

[8] *Such papers are sometimes referred to as 'rotated papers'. The reasons for the use of rotated papers is discussed in section 1.4.*

[9] *Item Response Theory (IRT) is the study of test and item (question) scores based on assumptions concerning the mathematical relationship between abilities (or other hypothesized traits) and responses to items. IRT analysis provides information about how students of different 'abilities' have answered a question. As discussed later, this can provide usvvteful insights into how students are learning.*

Class	Paper code	English	Maths	Science	Total questions	Writing Task	Duration (minutes)
4	401	23	16	16	60	Yes	75
	402	23	16	16	60		75
6	601	30	20	20	75	Yes	105
	602	30	20	20	75		105
8	801	35	25	25	90	Yes	135
	802	35	25	25	90		135

***Table 3**: An overview of the papers, number of questions and duration of the tests of the 'main study'.*

Classes	Papercode	Maths	Science	English	Duration (minutes)
4, 6 and 8	603	22	20	writing task	60

***Table 4**: An overview of the details of the 'secondary study' papers.*

1.4 QUESTION PAPER DESIGN

The question papers were designed to test competencies in English, Maths and Science that students should have developed by the respective classes. Each paper had multiple-choice questions and a free response language item.

In the Main Study, a rotated paper design was used – that is, two papers were developed which *together* covered all the competencies. However, the entire paper would have been too long for any student - so each student answers, in effect, half of a paper. A few questions were kept common between the papers, so that the performance in those questions could be used to calibrate the difficulty level of the two papers.

It is often a challenge when designing such tests to calibrate them accurately - both the overall difficulty of the test (pitched at 55%-60%[10] in this case) as well as the difficulty levels of individual questions which should range from easy to difficult. Since this test was assembled using past ASSET questions that have previously been tested on over 3000-8000 students, the difficulty level of each question was accurately known beforehand.

As mentioned earlier, the test sought to assess students' understanding and ability to apply what they had learnt. The questions were *not* based simply on the ability to recall information or use formulae or procedures, as most school exams are.

The specific competencies tested in English, Maths and Science are outlined in the following section. In addition in Science, it was also important to ensure that a range of concepts from the different subject areas were tested.

The questions of the secondary study - a common paper for classes 4, 6 and 8 - were pitched mostly at the class 5 level, although a few of the questions were of classes 4 and 6 also. A few questions were taken from the TIMSS papers of class 3-4 in order to compare the performance of the students with their peers in other countries. The English section contained only a writing task, common for all classes.

The details of the main study and secondary study question papers are shown in Tables 3 and 4. A complete set of question papers are available for download at **http://www.ei-india.com/projects/metrostudy**

1.4.1 Competencies Tested

Each question was assigned a specific competency and there were 3-5 questions per competency. The subject-wise competency and the key content areas are described below. Appendix E has the complete list of competencies tested.

Language: English is the medium of instruction for the relevant student group. Language is a means of communication, learning, advanced expression and appreciation - it also defines one's identity and is a vehicle of culture. The test papers assess 5 competencies that focus on various aspects of reading and comprehension. The competencies are the across classes, but aspects like the level of vocabulary and complexity of the reading passages increase from class 4 to 8. The writing task is designed to gauge the quality of expression, felicity with the language and knowledge of correct usage by students.

Mathematics: According to the NCERT's National Curriculum Framework 2005, "developing students's abilities for mathematisation is the main goal of mathematics education. Maths should help develop the child's resources to think and reason mathematically, to pursue assumptions to their logical conclusion and to handle abstraction." The key areas in primary and middle school Maths - numbers and operations, fractions, decimals, ratios, percentages, measurement and estimation, data interpretation, algebra, geometry and problem solving are covered.

[10] *As per convention, a 'difficulty level' of 60% means that 60% of students answer* correctly. *In other words, a question with a difficulty level of 90% is a very easy question.*

Science: In Science, mastery of content (topics like density or the chemical reactions or photosynthesis), as well as competencies (like observation and classification) are important to develop a scientific temperament. For example, the competency of classification is used with different content in Biology, Physics and Chemistry. Hence, the items in science were balanced both with respect to content and competencies. 4 basic competencies tested were recalling known facts, understanding/applying, analyzing/reasoning and designing/ generating. The content covered the environmental sciences, physics, chemistry, biology and the earth sciences. Since the relative percentage for these components is not standardised in India, standards documents of various countries and the frameworks of tests like the PISA and the TIMSS were referred to to finalise the percentage break-ups for classes 4, 6 and 8.

The types of questions used in the test are illustrated with some examples in the next section.

1.4.2 Types of Questions used in the Tests

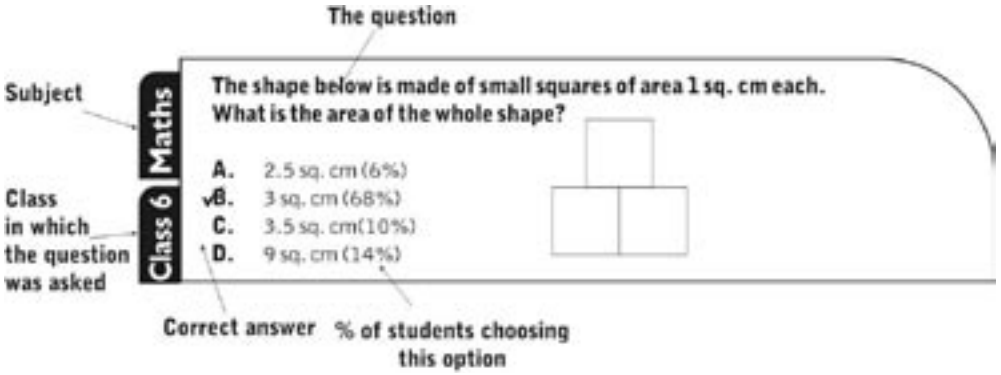
As discussed, the questions try to check if students have understood and internalised concepts. They do *not* simply test 'general intelligence' (or IQ). A student who has properly understood all that has been taught in school would actually find the test quite easy. The box below shows how the questions and graphs used in this document are to be read.

Sample Question 1, for example checks whether students of class 6 have really understood what the degree measure of an angle means, and what constitutes a 'bigger' angle.

The correct answer is B. (Students who choose C think that a bigger angle is one whose arms are bigger, which is wrong. It is possible that students who chose any answer other than B have not hproperly understood the concept of an angle.)

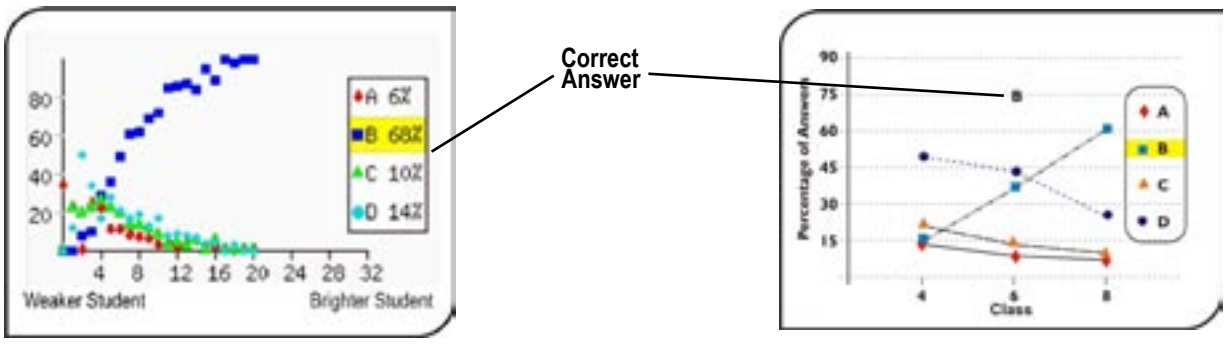
Understanding Question Examples

In order to give the reader an actual feel of how students have performed in the tests, almost 50 examples of actual questions are given in this report. Most questions are accompanied by detailed performance data, which provides a glimpse into what students found easy or difficult and even how they think.



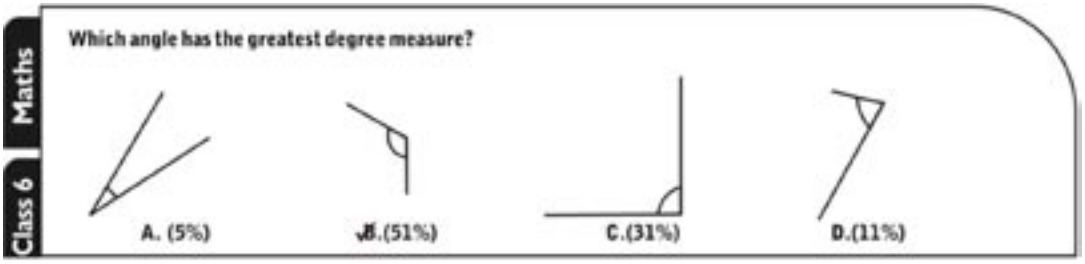
The details of the questions are presented in this manner:

Two kinds of graphs may appear with each question. The first graph maps how students ranging from the 'weak' to the 'bright' (based purely on their total score in the paper) have answered that question. Thus, the horizontal axis represents 'weaker' students on the left and 'brighter' students on the right. The vertical axis represents the percentage of students who selected different options. For example changing a vertical line not a value of 8 on the horizontal axis. In the graph on the left, for example, weaker students have preferred option B, but brighter students clearly move towards option B - the correct answer.

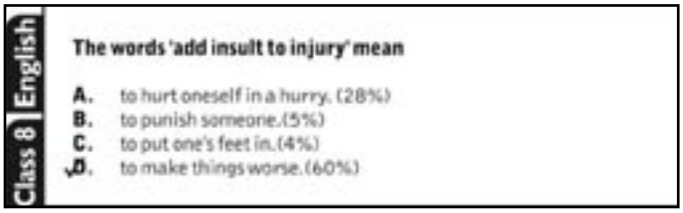


The second graph may appear for some questions that were a part of the secondary study. It shows the performance on the same question by students of classes 4, 6 and 8 - including the percentage who chose each option - and provides a glimpse into how the learning develops with age. *(Note: The two graphs shown here do not correspond to the question shown above)*

Sample Question 1 *- Many students do not understand that a 'bigger angle' is not simply one with bigger arms. That is sought to be checked by this question.*

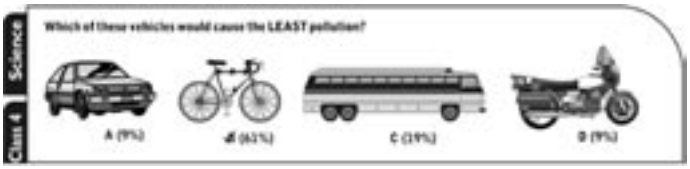


The language questions seek to test students's comfort with English in day to day usage. The question below checks if students of class 8 are familiar with the expression 'to add insult to injury'.



Sample Question 2 *- A common expression*

As far as possible, the questions try to bring out the practical relevance of the concept involved. In traditional tests, students are often expected to remember trivia that can be easily retrieved from a reference source and is often completely irrelevant. The question below checks if class 4 students are aware of non-polluting vehicles.

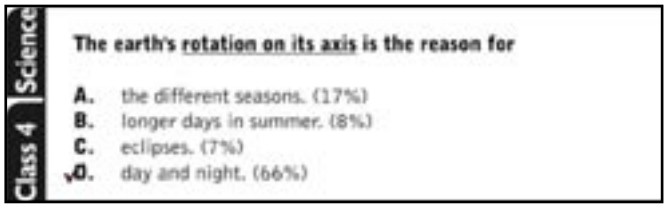


Sample Question 3 *- Polluting vehicles*

'Straightforward' Questions: It is sometimes argued that while students may not be learning with proper understanding, they can do extremely well on question types they are familiar with. In order to check this, the test also contained some questions which can be best described as 'typical', 'textbookish' or 'straightforward'. Here are two examples, one each from Maths and Science.

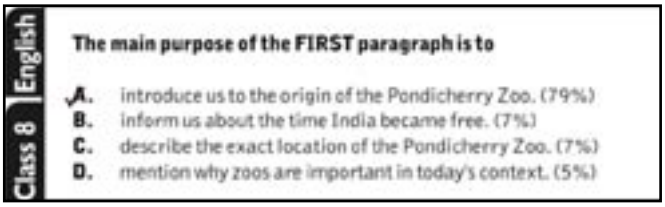
Sample Question 4 *- Simple addition*

While the above question is a simple addition, the one below tests a fact that is emphasised repeatedly in both textbooks and school tests.



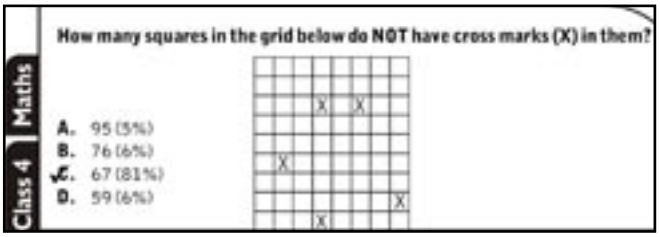
Sample Question 5 *- The earth's rotation*

Passage Questions: Most questions in the English papers test comprehension and are based on 'unseen' passages. This question from class 8 follows a passage on Pondicherry Zoo and tests a child's ability to gain an overall understanding of the passage and determine its theme.



Sample Question 6 *- Purpose of a passage*

An attempt was made to add 'fun' or puzzle-type questions that are based on a concept taught in class. In the question below, for example, there is a 'brute-force' (count the squares without crosses) as well as a 'cleverer' method (multiply and subtract the number of crosses) of finding the answer - with the latter requiring the student to spend much less time on the question!



Sample Question 7 *- A puzzle-type question*

Finally, it should be mentioned that trick questions, as well as questions that sought to deliberately confuse or mislead students were scrupulously avoided.

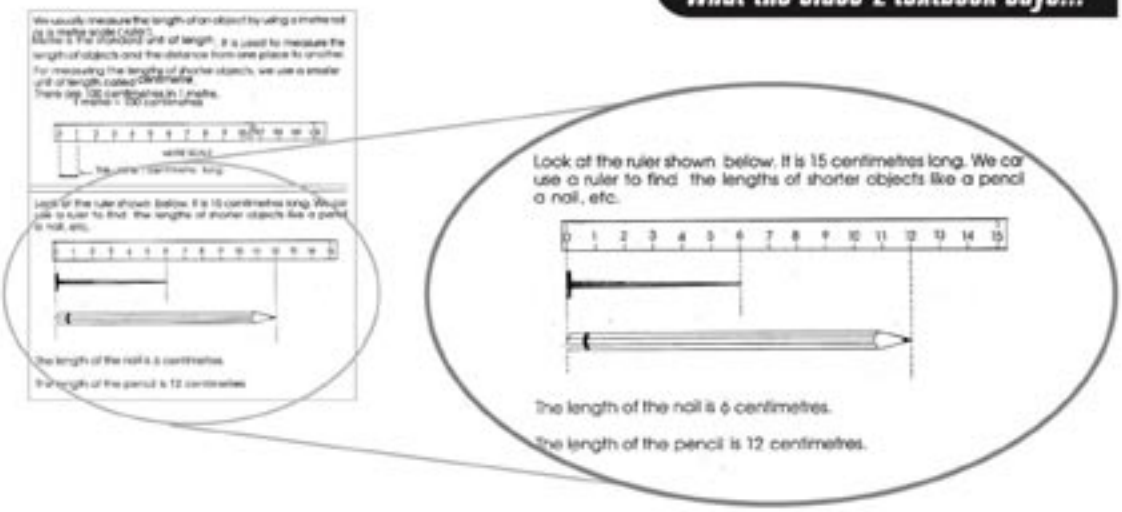
To summarise, the questions aim to be relevant, to relate to the topics taught in school and to test whether the student has truly understood, or has only gained superficial knowledge.

Textbook case study - 2

Measuring length of objects with a ruler is a hands on skill.

The NCERT mathematics textbook of class 2 carefully shows how the length of an object can be measured with a scale. However, we see that a lot of students having trouble measuring the length of an object correctly even at classes 4 or 6.

What the class 2 textbook says...



Source: NCERT, class 2 page 178, 'Measures of Length'

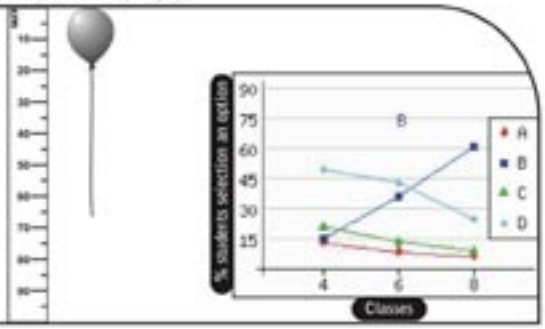
We asked students in Class 4,6 & 8 ...

... various questions involving practical measurement. Here is one example:

Class 4,6 & 8 | Maths

How many centimetres of string is hanging below the balloon?

A. about 20 cm
✓B. about 45 cm
C. about 60 cm
D. about 65 cm



It looks like a majority of children (49% in class 4, 42% in class 6, 25% in class 8) are learning measurement mechanically and choose option D. When measurement does not start from zero, as is in this question, they do not see a need to subtract the starting point from the final one (in our case, 65 - 20 = 45 cm).

2.1 HOW WELL ARE OUR CHILDREN LEARNING?

Over 32,000 students of classes 4, 6 and 8 participated in this study. An analysis of their performance suggests that even in our 'top' schools, students are not learning well and with understanding. Schools seem to be laying disproportionate emphasis on rote and procedural learning and not surprisingly, students tend to be strong in those. To a certain extent this is good - for one, it builds habits of rigour and hard work. But when it starts replacing original thinking and creativity, over-reliance on rote can be extremely counter-productive. This is happening, and we need to be alarmed.

The overall learnings are discussed below:

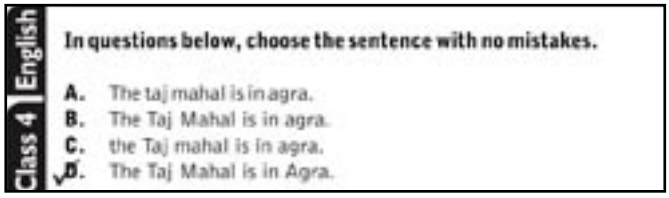
1. ***Students across classes answer rote-based or procedural questions relatively well. The flip side of this, however, is that students seem to rely on memory or learnt procedures to answer almost all questions, rather than trying to think through and solve the unfamiliar ones.***

The term 'rote-based questions' is used here in a slightly broad sense to refer to questions that are either typical, straight-from-the-textbook, very simple, or a question type that is normally practised a lot.

Students clearly do better in questions like these. For example, 81% of class 4 students correctly divided 72 by 6[11].

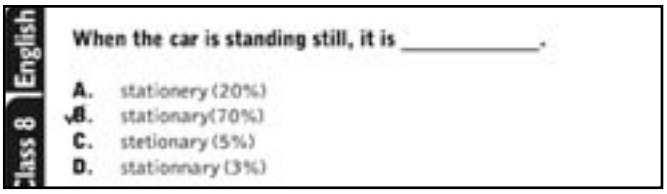
Sample Question 8 *- Simple division*

A similar example from language is a question requiring the sentence with the correct punctuation to be chosen. Grammar rules tend to be emphasised and tested a lot in our system, hence this is considered a typical 'rote' question and answered correctly by 80% of students.



Sample Question 9 *- A punctuation question*

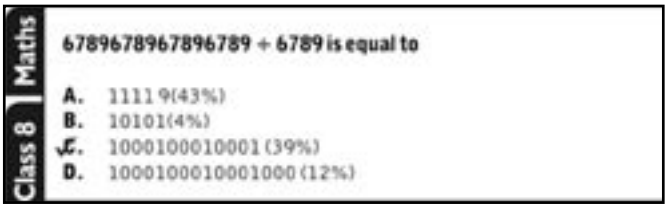
Though it would be incorrect to say that students are strong in spellings (as is also evidenced from the writing test analysed in section 2.3), some examples do suggest that spellings are being learnt well. 70% of class 8 students spelt *'stationary'* meaning 'standing still' correctly, which, it was felt, was good, since this is considered as error which is common even among adults.



Sample Question 10 *- Correct spelling*

There are benefits of rote learning and the rigour that repeated practice often develops. For example, a student who knows the multiplication tables well may be quicker and more confident in calculations, especially mental calculations. A good memory can significantly aid learning - if basic facts and definitions are clearly committed to memory, they can form a useful base on which further learning can be built. This kind of learning also plays a part in instilling habits of hard work and discipline in students, which will yield positive dividends later.

However, there are two areas of concern. One is that even in certain procedural questions, students are making basic mistakes. The question below, for example, is a division problem, but in a slightly atypical form. Only 39% of class 8 students manage to get this division right - the pattern of wrong answers clearly suggesting that zero digits in the quotient trip up most of the students! So there seem to be gaps even in the procedural learning. (Note that this division question was asked to *class 8* students.)



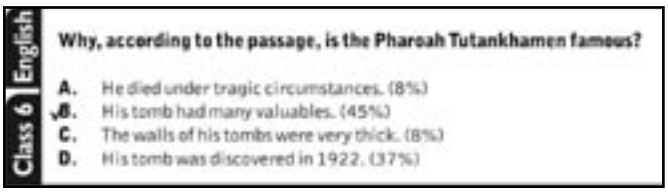
Sample Question 11 *- A division problem*

The second problem is that an over-emphasis on rote learning results in students adopting a single strategy to solve all questions: *try to match any given question with a similar one in memory and follow identical steps*. If they are not able to find this 'matching question' they seem to lose interest and either get nervous or lose the patience to try and solve the question.

[11] Of course it can be argued that 81% of students answering a simple question like this correctly is not so good at all. Experience with tests like these shows that performance rarely exceeds 90% in *any* question. This may probably be due to careless errors. Hence questions answered correctly by over 80% of students seem to reflect the *best relative performance* at any rate.

Sample Questions 12 and 13 from English and Science respectively illustrate this problem. In passage-based questions in English, students are often trained to find *key words from the question* in the passage[12]. If they do not find them, they get stumped.

For the question below, the passage mentions that *"Tutankhamen's tomb was forgotten until Howard Carter discovered it .. (in) 1922.... (The) treasures (in his tomb) made Tutankhamen perhaps the best known of the pharaohs..").*



Sample Question 12 *- A passage-based language question*

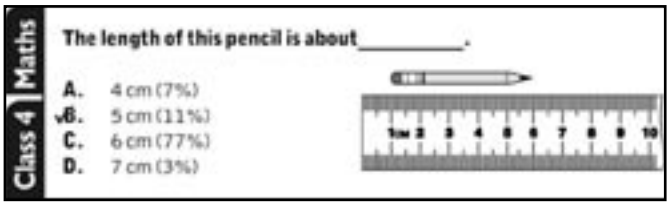
Note that none of the words or phrases in the question appears in exactly the same form in the passage and this seems to throw students off-track. Only 45% students got it right.

Similarly Sample Question 13 below cannot be answered by rote. It presents class 8 students with a new situation. They are told what happens if a solid of *lesser* or *more* density than a liquid is placed in it. They are then asked what would happen if the densities were the same. Only 28% of students were able to make this deduction.

2. ***It appears that many practical competencies, important in real life, are not being developed very well. Students' performance on questions based on measurement, estimation, problem solving, general observation and day-to-day language use is not very good.***

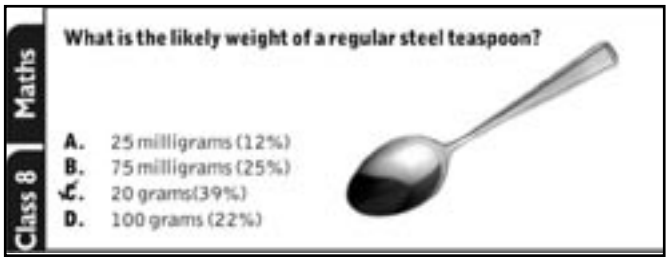
Many competencies - important in real life - do actually form a part of the school curriculum. But probably the way they are taught distances them from the real world - resulting in surprisingly low performances in questions testing these competencies. These include competencies like measurement, correct use of language and problem solving.

Measurement is all about the physical world and can be taught with a number of concrete activities and examples. However, straightforward measurement question like the one below is found to receive a poor response (only 11% students got it right!)



Sample Question 14 *- Measuring length*

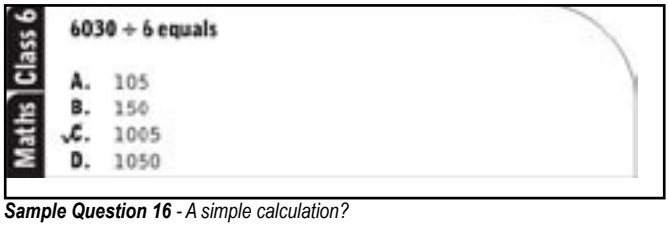
People sometimes think that the above represents a careless mistake. However, the repeatability of this mistake across similar question forms and different student groups shows that it is not. Students have understood that readings have to be read off the scale at the right end, but not that if *the left end is not at the 0 mark, the measurement process has to be different.*



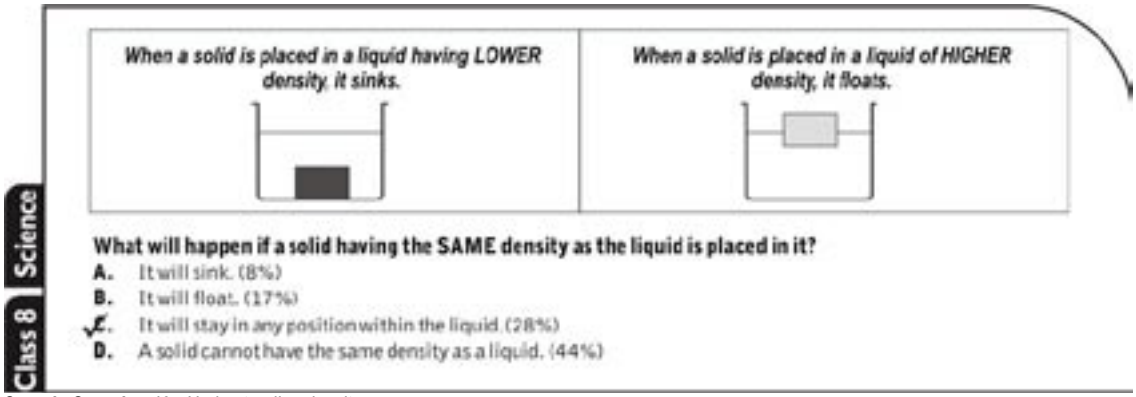
Sample Question 15 *- Estimating weight - a useful practical competency*

A related practical competency is that of estimating weights, lengths, etc. This is a very important competency in real-life and yet students - even in class 8 - are often not aware how much 100 grams or 1 litre actually is.

Another aspect of estimation is numerical estimation. 59% of class 6 students solved 6030÷6 correctly. But 34% of students did not sense that the answer has to be closer to 1000, not 100. Interestingly the percentage who chose these wrong answers (105 or 150) has not reduced between class 4 (not shown here) and class 6.

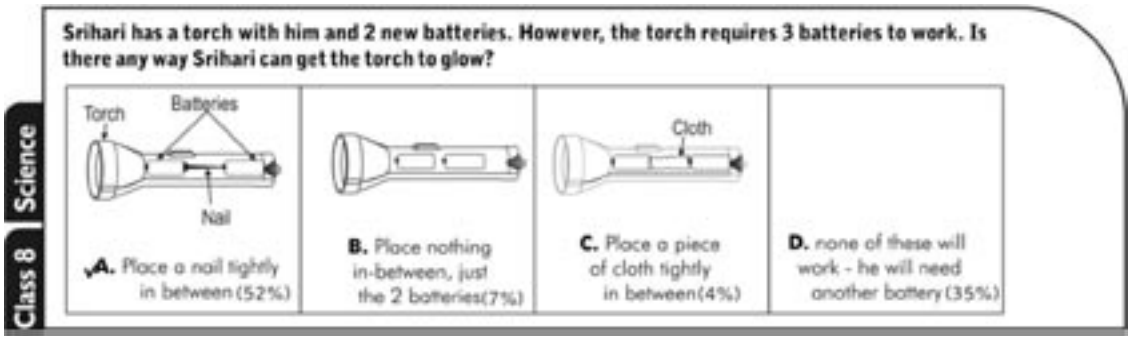


Sample Question 16 *- A simple calculation?*



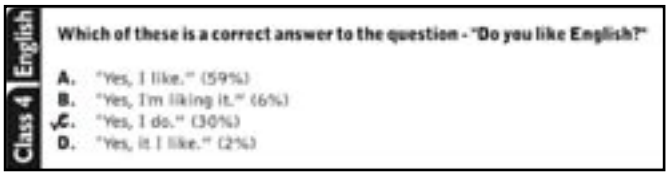
Sample Question 13 *- Understanding density*

[12] Many teachers are unaware that this is a patently incorrect strategy, and continue to teach this as the correct way to solve passage questions. This, in fact, is an example of a typical rote strategy that is used in a situation where the correct approach is to read and understand the passage, understand the question and answer the question on that basis.



Sample Question 18 *- A practical question that tests understanding of electrical conductivity*

In the teaching of language, grammar rules are emphasised a lot in our schools. Yet it is sometimes seen that students do not learn to speak correct English probably due to the way those rules are taught.



Sample Question 17 *- Applying grammar rules in conversation.*

The next example is a practical science question that tests if students have really understood electrical conductivity. See Sample Question 18. To answer it correctly, students should either have remembered the meaning of conductors and that iron nails are conductors; or they should have 'played around' with batteries and torches! About 52% answered this question correctly.

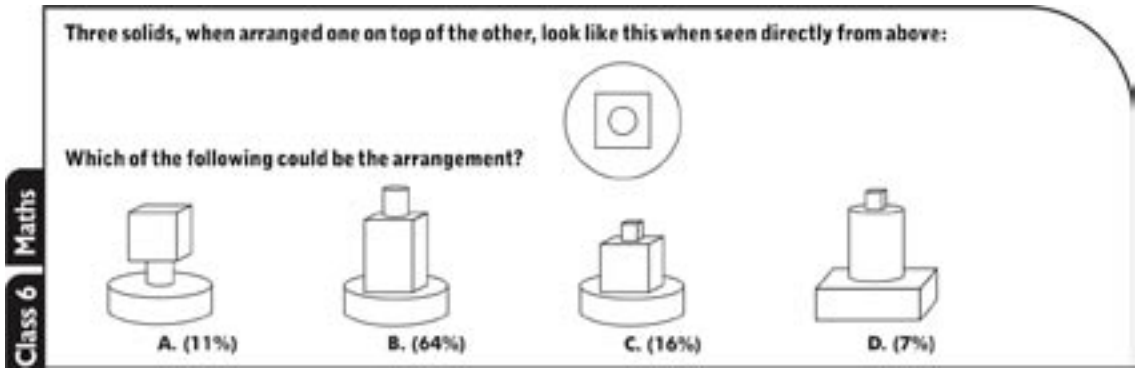
Ironically, students performed well in a question requiring visualisation (Sample Question 19), something which is *not* taught as part of the regular syllabus. This, it was felt, was creditable and suggests that their ability to visualise and deduce are good.

3. ***Instead of acquiring concepts, students seem to be learning to handle a limited number of question types. So when they come across a question similar to one they have 'learnt', they 'jump' to the most familiar answer they find!***

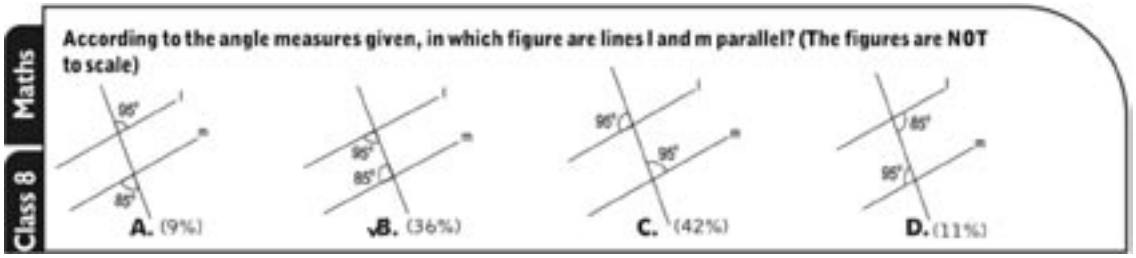
It is not unusual to find students, parents or even teachers sometimes referring to a question that is not in the textbook or from the class discussion as 'out of syllabus', even if the topic of the question is very much a part of the syllabus. Incidents of students memorising essays or proofs of theorems are other manifestations of this thinking.

According to some experts, this is precisely what learning is *not*.[13] If a concept or idea has been learnt, students should be able to answer questions related to it, even when they are posed in an unfamiliar form. Students do not seem to be doing that very well.

Sample Question 20, for example, does not follow the textbook pattern of giving two parallel lines and asking what the angles formed by the transversal will be equal to. Rather it gives the angles and asks which pair of lines would be parallel. Only 36% of class 8 students could correctly answer this question (which is based, incidentally on class 6 content.)

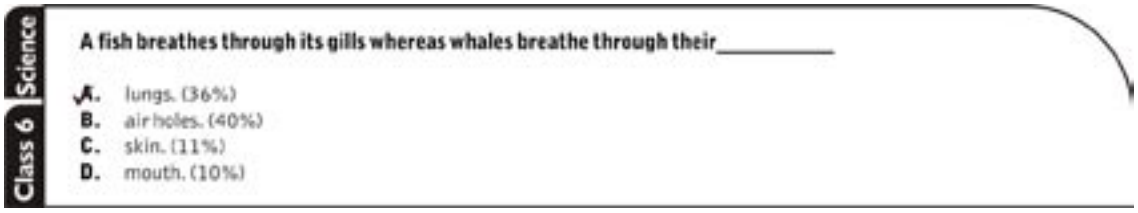


Sample Question 19 *- Relatively good performance on a 3D visualisation question.*



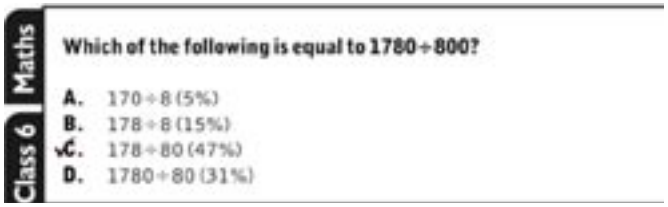
Sample Question 20 - *A slight twist confuses students about parallel lines and transversals.*

[13] John Bransford, for example, says that "a major goal of schooling is to prepare students for flexible adaptation to new problems and settings.", Bransford, Brown and Cocking, ed., *How People Learn: Brain, Mind, Experience and School, 1999*



Sample Question 23 - *Whales breathing*

The next question also represents a familiar concept in a slightly unfamiliar form, and again it confuses class 6 students. 47% got it right, but 31% - that is, almost one-third of students from our top schools - seem to believe that 1780÷800 is the same as 1780÷80. That is worrying!

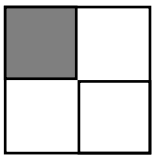


Sample Question 21 *- Another simple (?) division concept*

Consider the following Maths question:

Sample Question 22 *- Understanding fractions*

Only 37% of students answered this correctly, but previous testing experience suggests that if the question had used a square like the one on the right, a much higher proportion of students would have answered it correctly as that is a familiar form.



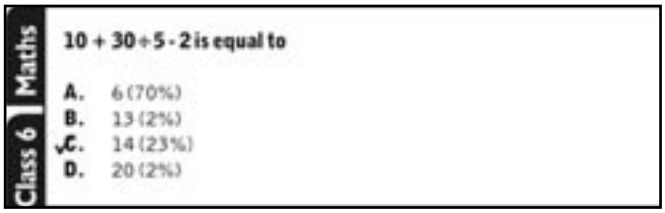
4. Students are learning in 'compartments', i.e. they may be aware of two pieces of information, but often not know how they are related or how that relation works in a real life situation.

Learning is not merely the accumulation of facts. In fact, making connections between learnt facts is far more important. There are different types of connections that should be made, and there appear to be gaps in the extent to which students are able to make them.

Connections between different topics: Students are taught that mammals breathe through lungs. They are also taught that whales are mammals. Though most students are aware of these facts, many are not able to connect these two facts to correctly answer Sample Question 23.

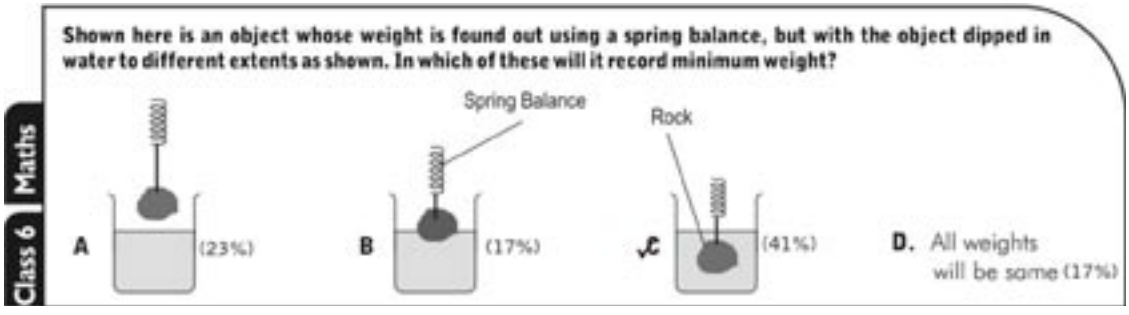
Connections between real life experience and what is being learnt: Students do not seem to be encouraged to use 'real life experience' as an input to solve problems. A barrier appears to exist between what happens in schools, textbooks and tests, on the one hand; and what happens in real life, on the other. The experience that an object (a part of our own body) feels lighter under water can be used to answer the following question, but only 41% answer it correctly (Sample Question 24)

Not connecting different facts under different heads or sub-topics or disciplines: Students learn about the order of arithmetic operations (sometimes called BODMAS) by class 6, however, they do not see it as a universal convention. This convention applies whenever calculations are to be made but the explicit order of the operations is not specified. (It is easy to verify this using computer programs like Excel). Only 23% of class 6 students got Sample Question 25 right, but experience suggests that had the question been *labelled as a 'BODMAS question',* the percentage of students answering it correctly would have been much higher.

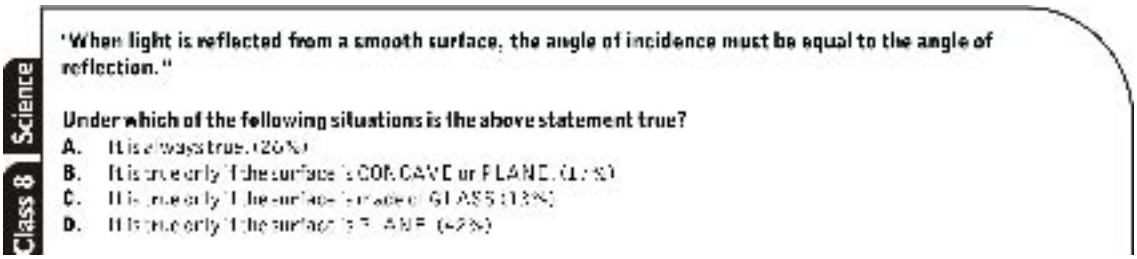


Sample Question 25 *- A BODMAS question*

Seeing the larger picture (getting the central idea): The universality of laws and rules is also often not understood by students. Does the law of reflection (stated in Sample Question 26 below) apply to



Sample Question 24 *- How does an object's weight change when it is immersed in water?*



Sample Question 26 - *Does the law of reflection apply to spherical mirrors?*

all reflection? It does, but students normally learn this law only in the context of plane mirrors, and its applicability with curved mirrors, for example, is not taught or discussed explicitly. Ironically, the ray diagrams for curved mirrors, which students extensively practice with, are based on this very law.

5. ***Apart from problems with learning strategies, a number of specific and clear 'common errors' exist in the different subjects. Since they are widespread, it should not be difficult for textbooks and teachers to specifically address these errors.***

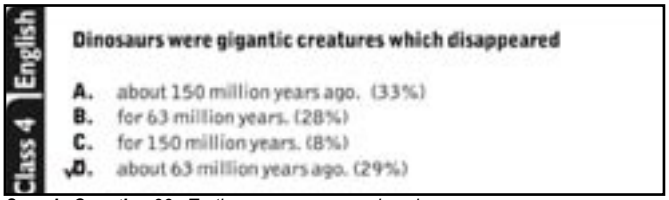
Here are some common errors found in the different subjects.

ENGLISH

A number of basic errors related to spellings and pronunciation were noticed as suggested by Sample Question 27, in which students were asked to identify a word rhyming with 'dawned' in class 8.

Similarly, students chose 'hear' (60%) rather than 'pear' (22%) when asked which word rhymes with 'hair'. They also felt that 'size' rhymes with 'seize', not 'flies'. It is clear that many students are choosing words that are spelt similarly, rather than rhyming words.

Comprehension errors are common in cases where the answer does not appear explicitly in the text. In Sample Question 28, the passage mentions that 'Dinosaurs lived for more than 150 million years and disappeared some 63 million years ago.' Only 29% of students correctly understood this point.

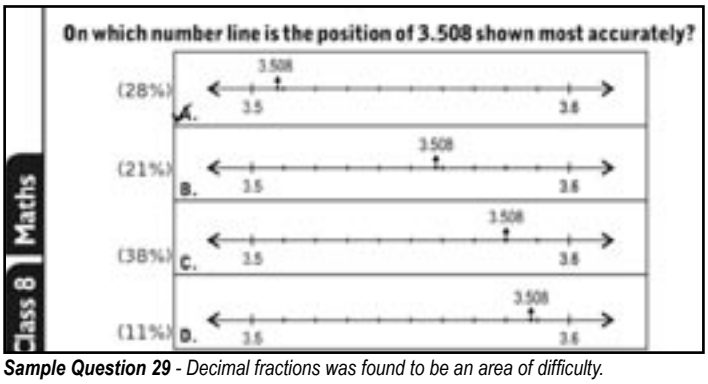


Sample Question 28 *- Testing passage comprehension*

MATHS

Analysis shows that conceptual understanding tends to be weak in certain topics like decimal fractions, concepts like perimeter and general number sense.

Even by class 8, students do not seem to have developed a firm conceptualisation of decimal fractions. See the question below.

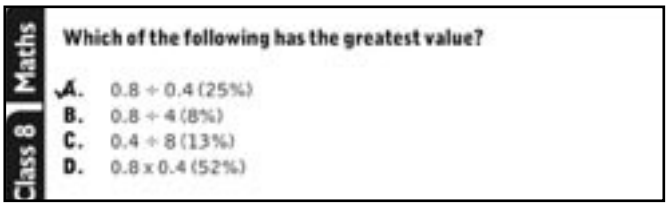


Sample Question 29 *- Decimal fractions was found to be an area of difficulty.*

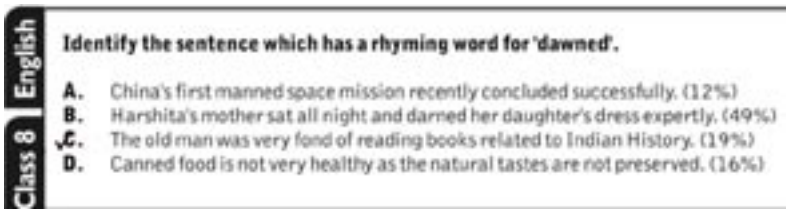
The most popular option is C (representing the number *3.58*) chosen by 38% of the students. Only 28% choose the correct option A. This is particularly surprising among class 8 students.

Similarly, a common misconception is that multiplication must always yield a greater number than division or other operations. Here again, 52% go with this incorrect notion. Actually, dividing by a fractional number results in an answer greater than the dividend.

Students seem shaky with the concepts of area and perimeter. Even



Sample Question 30 *- Can multiplication result is a smaller number than division?*



Sample Question 27 *- A number of common spelling and pronounciation errors were observed.*

Class 8 | Maths

Nandita cut off a square of side 1 cm from a rectangular sheet as shown:

What would be the change in perimeter as compared to the original sheet?

A. It would remain the same (7%)
√B. It would increase by 2 cm (23%)
C. It would decrease by 2 cm (46%)
D. It would decrease by 3 cm (23%)

Sample Question 31 *- Students do not demonstrate a good understanding of the concept of perimeter*

among the two, perimeter seems to be less understood - about 46% of students seem to think that cutting something off will necessarily cause the perimeter to reduce, which is incorrect. (See Sample Question 31)

SCIENCE

Biologically, is Man an animal? A fly? The answer is yes, and it discussed under classification of living things - an important topic. Yet 19% of *class 8* students do not think that Man is an animal and 47% do not think flies are animals. Note that this is in spite of the question (Sample Question 32) specifying that 'all living things are either plants or animals'.

The next example (Sample Question 33) relates to the principle of a rain gauge. The height of the water collected (though not the volume) in any vessel of uniform cross-section in a rain will be the same - that is why rainfall is measured in cm. This kind of question will be answered well if students are required to do simple experiments like collecting rain water and checking what the height of water collected depends on.

This third item, yet another science common error, is also a consequence of students failing to make a 2-step reasoning. Each of these three facts is known to students by this stage:

1. The chemical formula of water is H_2O.
2. Water changing to steam is a physical change
3. Chemical composition does not change in a physical change.

Yet 51% of class 8 students believe that 'steam does not have a chemical formula.'

All these are misconceptions or common errors that can be addressed either at the textbook or the class teacher level, without much difficulty!

Science
Class 8

What is the chemical formula of pure steam?

A. CO (4%)
√B. H_2O (37%)
C. O_2 (6%)
D. (Pure steam does not have a chemical formula) (51%)

Sample Question 34 *- Chemical formulae*

Science
Class 8

All living things can be grouped as PLANTS or ANIMALS. Which of these in the list below are ANIMALS?

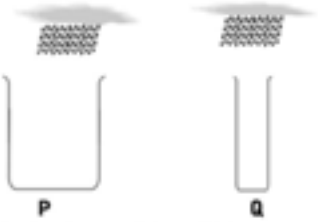
FISH FLY MAN LION GRASS CROCODILE

A. All are animals. (4%)
B. Lion and crocodile are animals.(19%)
C. Lion, man and crocodile are animals. (28%)
√D. Lion, man, crocodile, fly and fish are animals. (49%)

Sample Question 32 *- What is an animal?*

Science
Class 6

Two empty vessels P and Q, as shown in the figures below, are kept outside at 4:00 pm. There was rain from 5:00 pm to 7:00 pm. Water filled up in these vessels, but they did not overflow. The two vessels were observed after the rains.



What can be said about the LEVELS of water in vessels P and Q?

A. The level of the water in vessel P will be more than that in vessel Q. (39%)
B. The level of the water in vessel P will be less than that in vessel Q. (34%)
√C. The level of the water in vessels P and Q will be the same. (16%)
D. Both vessels P and Q will be full. (19%)

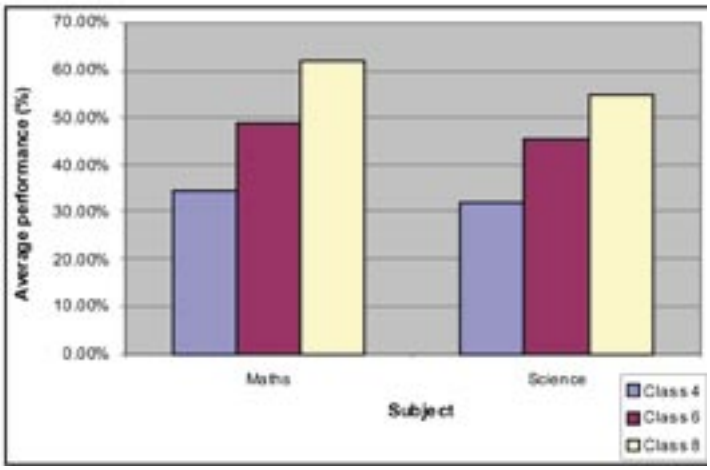
Sample Question 33 *- What happens when it rains?*

2.2 LEARNINGS FROM THE SECONDARY STUDY

An important purpose of this project was to understand the quality of learning in the 'top' schools of the metros. But how does that learning increase from lower to higher classes? Does it always increase or are there concepts where learning drops, for example?

The Secondary Study tried to answer these questions[14]. The same question paper was administered to students of classes 4, 6 and 8. Here is a snapshot of the overall results:

1. ***Student performance does clearly increase across subject and item type from class 4 to 6 to 8. However the nature of increase differs significantly for different types of items.***



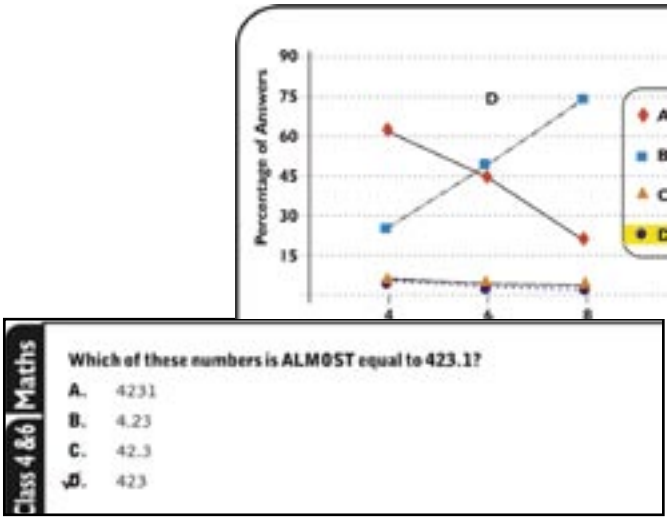
Graph 3 - *As expected, learning improves from class 4 to 6 to 8.*

Since the items tested were mostly of class 4-5 level, the performance was expected to improve between class 4 and 6, reach a fairly high level (like 70-80%) by class 6 and then level off. This, however, has not happened.

In some cases, like Sample Question 25, the increase in learning across classes is high. This is apparent especially from the graph.

The percentage of students who think that 423.1 is closer to 4231 than 423, is much lower in class 8 (21%) than in class 4 (62%), as may be expected.

However, such cases of clear-cut improvement in learning across classes are surprisingly, few and far between. In most cases, even though improvement is there, the percentage of students who answer correctly does not change as dramatically.



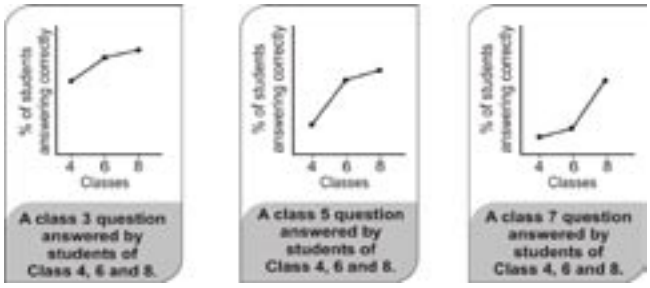
Sample Question 35 *- The graph suggests that many students understand a basic aspect of decimals only by class 8*

In the above example, the graph clearly shows that the improvement is much less for this question compared to the previous one. 38% of class 8 students get the question right, compared to 16% in class 4.

(The above example also shows that even in the case of something that has clearly been taught, *intuition seems to have a stronger hold on student perception*. Students know that humans are warm-blooded; and that the body temperature of warm blooded animals does not change significantly with the outside temperature. They do not really connect these two points to understand how the human body copes with extreme temperatures.)

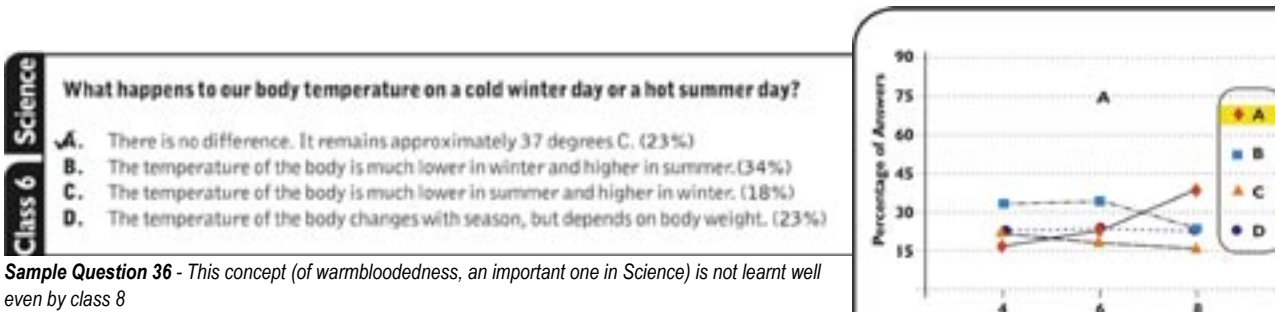
2. ***Concepts which should be learnt in the lower classes actually seem to be understood in much higher classes, and even then not by most students.***

Ideally, if questions based on concepts of classes 3, 5 and 7 were to be asked to students of classes 4, 6 and 8, the following type of response pattern would be expected.



Graph 4: *Expected responses to common questions across classes.*

[14] The design of the secondary study is described in detail in Section 1.

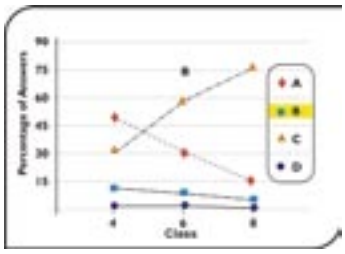


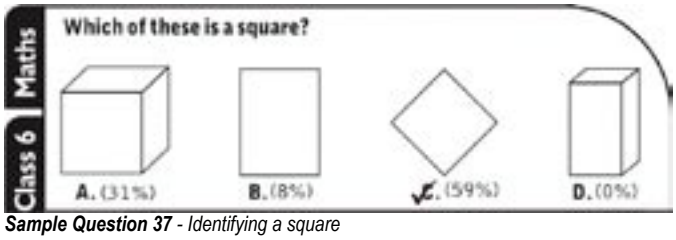
Sample Question 36 *- This concept (of warmbloodedness, an important one in Science) is not learnt well even by class 8*

This is because we expect that class 3 concepts would have been internalized by most of the students by class 4, maybe a few of the remaining students would internalize by it class 6. However, from class 6 to 8, we would not expect too much of an increase, partly because the class 6 percentage it self would be close to 100%. The same reasoning may be extended to the higher classes also.

However, this is not happening in practice. For example, when students were asked to recognise a square (introduced in classes 2 -3) in a rotated orientation, it was found that:

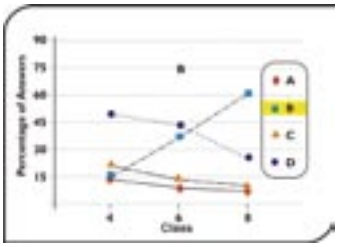
1. the increase from class 6 to 8 is comparable to the increase from class 4 to 6, suggesting that the learning in class 4 is poorer than may be expected.
2. even in class 8, the percentage correct is less than 80% on a basic concept like this.

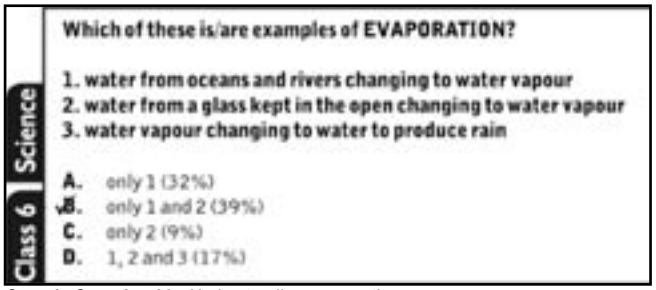




Sample Question 37 *- Identifying a square*

Similarly, what is evaporation? Most students (85% in class 4 and 95% in class 8) are clear that water from oceans changing to vapour is evaporation. But:





Sample Question 38 *- Understanding evaporation*

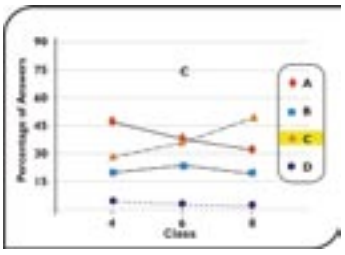
1. Only 26% of class 4 and 53% of class 8 students realise that water in a glass changing in water vapour is also evaporation.
2. 20% of class 4 and 13% of class 8 students think that water vapour condensing to rain is also evaporation

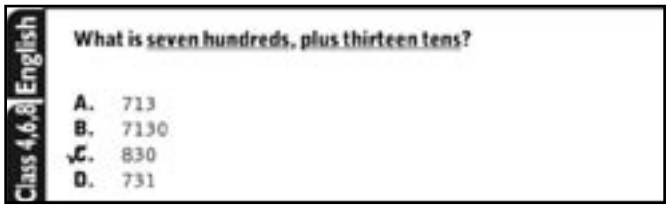
If textbooks and teachers are aware that students think in this way, such errors can be addressed when these topics are being discussed.

3. Many misconceptions that exist in lower classes reduce or disappear by higher classes, but some misconceptions remain, and others even strengthen.

The study suggests that certain groups of students holding specific misconceptions can be clearly identified[15]. It also seems likely that students holding a certain type of misconception continue to hold the same or a variant of it as they advance to higher classes - this can be investigated by studying the student pattern of answers in classes 4, 6 and 8.

Consider this question and the percentage of students solving it correctly in classes 4, 6 and 8.





Sample Question 39 *- Analysis misconceptions in place value across classes*

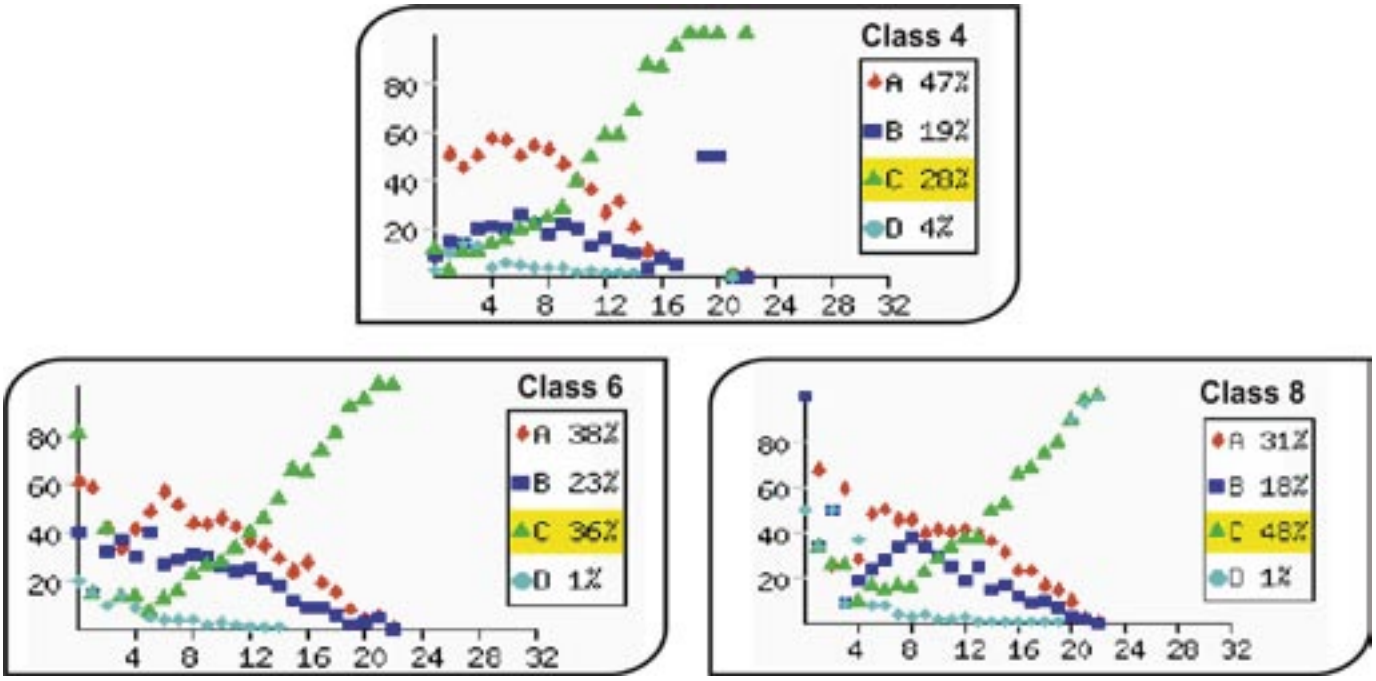
If the percentage of students opting for the different choices in classes 4, 6 and 8 is plotted, we obtain Graph 5 (on the next page.)

These three graphs can be used to analyse which students are choosing which option across classes 4, 6 and 8. This will help identify if misconceptions are reducing:

- *The correct answer to this question is C. 830.*
- *Very few students opt for wrong option D. 731, in any class.*
- *Option A. 713 is the most common answer in class 4[16]. By class 8, however, a significant percentage of students (13%) have*

[15] Interestingly, the percentages of students holding various misconceptions is quite invariant in a large population. This can be shown by studying the percentages of students choosing the different options - these are found to vary by less than 3-4% across different samples of students.

[16] There is a very interesting hypothesis why this happens. Students seem to *ignore parts of questions that they do not understand*. For example, students in class 3, will often fill the blank in 4 x 5 = __ x 10 with 20. Not used to anything other than a blank after the 'equal' sign, they simply ignore the 'x10', and solve 4 x 5 = __. Similarly in the question under discussion, students simply ignore the last word of the question 'tens' and answer it - obviously then choosing option A!



Graph 5 *- These graphs show what percentage of students scoring different total scores chose which options for Sample Question 39 (on the previous page). The X axis is the total score in the paper and the Y axis is the percentage of students. The legend box shows the total percentage of students who chose each option. Note that a significant percentage of low-scoring students choose wrong option A, and this trend does not change even in higher classes!*

moved away from option A (presumably to option C, as can be verified by other means).

- *Wrong option B, interestingly has a consistent following of about one-fifth of students right across the classes. These students understand that 13 tens is 130, but then simply place the 7 (representing hundreds) to its left! It seems likely that students with this misconception are not able to clear this even over 4 years.*

Thus, while some misconceptions do get cleared, others, it appears, do not.

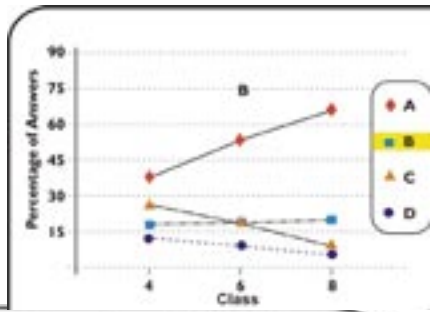
Are there misconceptions that probable strengthen?

Do heavier objects fall faster than lighter ones? If you thought Galileo had settled this question, think again!

In the above example, the misconception that heavier objects fall faster is seen to strengthen up to class 8. In reality, when air resistance is not significant, objects fall at the same rate irrespective of their weights. However, this misconception seems to be widespread among teachers and adults also. Experiments5 can be conducted to clear this misconception.

Such analysis can be useful as it allows a teacher to identify groups of students who are thinking in a similar (wrong) ways, and take appropriate, corrective action.

Sample Question 40 *- Misconceptions persist about heavier objects falling faster. In fact, in student interviews (conducted for another study), students said that a crumpled piece of paper falls faster than an identical uncrumpled sheet, because its weight increases upon crumpling!*



Science
Class 6

A large sheet of paper, a thick book and a heavy iron block are each dropped from a height of about 10 metres. In what order will they reach the ground? (The book is taped, so it does not open while falling.)

A. The iron block, next the thick book, next the sheet of paper. (54%)
√B. The iron block and thick book together, then the sheet of paper. (18%)
C. The sheet of paper first, then the thick book, then the iron block. (18%)
D. The thick book, next the iron block, next the sheet of paper. (6%)

[17] *A video showi.ei-india.com/projects/metrostudy*

2.3 WRITING ABILITIES OF STUDENTS

2.3.1 Introduction

In addition to the objective type items used in the main and secondary studies, a writing task - writing a paragraph, describing a picture/incident or writing a story - was also given to each student. About 32,000 student writing samples were thus obtained. A random sample of these were selected and analysed.

The analysis shows that although students' proficiency in English increases with class, even in class 8 about 80% of students are making mistakes in comprehension, grammar and syntax. It appears that in a large population of students language learning is mechanical, with students often failing to relate a writing task to its real life implications.

The main study had different writing tasks for the different classes. This report is based on an analysis of the writing task in the *secondary study* - in which an identical task was attempted by students of classes 4, 6 and 8.

2.3.2 Testing and Evaluation Procedure

The writing item required students to convert a telephone conversation (see below) into a short message containing the key points. This item was answered by about 14,000 students of classes 4, 6 and 8 from 134[18] schools. From these, 2 answer scripts were randomly selected per class per school. A total of about 750 answer scripts were thus obtained representing all the metro cities involved in the study[19].

A team of 7 evaluators checked these responses. All these evaluators were English teachers at the middle school and high school level. Of the 750 papers, about 425 were rechecked and 100 were checked for a third time to rule out subjectivity and to ensure uniformity in evaluation.

The responses were evaluated on four aspects:
- *whether the task had been understood;*
- *whether key details were covered in the message;*
- *whether the message was free of spelling, grammar, syntax and punctuation errors and*
- *the extent to which the student had used his/her own language as appropriate.*

Aditya is alone at home when his mother's friend, Mrs. Sharma calls. Read the dialogue given below, carefully, and write Aditya's message to his mother in the box provided. The note must contain all the important information of the dialogue and should be about 5-7 lines.

Aditya:	Hello?
Mrs. Sharma:	Hello, is this Aditya? This is Rama Aunty speaking. May I talk to mummy, beta?
Aditya:	Aunty, Mummy is not home. She has gone to pick up some flowers for Dipti Aunty, who is at the hospital. She will return home at 3 p.m. but leave for the hospital at 5 p.m.
Mrs. Sharma:	Oh good! I'm also going to see Dipti. It's 2:45 p.m. now. Aditya, can you tell your mummy to pick me up from the Crossword bookstore on her way to the hospital?
Aditya:	Yes, Aunty.
Mrs. Sharma:	Also, tell her that I'll be carrying some fruits for Dipti Aunty.
Aditya:	Okay.
Mrs. Sharma:	And is she is going to be delayed, tell her to call me on my cell phone. The number is: 9285901500. Please write it down.
Aditya:	Say it again, Aunty.
Mrs. Sharma:	9285901500
Aditya:	I'm repeating the number. Please tell me if it is right. Is it 9285901500?
Mrs. Sharma:	That's right! Okay beta. Bye!
Aditya:	Bye Aunty.

Sample Question 41: *The writing task that was a part of the Secondary Study paper and attempted by students of classes 4, 6 and 8.*

[18] *Out of 142 schools that participated, 134 wrote the secondary study papers.*

[19] *The number 750 is approximate mainly because some schools did not take the test in all 3 classes.*

	Papers evaluated	Non-attempts	Copied Verbatim	Almost error-free response	Completely error-free response
Class 4	236	19	63	5	0
Class 6	250	2	5	12	0
Class 8	264	1	0	20	19

Table 5: *Writing task responses category-wise and class-wise*

2.3.3 Key Observations and Insights

1. ***Almost all the students attempted the question. However, a large number of students of all classes failed to follow instructions and misinterpreted the task. From the nature of the responses, it appears that this may have happened due to carelessness or an incomplete reading of the question.***

Most class 4 students do not seem to have understood what they had to do, which was to report a telephonic message in writing (see Table 5). Many students simply reproduced a part of the question, while other wrote imaginary dialogues or stories, descriptions of the people involved in the telephone conversation or even replied to the caller! (Refer Samples 42 and 43 for samples). Students from classes 6 and 8 seem to have better understood the instructions, yet the number of almost or completely correct messages were still very low as shown in the table.

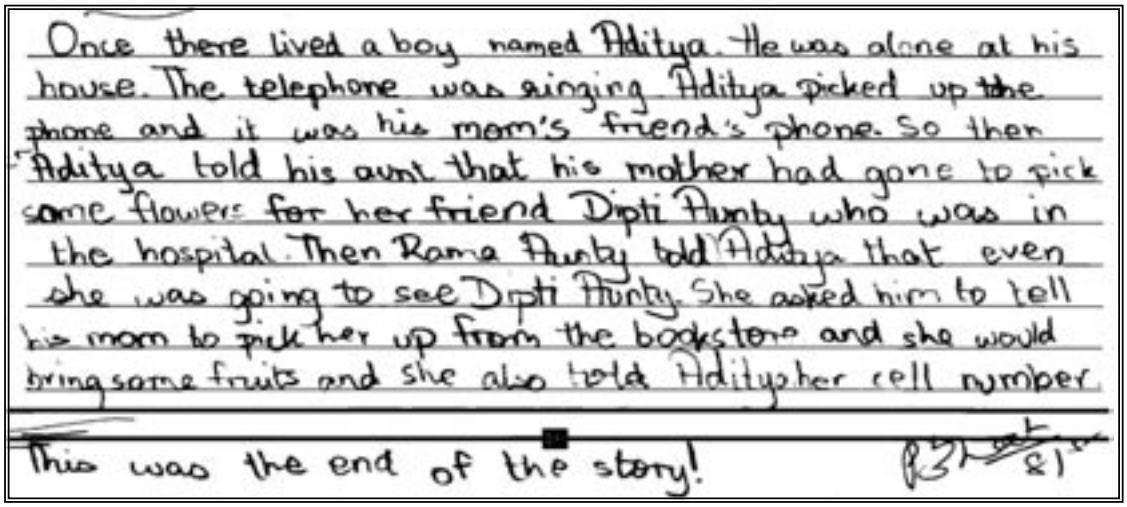
Regardless of the class level, however, nearly all students attempted the question. Only 19 out of 236 students of Class 4 did not answer the question as against 2 in Class 6 and only 1 in Class 8.

2. ***Students seem to be learning language less as something integral and useful to real life, and more as if it were merely a school subject being studied for a test to be passed.***

Very few students included all the critical points that would have to be conveyed for the message to be meaningful in a real life situation. The critical points in this message were:

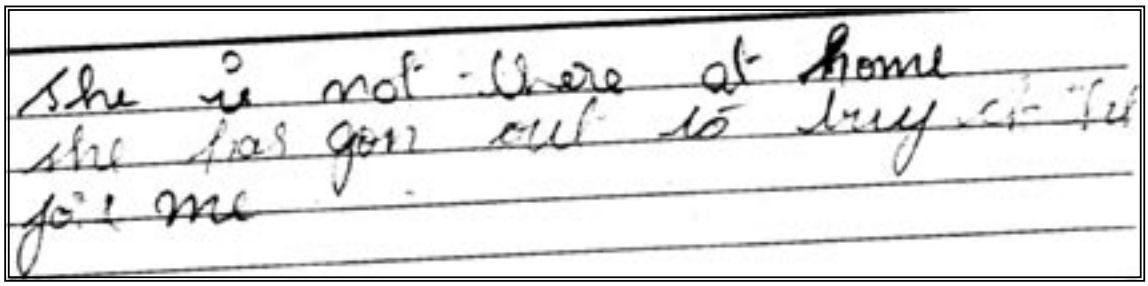
- Who called?
- For whom?
- Time of the call
- Why did the caller call?
- Pick the caller up from where?
- Alternative plan if any
- Contact number
- Information: Mrs. Sharma will be carrying fruits for Dipti Aunty
- Use of the correct names

Interestingly,5 students of class 4 (about 1.5%) did include all these important details (a sample with most important facts included is shown in Sample 44). About 12 students (5%) mentioned them

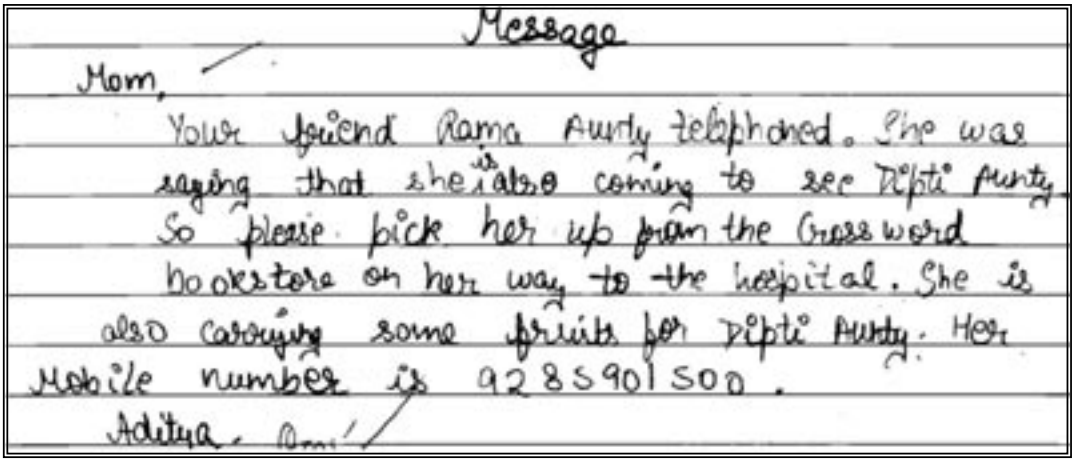

Once there lived a boy named Aditya. He was alone at his house. The telephone was ringing Aditya picked up the phone and it was his mom's friend's phone. So then Aditya told his aunt that his mother had gone to pick some flowers for her friend Dipti Aunty who was in the hospital. Then Rama Aunty told Aditya that even she was going to see Dipti Aunty. She asked him to tell his mom to pick her up from the bookstore and she would bring some fruits and she also told Aditya her cell number.

This was the end of the story!

Sample 42: *Some students wrote stories where they had to report a telephonic message*


She is not there at home she has gone out to buy it for me

Sample 43: *Some answers like the above were replies to the telephone message*



Message

Mom,

Your friend Rama Aunty telephoned. She was saying that she is also coming to see Dipti Aunty. So please pick her up from the Crossword bookstore on her way to the hospital. She is also carrying some fruits for Dipti Aunty. Her Mobile number is 9285901500.

Aditya. Am.

Sample 44: *A near-perfect response of a class 4 student.*

all in Class 6 students. None of these students however wrote an otherwise error-free message. It is only in class 8 students that about 15% (39 students) mentioned all the details. However, for Class 8 level, this performance leaves much to be desired.

A large number of students weren't able to decide which facts were important and which were not and reported inconsequential details instead of important information. For example the message that the friend had to be picked up, was missed in many answer! Hence it appears that students may be learning language mechanically and as a subject, rather than as a tool for purposeful communication.

3. Use of own language and expressions – a sign of facility in the language – is very low even in class 8

It is probably a little unfair to expect clear and fluent expression and use of own words in class 4. However, that would be a fair expectation from students of classes 6 and 8 of English medium schools.

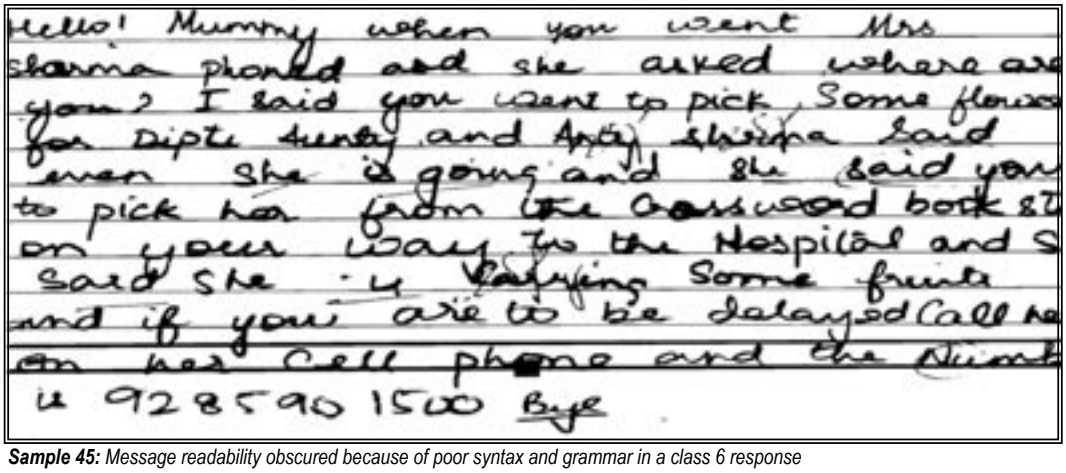
But even in class 6, it was found that students either did not try to use their own expressions, or those who did, made a number of syntax and grammar errors! Only in class 8 was it found that among those who answered in an appropriate manner, many could play around with the language relatively easily. These few students used apt and clear messages covering the key points succinctly.

4. There are a clear set of common mistakes - in grammar, spelling and syntax usage – that students are making across class levels.

Students make mistakes in choosing appropriate prepositions, articles, tenses and punctuation, across classes. Pronouns were often mixed up in Classes 6 and 8. 'she' was used for 'her' – (she mother) and 'his' was used for 'her' in about 50% of the papers in Class 4! Surprisingly the students of Class 4 made much fewer errors in spellings than their counterparts in Classes 6 and 8, probably because students were copying more from the passage in class 4

Class	Spelling errors	Grammar Errors	Errors in Syntax and Punctuation
4	*carring* for *carrying*, *gowing* for *going*, *sum* for *some*.	**Incorrect expressions:** *say the aunty, said you, asked that, Aditya said his mother* **Incorrect use of tenses:** *is been carrying*, *has went*	Ignoring the capitalization of proper nouns Errors in sentence formation and punctuation: *the rama aunty telephone coming in the home*
6	*minites* for *minutes*, *carring* for *carrying*	**Incorrect expressions**: *said you, not in the home* **Incorrect use of tenses:** *has went, is been carrying fruits, was come, calls to our house*	**Error in sentence formation** *aunty told to pick near shop* **Improper use of the capitals and apostrophe** *dipti aunty, crossword* *Aunties phone number is…*
8	*carring* for *carrying*, *receive* for *receive*, *aunti* / *anti* for *aunty*, *meat* for *meet*, *greatful* for *grateful*	**Incorrect expressions** *asked to me, rang of the phone, the Dipti Aunty* **Incorrect use of tenses:** *if you going be delayed*	**Ignoring the capitalization of proper nouns** dipti aunty, crossword bookstore, mrs sharma **Unnecessary speech marks in the text of the messages.**

Table 6: *Common errors in spelling, syntax, grammar and punctuation across class 4, 6 and 8*


Hello! Mummy when you went Mrs
Sharma phoned and she asked where are
you? I said you went to pick Some flowe
for Dipti Aunty and Ajay Shisha said
even She is going and She said you
to pick her from the Oakwood book st
on your way to the Hospital and S
said She is Carrying Some fruits
and if you are to be delayed Call me
on her Cell phone and the Numb
is 9285901500 Bye

Sample 45: *Message readability obscured because of poor syntax and grammar in a class 6 response*

(though its prominent presence in the passage did not prevent 'aunti' from figuring in the list of commonly misspelt words!). Table 6 has a list of the common errors in the different classes and Samples 45 and 46 provides an example.

2.3.4 Some Recommendations

1. Students must be encouraged to convey oral messages in short and simple sentences from the earliest classes. Day to day, real life situations should be used, and this should be extended to written messages gradually in higher classes.

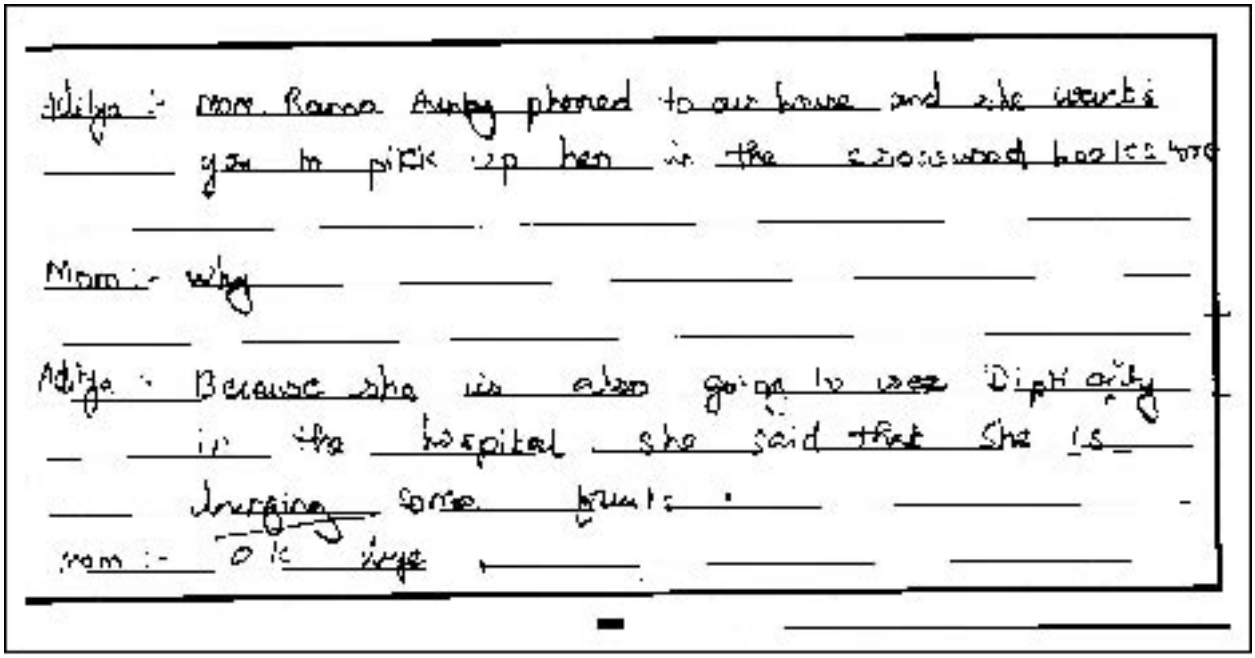
2. Some of the expression mistakes seem to occur due to students translating from another language. Eg.: 'then also' is incorrect in English, though '*phir bhi*' is correct in Hindi, 'told to me' (*'mujhe bataya'*), 'her mother' ('*uski ma*') instead of 'his mother', etc. Students should be exposed to reading and understanding as many unseen passages as possible in the form of authentic material. These could include advertisements, film posters, brochures, labels, interviews and reports from magazines and newspapers and factual passages. Regular reading of passages, short stories, magazines and the daily newspaper would familiarize students with contextual vocabulary, different sentence constructions and figurative expressions, conducive to creative writing.

3. Frequent use of the dictionary, using new words learnt in different situations and playing games like Scrabble and Pictionary help strengthen vocabulary.

2.3.5 Limitations of the Writing Task Analysis

1. An identical writing task was administered to all classes - though the nature of the writing task was probably slightly more appropriate for classes 6 and 8. Of course the task was a simple, real life one that any child may have to face in real-life .

2. The insights on student proficiency come from analyses of only one type of writing task. Other writing tasks were a part of the main study - their analysis is beyond the scope of this report.


Aditya :- Mom Rama Aunty phoned to our house and she wants
you to pick up her in the Oakwood book store
Mom :- why
Aditya :- Because she is also going to see Dipti aunty
in the hospital she said that She is
Carrying some fruits
Mom :- Ok Aditya

Sample 46: A *message written as a dialogue*

2.4 SCHOOL FACTORS AFFFECTING PERFORMANCE

Some background information - like the average class size, the number of hours of instruction per week, the number of working days per week and whether the school has laboratories for Maths, science and language - was sought from each participating school through a questionnaire developed for the purpose. A copy of the questionnaire is available in Appendix F.

The data collected is useful in two important ways. One, it provides information on some important parameters among the 'top' schools in our metros. Second, it provides a basis to investigate if there are any background factors that seems to correlate strongly with the quality of student learning. If any correlations are indicated, these could become the basis of future studies that investigate them further.

There are two caveats, however. The first is that the primary focus of this study was to provide a measure or a snapshot of the learning. The correlations, if any, are a subsidiary part of this research. This was consciously done due to a belief that a detailed understanding of a situation can help different players - teachers, parents, students and society in general - to start taking appropriate steps to improve the quality of learning. The second caveat is that correlations, even if found, may not be *causal factors*. To take a hypothetical example, it may be found that schools with higher levels of learning emphasise project work. From this it cannot be concluded that emphasising on project work leads to good learning. In other words, *what causes what* is a far more complex question, that *what is correlated to what*.

89 schools out of a total of 142 schools filled the questionnaire. Of these 89, about 50 provided complete information asked in the questionnaire - some schools, for example, refused to share their fee levels.

1. Some interesting data about the 'top schools' of the metros

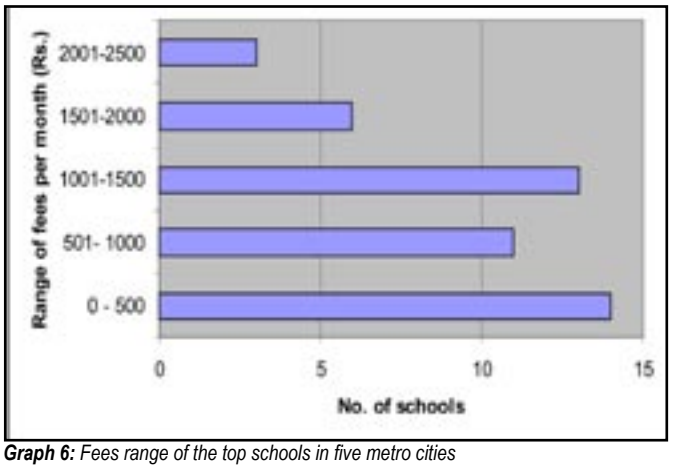
Interesting data on various aspects was collected. A snapshot is presented below:

Of the 89 schools, number of schools that say they	Number
share space	8
have a library	88
have a collection of more than 1000 books	88
added more than 500 books to their collection last year	88
have internet connectivity in all class rooms	6
have a football ground or cricket pitch	54
have tennis courts	20
have a gymnasium	18
have a swimming pool	13
have horse-riding facilities	5
provide air-conditioned classes	7

Table 7: *Facilities available in the schools*

Interestingly, 6% of these schools say they have horse riding facilities, 7% provide internet access in the classroom and 8% have air-conditioned classrooms. 23% of schools have tennis courts but just over 60% have facilities for team games like football or cricket which can be played by more students at a time. 9% of students work multiple shifts; almost every school claims to have a well-equipped, regularly-updated library.

Schools were also asked what their monthly tuition fees were. This was the range of answers obtained:



Graph 6: *Fees range of the top schools in five metro cities*

2. Student performance correlation with a few parameters

We checked if any of the following factors correlated with the overall student performance in the tests:

- *average class strength*
- *co-education vs. mix-sex schools,*
- *average number of hours the student received instruction in school per week,*
- *number of days the school functions in a week.*

Only a very weak negative correlation was observed with the class strength (correlation coefficient = -0.238). No other factors correlated significantly with the average performance of the schools/ classes. However, drawing negative conclusions about the effects of these factors (co-education/ number of hours of instruction etc.) on student learning is not advisable, for the numbers of responses on questionnaires was limited. A more detailed multiple regression analysis is being planned for the future.

2.5 COMPARISON WITH INTERNATIONAL BENCHMARKS

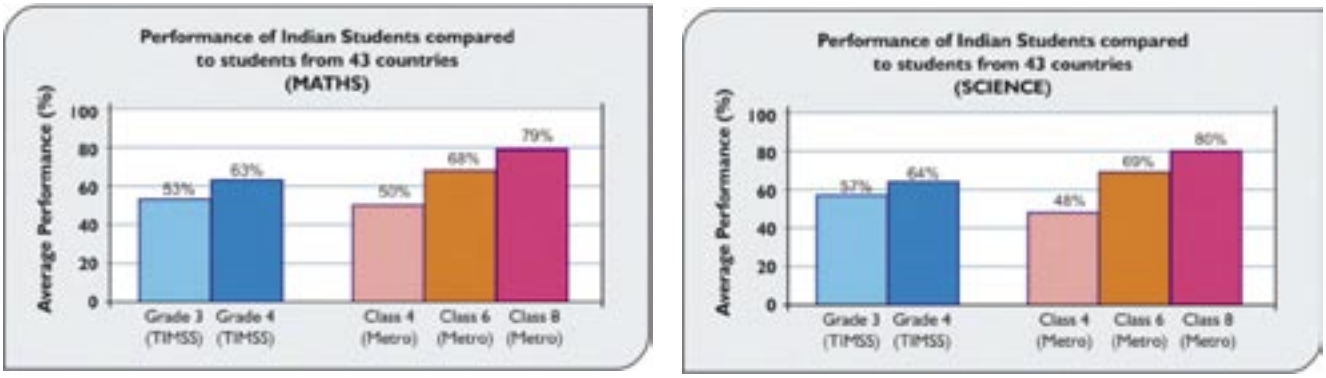
How are the students in the 'top' schools of our metros performing compared to their peers in other countries? To find this out, some questions from an international assessment which was conducted in over 40 countries were included in the paper used for the secondary study. Since the performance of students internationally on these questions was known, a comparative picture could be obtained.

The study from which these questions were taken is the TIMSS (Trends in International Mathematics and Science Study) – an international research project of high repute. These tests are conducted every 4 years, and some of the questions are publicly released along with their performance data. 11 items from the TIMSS test of 1995 were selected, 7 in Maths and 4 in science, and combined with 31 other items to form the secondary study paper. These 11 TIMSS questions were pitched at the grades 3 and 4 levels. About 11,000[20] students from over 40 countries have taken these tests. These questions were mostly used with no modification, except that 1. names were changed to Indian names and 2. from some questions that had 5 options, the least probable option was removed to make them fit the format of the questions of this study.

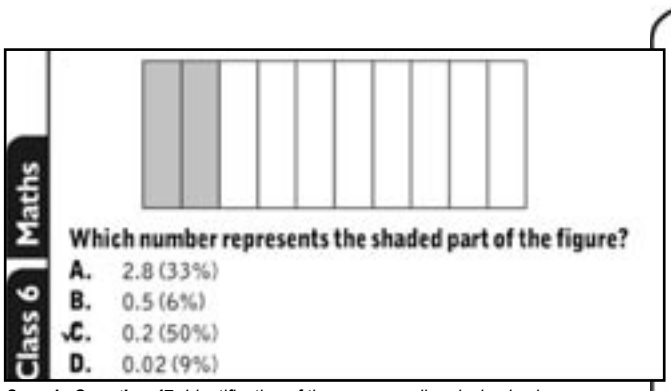
Findings: The findings are, to say the least, quite worrying. Students from the 'top' schools of our metros are performing below average international levels. The performance of the class 4 students is significantly lower than the international average in each one of the 11 questions. More strikingly, students of a higher class (class 6) performed only marginally better than the international average for class 4 students.

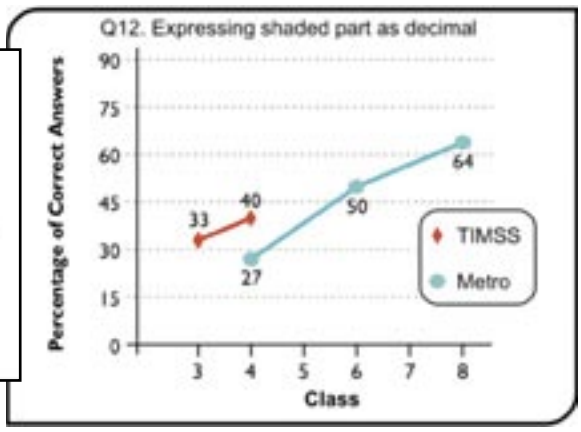
As seen in the graph, the trend is similar in both Maths and Science. It is worth remembering that the data being compared is of Indian students in *'top'* schools (by popular perception) and the *average* students of other countries.

Some examples: The Maths question below (Sample Question 47) tests the concept of decimal fractions. Greater use of the metric system and computers has lead to increased importance of decimal fractions as opposed to conventional fractions like ¼. Traditionally,



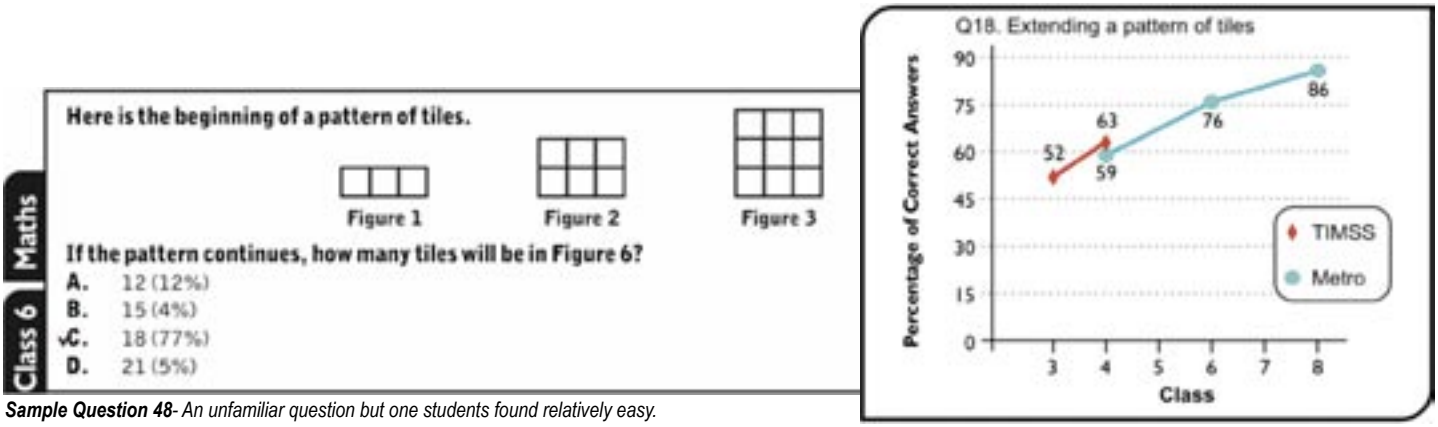
***Graph 7**: Comparative performance of students in Indian Metros with International average on TIMSS items in Maths and Science.*





***Sample Question 47**- Identification of the corresponding decimal value.*

[20] *The TIMSS tests used 8 different papers with some overlapping parts. The number 11,000 is approximate.*



***Sample Question 48**- An unfamiliar question but one students found relatively easy.*

conventional fractions are introduced earlier in the curriculum and taught over more years. But this is changing and many textbooks, including in India, are now increasing the emphasis on decimal fractions, which is desirable.

In this question, the performance of the class 4 Indian students is poorer than the international average of class 3 students. In class 4, in fact, over 50% of the Indian students opt for option A.[21] But by class 6, more students choose the correct answer 0.2 than the wrong option 2.8.

It is interesting to note that students found the 11 questions taken from the international test, the easiest of all the secondary study questions. In a way, this is to be expected because while the other questions were pegged at a class 5 level, the international questions were pegged at the class 3-4 level. Some of the questions, however, were of a type Indian students are not trained to do. For example see Sample Question 48 above. Students have done relatively well - 59% of class 4 students got it right, against 52% of international class 3 students and 63% of class 4 students. Even in this question, international students of class 4 have outperformed Indian class 4 students.

This last example is from Science (Sample Question 49). 73% of metro students in class 4 got this right, which is good, but internationally, 82% of class 3 and 85% of class 4 students answered correctly. The metro class 6 performance at 84% is between the international averages for classes 3 and 4.

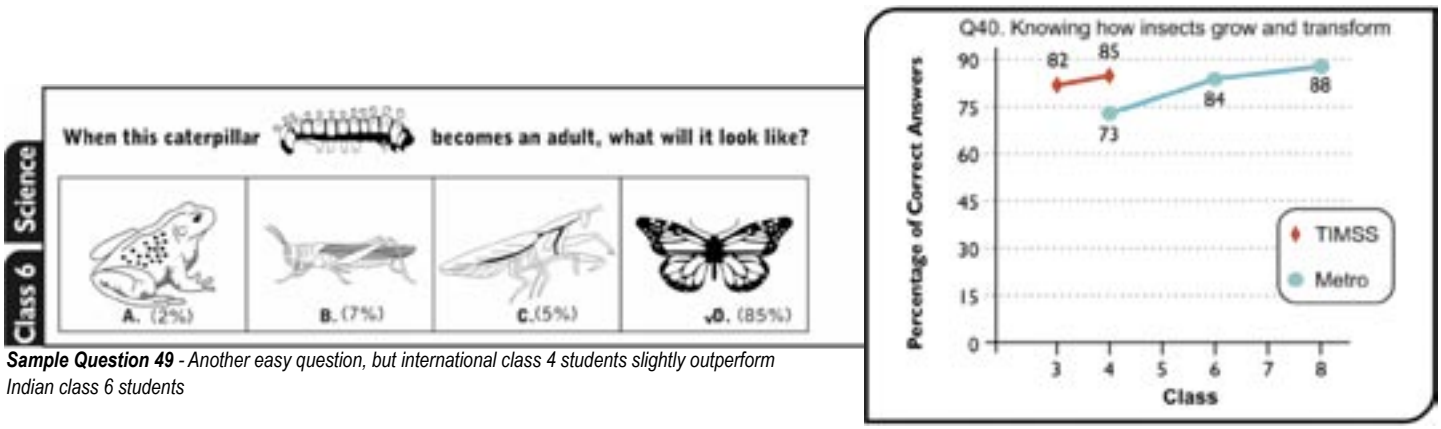
To summarise, Indian students of class 4 are performing consistently below their foreign counterparts in both Maths and Science. In some cases, they are performing at a lower level than even the class 3 international level.

2.5.1 Possible objections and explanations

1. *Students found the format of the TIMSS questions unfamiliar and hence did not do well.*

This is a partially valid argument. However, it must be appreciated that the international averages are based on the performances of students in 43 countries, not one or two. So, did our students find something unfamiliar that students in about 43 countries are 'okay' with? If so, either our curriculum or our teaching-learning methods probably need to be examined.

Can it be checked whether students actually *did* find the questions unfamiliar? For every question, the percentage of students who *skipped the question* (i.e. left it blank) is available. It seems reasonable to conclude that this percentage would indicate the extent to which students found it unfamiliar.[22] The data (Table 9) shows that students *have* skipped the TIMSS questions more than the non-TIMSS



***Sample Question 49** - Another easy question, but international class 4 students slightly outperform Indian class 6 students*

[21] *Option-wise international data is not available. It is possible that internationally too, option A was the most common answer, though one cannot be sure.*

[22] *The percentage of students skipping a q*

	No. of questions	Percentage of students skipping
Maths non-TIMSS questions	15	3.7%
Maths TIMSS questions	7	5.3%
Science non-TIMSS questions	16	6.3%
Science TIMSS questions	4	7.8%

Table 9: *Percentage of class 4 students skipping different types of questions.*

questions. However, even in the TIMSS questions, the percentage of students skipping the question is not unusually high. Also, these are the questions the students found easiest in the entire paper. Probably the learning from this is that students' understanding needs to be checked with a variety of tools and types of questions without following a set pattern thereby reducing predictability.

2. Metro students probably did not take the test seriously

One possible argument is that some students - maybe even most of them - may not have taken the test seriously knowing that its results would not matter much to them[23] (such tests are called 'low-stakes' tests). However, this does not appear to be a very convincing argument, when we consider the following points:

- a total of over 32,000 students have taken the test across 5 cities. This number is an extremely large one, so effects such as some students not taking the test seriously would cancel themselves out to make the overall comparison still valid. The number of schools in each city which participated is also large enough to ensure that even if students of a few schools did not taking the test seriously, it would not disproportionately impact the overall patterns.• Specifically, the international test scores are also likely to have been similarly depressed, as that too was, after all, a similar low-stakes test!

3. Are our students doing more poorly because they are younger?

- Some important factors that can affect the performance of students, for example, their age, the number of years of schooling so far, whether they had a preschool education, etc. Were the international students older than the students who wrote the metro study test?
- The TIMSS Study was actually designed to test students aged 9 years. This was found to be class 3 in some countries and class 4 in some countries. Interestingly, in India today, schools take students into class 1 either on completion of 5 years, or 6 years or something in between. Thus Indian students would also have been between 9 and 10 years when they took the test.
- To maintain individual anonymity, the dates of birth of the students were not collected in the Metro Study. Hence the exact ages are not available. It does appear however, that the ages of students in India are not significantly different from international average and hence the comparison is between students of roughly the same age.

Conclusions

The comparative performance of Indian students on 11 questions probably reflects deeper issues within our educational system. It appears that students of this age across the world are able to answer some of these questions better than Indian students. This is a strong pointer that either our teaching systems or our syllabi need to be given more thought. It is likely that something at a systemic level - for example, the textbook pattern, or national teaching styles - may need to be studied to find a reason for these kinds of results. Of course, such results need to be further looked into, and more such studies performed.

Another question that could be asked is whether Indian students 'catch up' by the time they reach class 8 or higher. Though there is no reason that strongly indicates that they do, it should be remembered that all the comparisons in this study were at the class 4 level only. More studies are needed to confirm or negate that hypothesis.

Caveat: In the following parts of this report the comparative performances of metros, boards, boys and girls, etc are discussed. A classification is in order here. The performance of 'top' schools based in this study is being used to compare the cities – E.g. Chennai and Mumbai. Obviously, the government schools of Chennai and Mumbai, for example, have not been studied. The same applies to the Boardwise comparison – Hindi medium schools, for example, which form an important part of CBSE schools, are not considered at all. Hence all comments and conclusions are only in the context of the 'top' performing schools in these 5 metros.

[23] *As explained in Section 1, students were told at the start of the test that the marks would not count in any way and hence they should not be nervous. At the same time, they should do their best so that the results of the research would provide an accurate picture. Student response patterns can be analysed to estimate the extent of guessing or random marking of answers. These analysis also clearly suggest that students have not guessed or taken the test lightly.*

2.6 COMPARATIVE PERFORMANCE OF THE METROS

It may be expected that the 'top' schools of the 5 metros will NOT show any major difference in their overall performance. After all, many important factors are similar across the schools. These include factors like infrastructure, socio-economic background of the students, and teacher profile. The differences in board affiliations are discussed in the next section. Thus, the similarities appear to clearly outweigh the differences.

However, the data sprang a big surprise here and showed very clear differences between the performances of the cities! Graph 8[24] depicts the pattern observed.

The data reveals that the five metros are split into two groups, with Bangalore[25] and Chennai falling in one group and Delhi, Kolkata and Mumbai in another. There is a significant difference (with 95% confidence) in the performance of these two groups, i.e. top schools of Delhi, Mumbai and Kolkata performed significantly better than those of both Chennai and Bangalore.

It is interesting to note that cities that are doing better than others are mostly doing so *across all classes and subjects*. However, specific patterns can be discerned within cities - for example Maths scores are higher than English scores across the classes in Delhi; whereas in Bangalore, English scores are higher than Maths scores in all classes.

Since these results were unexpected, three different cross-checks were done to verify them:

1. The performance in the secondary study was the first obvious place to check. The secondary study paper did not have an objective-type English paper, so data was studied for Maths and Science. It was found that though the city difference was not as pronounced as in the main study, the inter-city pattern observed was identical to that in the main study. This is depicted in Graph 9 on the next page[26].

   Appendix G has the details and the data on student performance in these papers.

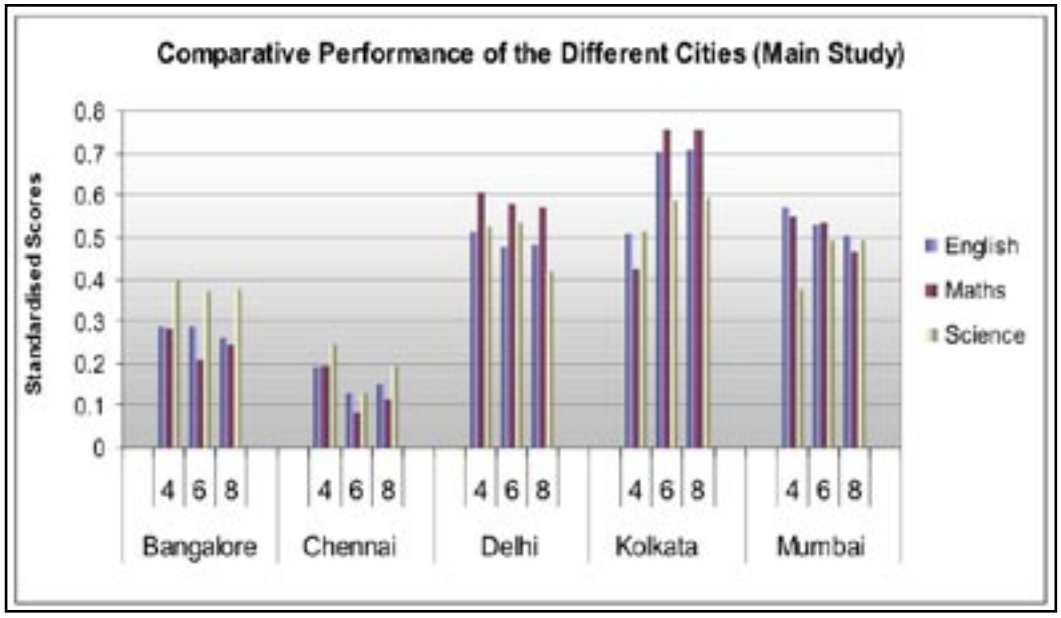
2. 'Outliers', a few schools which are either performing very well or very badly may be unduly influencing the average. To correct for this effect, city averages were recalculated by *removing the two best and worst performing schools* from each city. The results are presented in Appendix J. The performance pattern does not change - Chennai and Bangalore continue to underperform the other cities even with the outliers removed.

3. In each city, certain schools refused to participate in the study. Did this refusal affect the average of certain cities more than others? This was a critical point and was analysed next.

   The refusal of certain schools to participate would reflect in the the following parameters:

   - *the average 'rank' of participating schools, and*
   - *the ratio of the votes received by participating schools to the votes received by the top 50 schools*

   These parameters were compared for the metros.

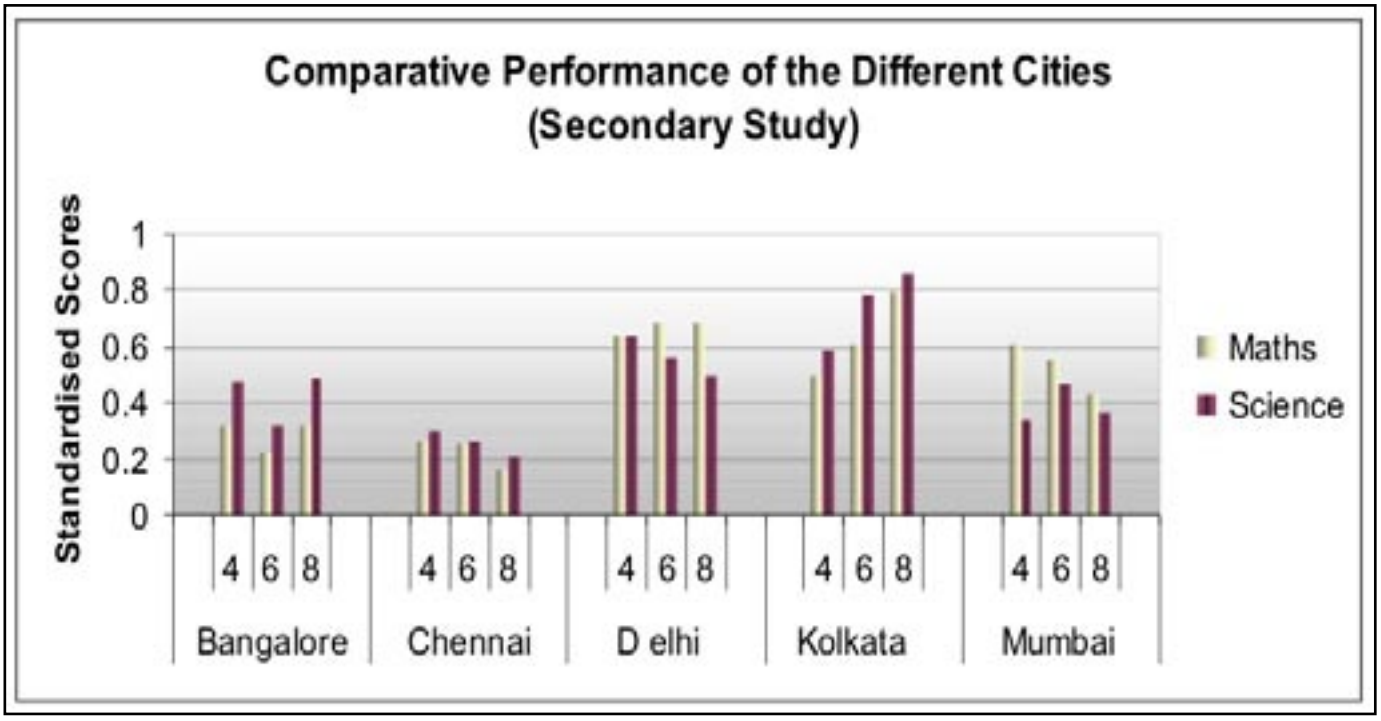


***Graph 8**: Possibly contrary to expectations, a clear difference is seen between the performances of the different cities. Note that these are only comparative performances - insufficient to conclude that particular cities are doing 'well' or 'badly' in absolute terms.*

[24] *As is explained later, there is reason to believe that the Bangalore results may have been depressed by the refusal of certain schools to participate in the study.*

[25] *Only 123 of the 142 schools that wrote the test were considered for the city-wise and board-wise comparative analysis. Please see Appendix K for details. The graph (and the next) shows the* standardised *scores of students in all the 9 papers (English, Maths and Science for classes 4, 6 and 8). In standardisation, the average and standard deviation of each paper is made the same (0 and 1 respectively) so that scores on the different papers can be depicted using a common scale.*

[26] *Educational Initiatives also conducts the ASSET test for students of classes 3 to 10 of English medium schools. Of course, the students who write ASSET are a self-selected and not a random sample, hence the sample is not representative. However, when the data for students who had taken the test in December 2005 from Mumbai and Chennai was compared, it was found that Chennai average was clearly lower than Mumbai's.*



Graph 9: *The data from the secondary study reveals a pattern similar to the main study.*

The data obtained is shown in Table 10.

The average rank of the schools that agreed to participate was slightly higher in Kolkata and slightly lower in Bangalore compared to the other cities. Similarly the percentage of votes that were received by the participating schools in Bangalore is lower than the corresponding figure in the other cities.

It appears from this that the performance of Bangalore schools may be slightly understated due to the refusal of certain schools to participate[27]. It is hoped that in subsequent studies like this, all schools agree to participate as that increases the validity of the results obtained.

Hence, it appears that the observed trends do correctly reflect the ground situation, with the possible exception that the learning levels of Bangalore city may be higher than what the current results seem to show. Though surprising, these results need to be verified and analysed in detail.

2.7 COMPARATIVE PERFORMANCE OF THE BOARDS

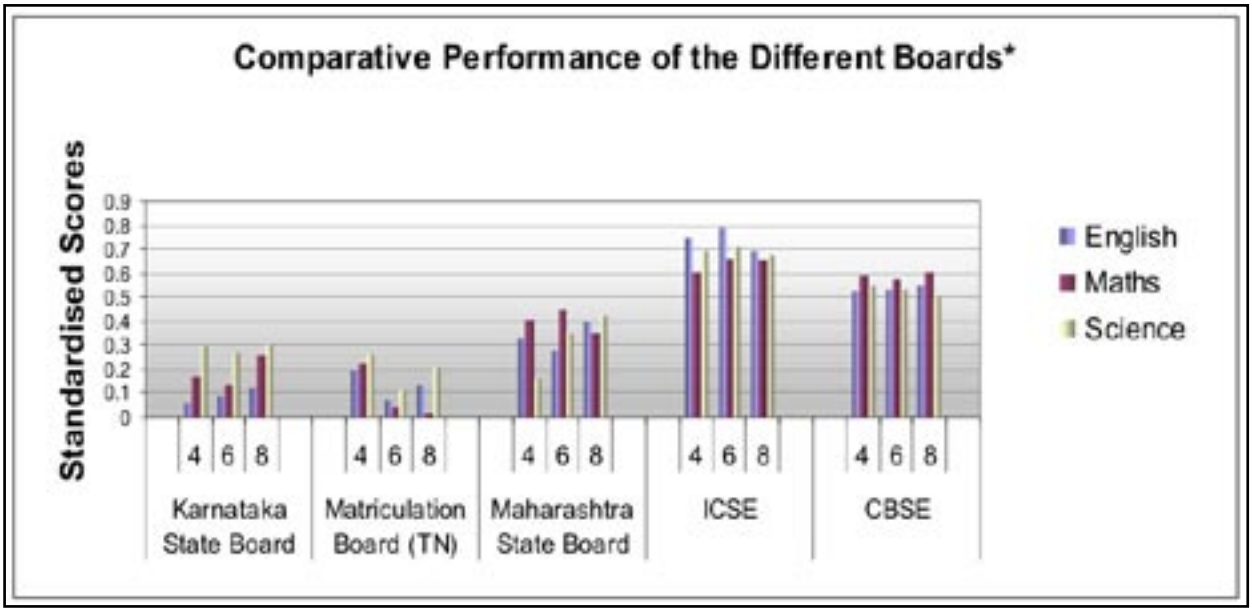
As mentioned earlier, these 'top' schools of the metros have many similarities. In this context, the difference in board affiliations attain special significance and merits analysis. Though boards are concerned only with the school-leaving exam and often insist that they do not directly influence the curriculum or teaching methods in the primary classes, it has been observed that there is a downstream effect in the lower classes also. If the basic ability of students is taken as the same across the cities - and if city or state-level initiatives are not very significant - the only city-level systematic difference comes from the board of affiliation.

Among the schools that participated in the study, the two all-India boards - the Central Board of Secondary Education (CBSE) and the Council for the Indian School Certificate Examinations (popularly referred to as the ICSE), the State Boards of Maharashtra and Karnataka and the Matriculation Board (Tamil Nadu) are represented significantly. Analysis of the board data reveals the following:

City	Average Rank of Participating Schools	% of top 50 votes that participating schools got
Bangalore	26.0	38.8%
Chennai	24.8	62.3%
Delhi	24.6	55.2%
Kolkata	23.0	59.7%
Mumbai	24.9	57.6%

Table 10: *Except Bangalore to an extent, the pattern of participation has been similar in the cities*

[27] *The schools that refused to participate (across cities) did so in spite of persistent follow-up by the testing teams. Letters, phone calls, personal meetings and efforts through the expert panel and others were used. In a*



Graph 10: *A difference is observed in the average performance of the schools affiliated to the different boards.*
**The above graph only represents the performance of top schools from five cities (by popular perception) based on their board affiliation. Except amongst such schools in these cities, this should not be taken to reflect the overall performance of the board.*

1. Schools affiliated to the ICSE board are outperforming the other boards. Performance of the state boards is not as good as the all-India boards, but even within them, there is a fairly clear-cut ordering as is illustrated by the graph. The data is provided in Appendix K.

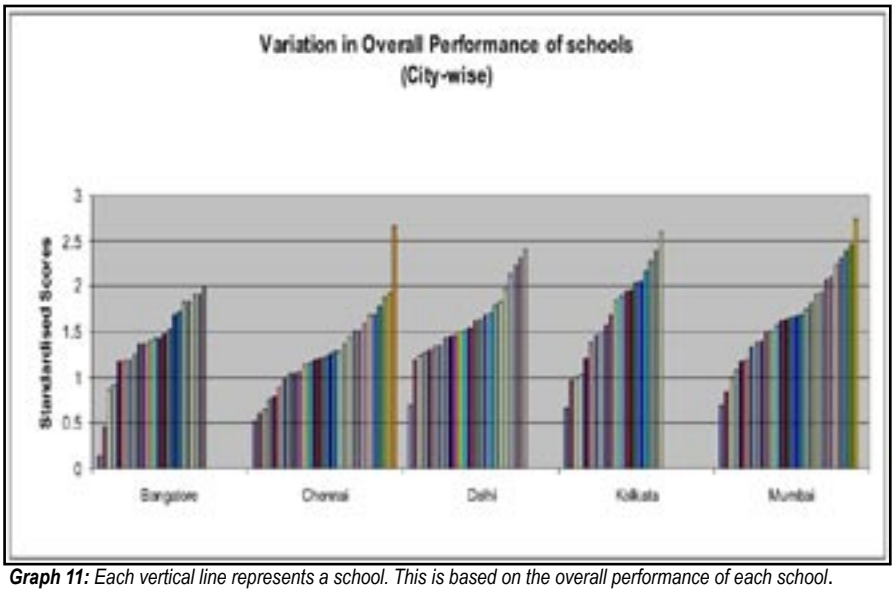
2. Even before we look at the performance, all-India boards clear dominate as per *public perception* - schools affiliated to these boards dominate the list of 'top' 50 schools in every city! 89 of the 123 schools are affiliated to the all-India boards though the bulk of schools in the country including in the 5 metro cities, are affiliated to 'state' boards . The percentage of schools affiliated to the all-India boards is shown in the table below.

Of course, it cannot be said that certain boards are the *cause* of the good performance of schools. It is possible, for example, that a board with more flexible policies is preferred by more proactive school managements, who, rather than the concerned board, may be the real cause for the better performance. Similarly, discerning parents may believe that all-India boards are better than state boards, and then send their students to such schools, creating a self-fulfilling loop! That said, it is likely that some of the good practices of the better performing boards may be useful for the other boards.

It is also interesting to note that even between the state boards themselves there is a perceptible difference in the quality of learning.

	CBSE schools	ICSE schools	All-India Board schools (CBSE+ICSE)	Total schools	Percentage of total schools affiliated to CBSE/ICSE
Bangalore	6	9	15	22	68%
Chennai	12	4	16	29	55%
Delhi	23	1	24	24	100%
Kolkata	5	13	18	20	90%
Mumbai	3	13	16	28	57%
	49	40	89	123	72%

Table 11: *A high percentage of schools that were named and participated in the study were affiliated to one of the all-India boards*



Graph 11: *Each vertical line represents a school. This is based on the overall performance of each school.*

2.8 EXTENT OF VARIATION AMONG 'TOP' SCHOOLS THEMSELVES

Just as a significant variation may not a priori be expected between cities, a very large variation would not be expected between the schools. This is because every metro would have over 1000 English-medium schools (with the exception of Kolkata) and the top 50 form only a small fraction of these. Of course, there may be better and poorer performing schools at the extremes and variations within the population of each school, but apart from these it may be expected that the average performance would be similar.

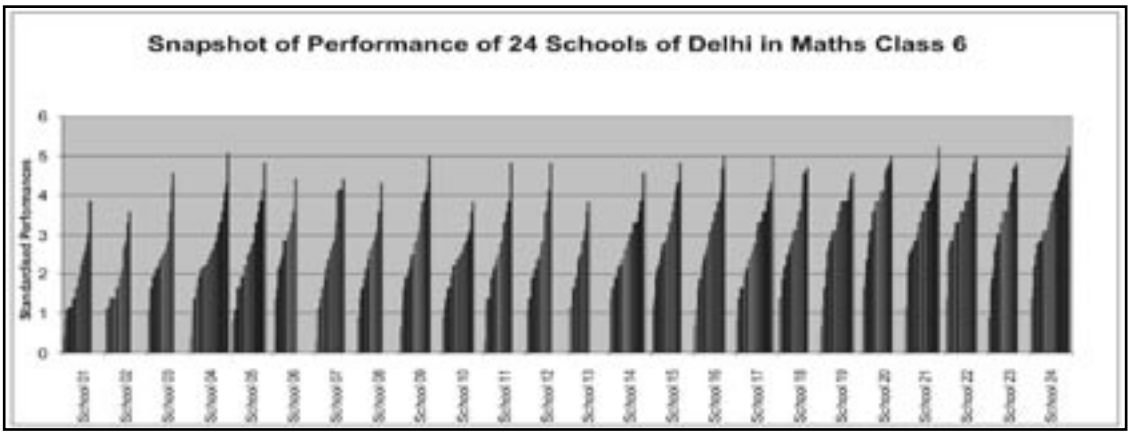
Again the results are surprising as they show an almost steady difference even among the 20-30 schools being considered in each city. An overall performance graph (based on average scores in English, Maths and Science after standardisation) is shown in Graph 11 above. Subject-wise data is provided in Appendix L.

What can be concluded from this? This graph actually represents a disturbing trend which suggests that a kind of 'class-system' may exist among schools. In a sense, this is the opposite of the 'common school system' sometimes talked about where schools charge similar fees and provide similar facilities and provide a uniform (and high) quality of teaching. In such a situation, parents would be less particular about which specific school their students must go to. In our current system on the contrary, there seem to be steady differences between schools.

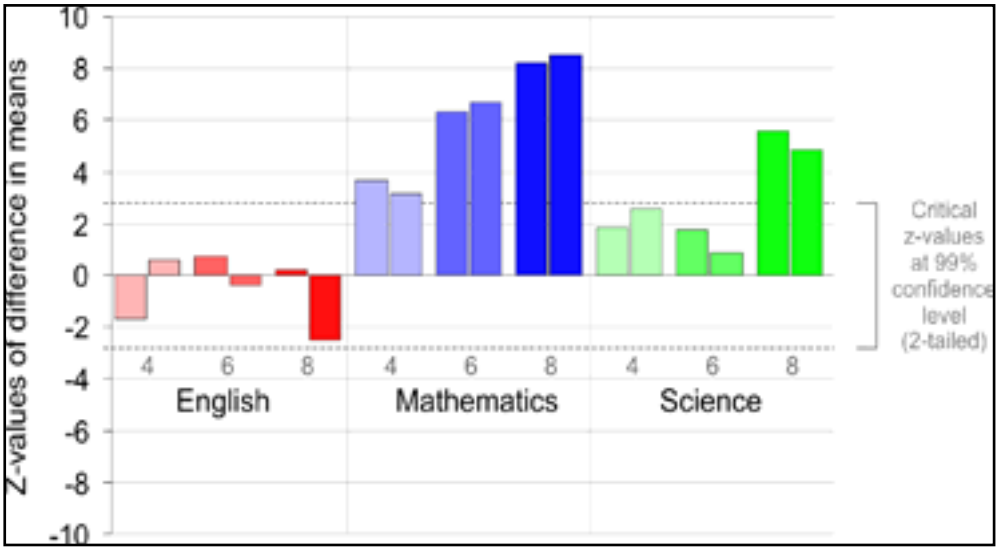
The effect of outliers on the city's average, for example, a top performing school in Chennai or a poorly performing school in Delhi, are also apparent from this graph.

The data allows one to look one step further - inside schools. 24 schools participated in the study from Delhi. In Graph 12 below, the performance of every single student (in Maths class 6) is plotted. The plot is arranged left to right from low to high performing schools.

As before, the zero level represents the average performance in Maths of all the students in the study (not only the Delhi students). As may be expected, the school at the left extreme has a number of students performing below average while the school in the right extreme has most of its students performing above average. One interesting pattern should be noted. The variation between the maximums (or the minimums) of the schools does not seem to be as high as between the averages of the schools. This suggests that there is probably not a conscious selection of good students by the school (save what happens due to fee levels). A more detailed discussion on this important topic is reserved for the last section of this report.



Graph 12: *Every vertical line on this graph represents a student's performance in Maths class 6. Schools outperform those to their left.*



Graph 13: *z-values of difference in means between Boys and Girls (excluding papers which did not have the gender marked). Each class-subject combination is represented by 2 bars as there were 2 main study papers used (refer page 7 for details)*

2.9 COMPARATIVE PERFORMANCES OF GIRLS AND BOYS

Over 8700 boys and 7700 girls participated in the secondary study (Papers that did not have gender marked are excluded). Is there a difference between the average performance of the boys and girls in this study? The analysis indicates that the girls are slightly brighter in language, and boys are brighter in Maths and Science. However not all these differences are statistically significant. The only difference statistically significant (at a 99% confidence level) is that *boys outperform girls in Maths across all classes and that boys outperform girls in science in class 8*. The difference is even more when the best performing students are compared, or the more difficult questions are considered.

It should be emphasised at the outset that these results do not in any way suggest that boys are inherently more capable of doing Maths than girls or something similar. If anything, the observed differences may be a result of subtle social messages that encourage boys and discourage girls from studying Maths. Teachers, schools, the government and society in general should take steps to encourage girls who are interested to take up Maths, and offset this disparity.

A summary of the overall performance is depicted in the Graph 13 above. Paper-wise performance details are available in Appendix M.

The difference in means is measured as ('Boys' minus 'Girls'), therefore bars above zero indicate that boys have a higher mean score on that paper, and bars below zero indicate that girls have a higher score on that paper. Bars that cross the line representing the critical z-value are significant at the 99% confidence level (2-tailed).

2.9.1 Effect of Ability and Question Type on Relative Performance

The levels of difficulty of different questions vary, and so do the abilities of different students. Questions can be classified as easy, medium and difficult based on the percentage of students who answer them correctly. In a similar way, students can be classified bright, average or weak in a subject based on their score in the test. How do the relative performances change for these different groups?

Data from the performance of class 6 students was analysed to answer this question. It was found that the *difference in performance between top performing boys and girls is actually more than the overall boy-girl difference*. *Boys also increase their lead in the more difficult questions.* Both these differences are statistical significant. The differences in the other categories are not significant. (Table 12)

BOY-GIRL DIFFERENCE IN PERFORMANCE		
3%	3%	2%
4%	7%	2%
11%	9%	3%

Weaker students →

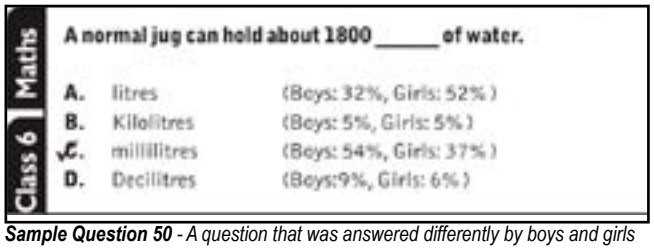
Easier Questions →

Table 12: *The graphic shows that the difference in the performances of boys and girls is more on questions of greater difficulty and for brighter students. (Positive values indicate better performance by boys.) Details are in Appendix M.*

2.9.2 Interesting Differences Observed in Individual Questions

Although the differences in the performance of boys and girls in individual questions was normally less than 5%, even dropping to negative values for a few questions on which girls outperformed boys, there were a few questions that had extraordinarily high differences between boys and girls.

Capacity of a jug:

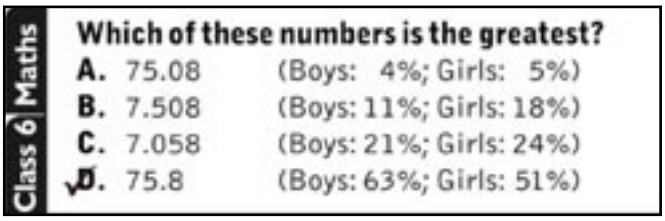


Sample Question 50 *- A question that was answered differently by boys and girls*

53% of the boys correctly answered that a typical jug would hold 1800 millilitres of water, which is correct; however, 51% of the girls felt it was 1800 litres! Only 36% of the girls got this right.

An analysis to check if the pattern was limited to certain schools or cities revealed no such pattern, though there are schools where girls answer this better than boys! This is surprising and merits further investigation.

Understanding Decimals:



Sample Question 51 *- Another question in which there was a difference*

It was surprising to find a difference of 12% between boys and girls on a basic question on the understanding of decimals. Students had to identify which number was the greatest and these were the answers obtained:

A similar question on decimal fractions was answered correctly by 55% of the boys and 47% of the girls.

2.9.3 Conclusions

Boys performed better in Maths, especially in the more difficult questions and when top performing students were compared. It is self-evident that the intrinsic abilities of boys and girls are the same. Hence, it is important that society's role in the development of its students is recognised and its positive influences encouraged and negative impacts minimized.

When a plant makes food for itself, it takes in carbon dioxide from the air and gives out oxygen; whereas when it respires, the opposite happens.

Textbook case study - 3

The NCERT science textbook of class 6 describes the difference between the processes of photosynthesis and respiration. Surprisingly, many class 6 and class 8 students found it difficult to identify which of the two was taking place in a plant when shown in pictorial form.

What the class 6 textbook says...

The following equation explains the process of food synthesis by the plants :

Carbon dioxide + Water $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Food(Carbohydrate) + Oxygen

This process of synthesis or preparation of food by plants is called **photosynthesis**. Since plants prepare their food themselves, they are called **autotrophs** (auto: self, troph: food).

All living organisms carry out process of respiration. This is a process in which organisms take in oxygen gas from the environment and release carbon dioxide gas. Compare the process of respiration with photosynthesis, mentioned earlier. Is it the same or different? You will observe that in photosynthesis, carbon dioxide is taken in and oxygen is released. In the process of respiration, oxygen is taken in and carbon dioxide is released. Thus, both photosynthesis and respiration help in maintaining balance of these gases in the environment.

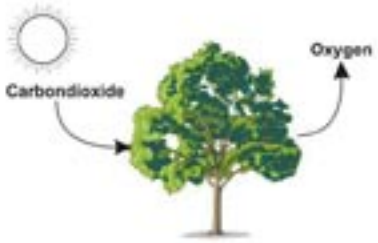
Source: *NCERT, class 6, page 18, 'Our Environment'*

We asked in Class 6 & 8...

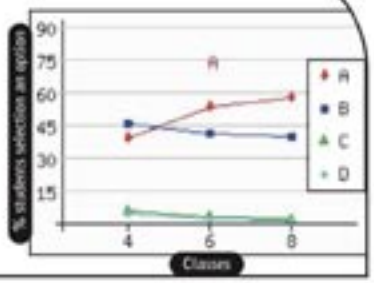
...a question asking children to identify the process occurring in the plant from the gas exchange taking place.

Class 6 & 8 Science

Which process that happens in a tree is shown in this picture?



✓**A.** making of food
B. breathing
C. resting
D. losing water



Class 8 Science

Ashok has an aquarium at home. He wants to increase the oxygen available to his fish. What should Ashok do?

A. add some more fish to his aquarium *(4%)*
✓**B.** add some water plants *(89%)*
C. reduce the light in the aquarium *(7%)*

Students learn about respiration and photosynthesis, the gas exchange involved and the role of each process. However, only 53% of class 6 and 57% of class 8 students identified the process as that of food production. Maybe these concepts are being 'learnt' without really being *internalized*.

3.1 DISCUSSION

"If you learn how to look at data in the right way, you can explain riddles that otherwise might have seemed impossible. Because there is nothing like the sheer power of numbers to scrub away layers of confusion and contradiction"- S.D. Levitt

In a limited sense, the purpose of this study was to understand how well students are learning in our 'top' schools. However the larger goal was to take a critical issue - the quality of student learning - and to try and gain insights about it based, not on opinion or 'experience', but on hard data.

This study shows surprising results- that even in the 'top' schools, a significant fraction of middle school students have not mastered primary school competencies; and that significant differences exist in the learning levels in various Indian cities. We would like to emphasize that the purpose of this study is not to sensationalise these gaps or even to identify the so-called 'top cities' or 'top schools' - in fact, these aspects have been consciously downplayed in the report. The question of interest is how can we discover underlying, non-apparent patterns and use that learning to improve the system? That is the purpose of this study.

In the present section, we attempt to step back and look at various issues which this report has raised. We will attempt to propose possible reasons for some results, discuss what the elements of 'good schools' and 'good learning' may be and make a few overall recommendations.

3.1.1 Possible Reactions to the Findings

The first reaction to results like these is often one of denial, "This cannot be true - there must be something wrong." An advantage with detailed data based approaches is that they can be critically examined and flaws, if any, can be identified. Also studies like this can be repeated and their results confirmed or refuted. We believe that these results will stand up to both those kinds of tests.

A second reaction - especially among those who are an integral part of the system - may be one of frustration - "Whatever we do, there seem to be no positive results." We do not believe that there is a reason for frustration, especially at the individual or school level. Many of the reasons responsible for these results are systemic, and the solutions also need to be systemic. This is discussed later in this section.

A third reaction may be one of challenge. Some people may disagree that learning with understanding is so important - "rote learning has worked well for us - look at India's standing in a field like IT" "The view taken of learning, and good schools is a very limited one." These views are also discussed in the following pages.

We would like to believe that studies like this help us identify problems and thus give us a chance to move onto the cycle of problem discovery, cause identification, solution implementation and feedback (which may lead to a deeper level of problem identification) and thus create a positive spiral towards improvement.

3.1.2 How important is learning with understanding?

Many teachers and parents believe that rote learning is real learning. A common response may be, "How relevant are these results?" Our students are performing well in their school exams. Rote learning is good enough in these classes - the learning with understanding, if necessary, can come later."

The argument continues: "India's progress today in many sectors like IT, BPO and Pharma is proof that rote learning works! Besides, rote learning alone instils a sense of hard work and rigour in students which gives them an edge at the international level. And let us not forget that we've all learnt that way - it's worked out fine for us".

At the outset, we would like to acknowledge that the argument is partially correct. Indians have been successful in many sectors and a culture of hard work and the emphasis on academic achievement have played an important part in this. However, it is important to see the other side of the picture too. In any society there will always be a certain percentage of students who will learn and do well in any system. In a large country that small percentage itself will be a large number. Home background, intrinsic intelligence, a positive work ethic and a spirit of competition may contribute as much to success as school learning. Ironically, the rigour of rote may actually serve this small select percentage the best! The vast majority have probably not gained so much from this system.

Rote learning has serious disadvantages - it stifles a child's natural curiosity and may make the child a passive observer who does not question or speak her mind. This has multiple implications - whether in terms of the number of patents a country earns, or the number of entrepreneurs who can 'challenge the givens', or even ordinary people who can think and question age-old customs or the way 'things are always done'.

The advantages and benefits of learning with understanding (of which learning by rote is a part) are many. Learning becomes an engaging and interesting process. The faculties of critical thinking are better developed and students are geared to face new or unfamiliar situations. Learning becomes 'fun' (though in a way very different from how games are fun).

3.1.3 Possible reasons for low performance

One of the key learnings from the discipline of systems thinking is that 'Structure Influences Behaviour' - different people in the same structure tend to produce qualitatively similar results. A sincere, hardworking teacher may find that she is not able to influence the quality of learning in her class as much as she hoped, because of a certain inertia in the larger system.

Even if that sounds disempowering, a system is constituted by its members only, and change, too, has to be driven by these members. Each player in the education system - parent, teacher, principal or concerned citizen – contributes, even if in a small way, to making the system what it is. Often the first step in bringing about that change has to be a new way of thinking. In this case, there is a need to understand the cause of the problem and the influence of the constituents of the system, on the overall system. These two insights may suggest certain action points.

Our hypothesis is that an important reason for low performance is the cycle of the pattern of the Board Examination - a premium on high Board Exam marks - emphasis on rote learning so that scores are high - a notion that good schools are those that do well in the Board Exams - a system of tuitions to improve Board Exam results. This is a self-preserving and reinforcing cycle, and one that different members of the education system are actually strengthening through their actions! The Board examination pattern rewards learning by rote, which is reinforced further by textbooks and teaching styles that try to help the student score better in exams. Even in lower classes there are implications - for example, considering a thicker textbook to be a more difficult or a better textbook. All these factors not only reduce student learning, they build in complacency in the students' as well as the parent's mind that learning is happening well.

We believe that states where practices like rote learning, excessive textbook content and higher and higher board scores are more prevalent may demonstrate lower levels of learning than others. Even a wider recognition of these points could be an important step towards changing this system.

3.1.4 What is a 'good' school?

A lot of opinions exist about what constitutes a 'good' school. Is it one that has good infrastructure or well-qualified teachers or the best Board exam results? A little thought may suggest that schools that consistently demonstrate the highest levels of student learning - assuming that can be measured reliably - are the 'best'. Unfortunately, the reality is far more complex than that.

Many studies have shown conclusively that family background and socio-economic status have a powerful influence of level of learning - probably more significant than the school itself. Of course individual schools can make a lot of difference, but in general, schools with the best learning levels may simply have the 'right' students - they may not be 'best'.

Both 'teaching effects' and 'selection effects' would influence the overall learning level of a school. Here 'teaching effects' refer to the improvement in learning due to the effect of the school environment - this includes not only teaching, but exposure to books at school, peer influence, etc. 'Selection effects', on the other hand, can be of three types: 1. Parents choose to put their students in specific schools - in India, typically the 'good' or 'top' schools. Since parents influence student learning tremendously, the 'good' schools have a massive advantage in this regard. 2. Sometimes schools choose students - they conduct admission tests to take only the 'best'; they fail or even expel students who are not performing well. 3. There is a self-selection due to the level of the school fees.

Of all these, only the teaching effects are the desirable effects. All forms of the selection effect are - in an equitable society - undesirable. The debate on the common school system is essentially about completely removing the selection effect, yet our society is far from a consensus on this issue.

Thus, defining a good school may be a difficult task. However, awareness and sensitivity to some of these issues may help us develop a better educational system.

3.2 SOME RECOMMENDATIONS

This section contains some specific recommendations mostly at a systemic level. Some are easier to implement than others, but all of them, we believe, would help us move closer to the goal of improved student learning.

1. *The practice of Boards to give students very high marks - close to 100% in most subjects - has many negative effects. Apart from creating pressure (because a single mark matters so much more in a high scoring situation), inflated scores are often taken as indicators of thorough learning. Boards should start awarding students a percentile score in every paper. This is neither difficult to do, nor is it objectionable in any way.*

2. *Surprisingly, boards do not release the average scores of different schools in the Board Exam. (Some Boards release the pass percentage of schools.) The average score of a school provides some indication of how that school has done overall.*

3. *Stereotypical misconceptions / mistakes in comprehension exist among students – many of which are highlighted in this report. When updating textbooks and during teacher training programmes, such findings should be taken into account so that the incidence of such misconceptions may reduce.*

4. *India should participate in international benchmarking assessments like the TIMSS which test students on how well they can apply the learnt competencys/concepts. This will help the country benchmark student performance with the rest of the world and become the basis for improvement. Benchmarking studies like the TIMSS can be conducted within India also.*

3.3 OBJECTIONS AND LIMITATIONS

Some schools from the survey list of 'top' schools refused to participate in the study: This is a limitation as the results may have been different had every 'top' school participated. We hope that as the seriousness and usefulness of studies like these are recognised, such refusals will reduce. For comparison purposes, it was verified that the average rank and percentage of total votes received by the schools that participated were similar for all cities, and exceptions were flagged. In this study, for example, it does appear that the performance of Bangalore may have been adversely affected due to this.

Could schools have got their 'best' students to write the test? Schools were requested to choose sections at random from classes 4, 6 and 8, and not to break sections for this purpose. Where schools had sections streamed on the basis of ability, they were asked to give at least one 'average ability' section. Both the field experience as well as the data analysis (as mentioned in Section I) indicate that only average ability sections have written the tests.

Survey Challenges: Some challenges were faced during the conduct of the survey. People named school branches that did not exist, or were not aware of other branches that did. In the case of group schools or those that have multiple branches, it was sometimes not clear if a particular branch was being named or the group as a whole. In most cases, the central research team took what seemed the best call after consulting experts from the city in question. In future studies, an option is to additionally ask respondents to choose schools from a list of schools.

The issue of student seriousness: The reliability of data collected in tests like these is sometimes objected to on the grounds that students may not be performing to the best of their abilities in low-stake tests like these. According to this argument, it is only when students recognize that the cost of not performing 'well' is high, that they do their best. Hence the results may be lower than what students are really capable of.

For one, this factor would lead to depressed scores of students across the country, and indeed even the international students whose results have been compared. This makes the relative performance still comparable.

Besides, it is possible to check for indications of waning student interest by analysing their responses to individual questions - for example, an increase in the percentage of questions being left unanswered, or signs of guessing, which also manifest themselves in different options being selected equally by a subset of students - these indicators are suggesting that students did take the tests quite seriously.

Not enough typical (school test-like) questions in the papers: More such questions would have allowed a comparison between student performance on question forms that they are familiar with. Future studies should include a few more such questions, if possible.

Nothing to compare the 'best' schools with: No data is available from the 'average' schools (based on public perception) on the same test to compare with the performance of these 'top' schools - so it is not possible to know if the schools perceived to be the best are indeed the best. -

Objection to classification of schools as 'top' schools: The use of terminology like 'top' schools is sometimes objected to. It is absolutely true that this is not a standard terminology and different criteria can be used to classify a school in this manner. However, in the context of this study the term is used to refer to schools that were mentioned most frequently by about 200 respondents in each city. Thus the term is used purely in that context and not in a judgmental sense.

Miscellaneous Points: Only 89 schools returned the filled in background questionnaires. Had all the data been available, clearer correlation patterns may have emerged. The tests were conducted over a span of 3 months - this may hypothetically have affected the performance of students (though no such clear pattern has been seen.)

3.4 IDEAS FOR FUTURE STUDIES

It appears that a study like this provides interesting insights and snapshots into student learning at two different levels - one, for understanding how students are learning and two, at the level of policy making. At a more general level, it can help to create awareness about issues like what learning and good education are, and help initiate debates on deeper issues like, maybe, a common school system.

Such a study could therefore be expanded to more cities (maybe 10) and also consciously include additional categories of schools. For example, schools that are named, but do not fall in the top 30, can be included.

There are two other areas in which further research can be carried out. One relates to the extent students are learning in different topics - using common items across schools or across classes, but focusing possibly on specific areas like ‘fractions’ or ‘photosynthesis’. These focused studies can help identify misconceptions in a scientific way.

The second relates to the interesting question of what makes a good school good. As more scientific data on student learning is available, such studies may also provide valuable insights.

In the case of all these studies, if the various aspects including the test items, detailed student responses and analyses are transparently shared through the internet and other means, such studies can help collectively understand the state of learning in the country and how it can be improved.

The study, the discussions and these recommendations stem from a deep belief that the problem of student learning is closely linked to the larger questions and challenges society faces today. But this problem is not an insurmountable one - far from it. If it can be systematically tackled based on hard data and systematic analysis, the benefits will not be restricted to the education system and the current generation alone.

Textbook case study - 4

Latent heat, put simply is the amount of heat a substance requires to go from one state to another.

The NCERT science textbook of class 7 explains the phenomenon of latent heat through an activity as given below. However, class 8 students found it difficult to apply this concept to a slightly different situation in our question.

What the class 7 textbook says...

the whole ice melts. Though heat is continuously supplied to ice during this period, its temperature does not increase. Where does that energy go? You see that the ice melts, that is, it changes its state from solid to liquid. The heat supplied during this change is used up by the ice in changing its state from solid to liquid. Once the ice is completely melted, the temperature of water begins to rise.

Source: The NCERT textbook for Science in Class 7 *(page 167, 'Heat and Temperature')*

The textbook talks about the change in temperature of water when it goes from being ice to steam.

We asked in Class 8...

...a question about the temperature of water as it goes from water to ice.

Class 8 Science

The chart below shows the results of placing a 100 ml beaker of water in a freezer (temperature -4°C). The temperature was recorded every five minutes. Which of these could be the reason for the temperature remaining at 0°C for ten minutes?

Time in minutes	0	5	10	15	20	25	30	35
Temperature in °C	22	15	10	6	2	0	0	0

A. Energy was being absorbed by the water to change to ice. *(20%)*
✓B. Energy was being given out by water to change to ice. *(23%)*
C. The temperature of ice cannot go below 0°C. *(32%)*
D. The temperature of ice stays at 0°C before rising again. *(21%)*

Although the phenomenon works exactly in the same way as the one given in the textbook, only 23% students answered the question correctly. 32% of children seem to think that the temperature of ice cannot go below 0°C. Interestingly, it looks that the 20% who marked option A did know of the phenomenon, but faltered in its application.

Appendices

Appendix A – Members of the Expert Panel

EXPERTS PANEL

Dr. K Subramaniam : Homi Bhabha Centre for Science Education, Mumbai

Dr. S. C. Agarkar : Homi Bhabha Centre for Science Education, Mumbai

Mr. Y. G Rajendra : Trustee - The PSBB Group of Schools, Chennai

Ms. Deepa Ragahavan : Vice Principal – Delhi Public School, R.K Puram, Delhi

Ms. Deepa Sridhar : Principal - Sri Kumaran Children's Home English Nursery and Primary School, Bangalore

Prof. Rama Mathew : Department of Education, University of Delhi, Delhi

Ms. Sandhya Siddharth : Secretary - AV Education Society, Bangalore

Ms. Vaz, Principal : Jamnabai Narsee School, Mumbai

Ms. Vijaya Srinivasan : Principal - Lady Andal Venkatasubba Rao School, Chennai

Prof. Arvind Gupta : Inter-University Centre for Astronomy and Astrophysics, Pune

Prof. Geetha Nagaraj : British Council, Bangalore

Prof. H. S. Srivastava : Former Dean – NCERT, Delhi

Prof. Jalaluddin: NEEV, Delhi

Sister S.M. Cyril: Principal, Loreto Sealdah, Kolkata

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Archana Raja

Appendix B – Invitation Letter to Schools

20th January

To

The Principal

Subject: Invitation to participate in "Benchmarking Learning in Metros" research study

Dear Principal,

Warm Greetings from Wipro and Educational Initiatives (EI)

We are writing this letter to invite your school to participate in a research study that Educational Initiatives (EI) is undertaking with the support of Wipro Ltd. As part of this we would need to conduct a test in your school for 1 or 2 sections of your classes 4, 6 and 8 students at a time convenient to you around February 20, 2006.

About Wipro and EI

Wipro's community initiative, 'Wipro Applying Thought in Schools', aims to contribute to improving India's school education. Since its initiation in early 2001, WATIS has reached out to over 4,500 teachers and principals from 241 schools in 14 states across the country.

We (EI) are an educational research company with a mission of transforming the quality of learning in children of school-going age. Over the years EI has been studying student learning and has detailed performance data of over 1,00,000 students in schools across India and beyond.

About the Research Study

In order to accurately understand "how well children are learning in the 'good schools', EI with the support of Wipro Ltd. is conducting a benchmarking study of student achievement in 5 metros namely Mumbai, Kolkata, Delhi, Chennai and Bangalore. The study will cover English medium schools, specifically those which are perceived as 'good' schools based on a detailed survey in your city. This will be the largest such study at determining achievement levels in leading schools scientifically across India. The study is diagnostic and research oriented and is expected to generate data about the actual quality of learning in our education system.

30,000 students from class 4, 6 and 8 from the selected schools in the metro cities shall be tested on their Competencys and competencies in English, Mathematics and Science. The questions shall test understanding and application of knowledge in new situations, as against testing for recall.

Expected outcomes of this study

The expected outcomes of this study are: an overall understanding of how well children are learning in our metros, a detailed understanding of specific areas/Competencys in which students may be weak either across the nation or in specific metros, an understanding of the relative performance of students on questions that may be mechanical or conceptual; that may relate to content of previous years (phenomenon of forgetting), etc.

Based on the above, recommendations will also be made on how the quality of learning may possibly be made in these and other schools.

The Expert Panel for the study consists of:

Dr. K Subramaniam - Homi Bhabha Centre for Science Education, Mumbai

Dr. S. C. Agarkar - Homi Bhabha Centre for Science Education, Mumbai

Mr.Y. G Rajendra - Trustee - The PSBB Group of Schools, Chennai

Ms. Deepa Ragahavan - Vice Principal – Delhi Public School, R.K Puram, Delhi

Ms. Deepa Sridhar, Principal - Sri Kumaran Children's Home English Nursery and Primary School, Bangalore

Prof. Rama Mathew - Department of Education, University of Delhi, Delhi

Ms. Sandhya Siddharth - Secretary - AV Education Society, Bangalore

Ms.Vaz - Principal - Jamnabai Narsee School, Mumbai

Ms.Vijaya Srinivasan - Principal - Lady Andal Venkatasubba Rao School, Chennai

Prof. Arvind Gupta - Inter-University Centre for Astronomy and Astrophysics, Pune

Prof. Geeta Nagaraj - British Council, Bangalore

Prof. H. S. Srivastava - Former Dean – NCERT, Delhi

Prof. Jalaluddin - NEEV, Delhi

Sister S.M. Cyril - Principal - Loreto Sealdah, Kolkata

This is NOT an attempt to rate or rank schools and that will not be done. In fact, the study is NOT about individual schools, and hence no conclusion - absolute or comparative - can correctly be drawn about individual schools. Some conclusions can be drawn about the performance at the level of the metro.

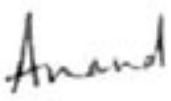
Your participation will help in providing the requisite sample size and the outcomes of the study will prove useful to parents, teachers, schools, researchers and educational planners.

Specific details about the test

The test will be conducted on one day in February end. There is no fee or any payment due from the school. All participating schools will receive a special certificate from Wipro/EI. The test will be conducted in the class itself and will be for about 1 to 2 hours for all students of classes 4, 6 and 8. EI will provide invigilators for conducting the test. You may give your preference for in case multiple branches of a school exist.

Please do write to us confirming your participation in the study within 10 days of receipt of this letter. For any further queries, please contact me or Anar, who is coordinating the project at anar@ei-india.com

We look forward to your confirmation to participate and in making our research study a success!



Sridhar Rajagopalan

Managing Director

Educational Initiatives Pvt. Ltd.

sridhar@ei-india.com

Mobile:09327093939

Anand Swaminathan

Manager - Community Initiatives

Wipro Limited.

Appendix C - Instructions/Guidelines for the City-coordinators and Invigilators for the test

3.C.1 INSTRUCTIONS TO CITY COORDINATORS

1. Please be aware and update the system about the number of students who will be taking the test class wise
2. You need 35 students per class for the main study and 35 for Secondary Study. Try to avoid doing more than this.
3. If there are more than 50 students taking either the main study or Secondary Study from any class, please send a mail about this to Anar / Devpal / VS / SRR, well before the test.
4. NO TEST BOOKLET SHOULD REMAIN IN THE SCHOOL OR WITH A TEACHER OR EVEN AN INVIGILATOR. PLEASE COUNT THE TEST PAPERS BEING HANDED OVER TO THE TEAM LEADER AND BEING RETURNED BY HIM / HER.
5. ENSURE THAT THE TEST DETAILS SHEET (attached) IS FILLED FOR EVERY SCHOOL.
6. Store all the OMR sheets in separate covers for EACH SCHOOL with the date, number of sheets, classes covered and school name mentioned on the top of the cover. ANSWER SHEETS OF 2 SCHOOLS SHOULD NEVER GET MIXED.
7. Explain how to fill the OMR sheets and solve any other queries that the students might have. NOT TO EXPLAIN THE QUESTIONS, AS THIS IS A RESEARCH STUDY AND ANY ADDITONAL HELP GIVEN TO STUDENTS TO ANSWER WILL INVALIDATE THE TEST ITEM / TEST.
8. The students have to write their name and OMR number on the test booklet cover.
9. Please ensure that all the students have written their class on all the Secondary Study papers and essay sheets.

3.C.2 GUIDELINES FOR ACTION AFTER SCHOOL HAS CONFIRMED PARTICIPATION

Before the test

1. Visit the school and meet the principal and check the location at least 2 days in advance.
2. Check the classroom where the test shall be taken. (This is to ensure the number of students sitting on a one bench)

Note down the following:

3. Total number of sections in class 4, 6 and 8?
4. Total number of students in each section: ____

   (Sections with 35 students is the minimum required, since we are coming across some 2 section schools with 35 in each section) we will require 2 sections. We need one class for conducting the Secondary Study, this should be kept in mind and the total number of sections and students per school that will be given the tests should be informed to the school.
5. Date of the test:
6. Time of the test
7. No of invigilation staff required:
8. Name and details of the invigilation staff: (This should include name, phone number, area and other contact details as well as classes they will be supervised by them.)
9. Total number of papers required: (preferably the CC should already have the papers grouped according to section, etc before reaching the school)
10. Total number of OMR sheets required: (Preferably the CC should segregated them section wise to be given to the invigilator)

11. Please inform the school principal and others coordinating that

    a. Students will need to carry pencils and erasers.

    b. They should not bring pens and geometrical instruments. (if possible we should try and make sure that they leave all their belongings out side the class)

    c. If students mark answer sheet using a pen, it is also fine, there is no problem.

    d. The total time that will be taken to conduct the test (E.G. half an hour prior to testing + duration of the test)

After the test:

12. Ensure test booklets are collected back and put in correct groups. ENSURE THAT NO TEST BOOKLETS REMAIN IN THE SCHOOL
13. LATER, after 1-2 days preferably, remove the essay page and store it.
14. Store all the OMR in separate covers for EACH SCHOOL with all test details like date, OMR batch numbers, classes covered, school name mentioned on the top of the cover. REMEMBER THAT IF ANSWER SHEETS OF 2 SCHOOLS GET MIXED, THEY WILL HAVE TO BE MANUALLY SEPARATED BY SEEING EACH SHEET.
15. Maintain a record of the invigilator payment details as well as grade them appropriately for future use.

3.C.3 CODE OF CONDUCT FOR INVIGILATORS

Before the test:

1. Do make sure that you reach the venue at least 45 minutes- 1 hour before the test starts.
2. Ask your coordinator or team leader your assigned responsibilities for the day.
3. Collect the relevant test booklets and the OMR sheets before reaching the classroom.
4. Note that each section / class for the main study has 2 versions of papers [class 4- 401, 402, class 6- 601, 602, class 8 –801, 802]
5. If the section assigned to you is doing the Secondary Study, then the paper with code 603 is the same for all classes –4,6, and 8.
6. Make sure the OMR sheets are also taken by you along with the test booklets to the class.
7. Once you enter the class, introduce yourself, take 5 – 10 minutes to explain something about the research study and to carry out icebreakers
8. Make sure that students are seated with space between each other [important to avoid copying
9. Ensure that students have pencils and erasers
10. Each column of the student is to get alternate versions of papers. [for example, in class 4, column 1 students seated one behind the other will get 401, while next column will get 402, 3rd column will get 401,etc]
11. Explain how to fill the OMR sheets and solve any other queries that the students might have. IMPORTANT DO NOT EXPLAIN THE QUESTIONS, AS THIS IS A RESEARCH STUDY AND ANY ADDITONAL HELP GIVEN TO STUDENTS TO ANSWER WILL INVALIDATE THE TEST ITEM / TEST.
12. The students have to fill the details asked on the essay page and test booklets too.
13. Please note the time the students start the examination paper
14. Ensure that the children answer the essay and the feedback questions at the end of the paper
15. Students should not talk amongst themselves and those who have completed the tests should be asked to leave the classroom.<check with school authorities if it okay to send the students out of the classroom after each completes the test>

About the study – (to tell students before the test):

Measuring Learning in Metros is a research study being conducted by WIPRO and Educational Initiatives in 200 schools across Mumbai, Kolkata, Chennai, Delhi and Bangalore. This is not a competition. This test will help us understand how well children like you in India are learning and how we can improve the quality of education. It is important that you take this test seriously attempt each questions honestly. PLEASE KEEP IN MIND THIS IS A RESEARCH STUDY AND YOUR DOING THIS TEST WILL HELP ALL CHILDREN ACROSS THE COUNTRY LEARN BETTER

After the test:

28. All the question papers and OMR sheets should be collected and the invigilation staff should note the OMR sheets number used in each class
29. The exact number of test booklets given for each code to be counted and recorded and handed over to the team leader.

Appendix D - School Details Form to be filled in by the invigilator and the city-coordinator

School Details Form

School Name: _____

Date of the Test: _____

Team Leader: _____

----------To be filled by the City coordinator----------

I - Details of Number of Students:

Class	Section1		Section2		Section3		Section4		Section5	
	MS	SS	MS	SS	MS	SS	MS	SS	MS	SS
4										
6										
8										

MS: Main Study; SS: Secondary Study

II - Test Papers and OMR sheets given to the Team Leader:

	Number
401	
402	
601	
602	
801	
802	
603	
OMR	

----------To be filled by the Team Leader at the school----------

	Used	Unused	Total
401			
402			
601			
602			
801			
802			
603			
OMR			

_____ _____

Team Leader Name City Coordinator Sign

Appendix E - Complete List of Competencies

COMPETENCIES TESTED IN ENGLISH

Class 4

	Competency	Total no. of questions	Questions[30]	
1	Knowledge of words	8	401:9,11,21,23	402:2,4,14,22
2	Correct usage	13	401:16,17,18,19,20,22	402:15,16,17,18,20,21,23
3	Understanding stated facts	11	401:1,3,6,8,10,12,15	402:1,7,10,11
4	Interpretation of information	14	401:2,4,5,7,13,14	402:3,5,6,8,9,12,13,19
5	Language appreciation	-	-	

Class 6

	Competency	Total no. of questions	Questions	
1	Knowledge of words	11	601:4,5,8,14,24,26	602:2,8,12,22,24
2	Correct usage	15	601:18,19,20,21,22,23,27,28	602:20,25,26,27,28,29,30
3	Understanding stated facts	9	601:1,2,3,11,12	602:4,11,17,18
4	Interpretation of information	12	601:6,9,13,16,17,25	602:3,5,7,9,10,14
5	Language appreciation	13	601:7,10,15,29,30	602:1,6,13,15,16,19,21,23

Class 8

	Competency	Total no. of questions	Questions	
1	Knowledge of words	12	801:4,10,15,20,30,32	802:1,6,18,20,25,34
2	Correct usage	17	801:16,22,23,24,25,26,27,28	802:4,10,11,12,13,14,15,19,24
3	Understanding stated facts	9	801:2,7,9,12,14	802:3,17,26,29
4	Interpretation of information	14	801:1,3,5,8,13,21,35	802:2,5,8,16,21,28,30
5	Language appreciation	18	801:6,11,17,18,19,29,31,33,34	802:7,9,22,23,27,31,32,33,35

COMPETENCIES TESTED IN MATHS

Class 4

	Competency	Total no. of questions	Questions
1	Number sense	5	401: 24,36 402: 28,31,33
2	The 4 Basic Operations	5	401: 26, 28 402: 24,34,39
3	Fractions	5	401: 29, 30, 37 402: 25,38
4	Geometry	6	401: 25,33,38 402: 26,30,35
5	Measurement	5	401: 31,34,35 402: 27,32
6	Problem Solving	6	401: 27,32,39 402: 29,36,37

Class 6

	Competency	Total no. of questions	Questions
1	Numbers and operations	7	601:31,36,44 602:32,35,44,45
2	Fractions and Decimals	8	601:33,34,39 602:31,33,36,41,50
3	Geometry	7	601:32,35,38,40,43 602:42,49
4	Measurement and Estimation	7	601:37,41,45 602:38,43,46,48
5	Data Interpretation	5	601:42,47 602:34,37,39
6	Problem Solving	6	601:46,48,49,50 602:40,47

Class 8

	Competency	Total no. of questions	Questions
1	Numbers and operations	6	801:36,41,46 802:36,39,56
2	Fractions, Decimals, Ratios, Percentages	9	801:37,39,42,43 802:38,40,42,47,51
3	Geometry	7	801:40,49,57,59 802:44,52,57
4	Measurement and Estimation	8	801:38,45,56 802:37,41,46,48,49
5	Algebra	8	801:47,48,50,52,58 802:45,50,53
6	Data Interpretation	5	801:44,54,55 802:43,54
7	Problem solving	7	801:51,53,60 802:55,58,59,60

COMPETENCIES TESTED IN SCIENCE

Class 4

	Competency	Total no. of questions	Questions	
1	Recalling known facts	12	401: 40, 45, 51, 54	402: 40, 41, 42, 44, 46, 47, 53, 54
2	Understanding/Applying	14	401: 41, 42, 46, 48, 50, 52, 53, 55	402: 43, 49, 50, 51, 52, 55
3	Analyzing/Reasoning	6	401:43, 44, 47, 49	402:45,48
4	Designing/Generating	-	-	

Class 6

	Competency	Total no. of questions	Questions	
1	Recalling known facts	13	601:53,61,62,63,65,68	602:51,59,60,63,65,69,70
2	Understanding/ Applying	15	601:51,52,54,58,66,67,70	602:53,54,56,57,58,64,66,68
3	Analyzing/Reasoning	7	601:56,59,60,64	602:52,55,62
4	Designing/Generating	5	601:55,57,69	602:61,67

Class 8

	Competency	Total no. of questions	Questions	
1	Recalling known facts	16	801:63,67,69,73,74,76,77,83	802:61,62,63,66,67,73,75,76
2	Understanding/Applying	17	801:62,64,65,68,70,71,75,79,80,82	802:64,68,69,72,82,83,85
3	Analyzing/Reasoning	11	801:66,72,78,84,85	802:70,74,78,79,80,81
4	Designing/Generating	6	801:61,81	802:65,71,77,84

Appendix F - Questionnaire for Schools

Educational INITIATIVES

MEASURING LEARNING

QUESTIONNAIRE FOR SCHOOLS

WIPRO

Dear Sir/Madam, Date: _____

As a part of the Measuring Learning project, we are trying to better understand if factors other than quality of class-room teaching affect student learning. We would be grateful if you could fill in this questionnaire and hand it over to the test co-ordinator.

School Name :

School Address :

City : Phone:

Please tick in the box or write in the space provided.

1) Which educational board is the school affiliated to? _____

2) What is the average strength of a class (one section) in the school?

a) 30 or less than 30 ☐ b) 31-40 ☐ c) 41-50 ☐ d) More than 50 ☐

3) Approximately, what % of students in a class (section) are boys? _____ girls? _____

4) How many sections is each class divided into?

	Number of sections
Class 4	
Class 6	
Class 8	

5) Please fill in the appropriate number for the following:

Total number of teachers in the school	
Of these, how many are B. Ed.s*?	
How many are Post Graduates*?	
How many are PhDs?	

*In the case of a teacher having both a B. Ed. and a Post Graduate degree, please include him/her in both categories.

6) Please provide information about:

	School timings	Total no. of periods per week	Out of total no. of periods, how many are Academic periods[1]?	Length of one period	How many days a week do students come to school?
Class 4					
Class 6					
Class 8					

[1]Academic periods: any language, Maths, Science, Social Studies periods. Please note any others _____

7) Does the school work in shifts? Yes ☐ No ☐

8) Does the school have a library? If yes, approximately how many books does the library house?

Yes, _____ books No ☐

9) Approximately how many new books were added to the library's collection last year?

_____ Books Do not know ☐

10) What is the total area of the school campus? _____ sq. meter or _____ acres

11) Do individual class rooms have a computer with internet connectivity?

Yes ☐ No ☐

12) Are students given online assignments to work on?

Class 4:	Yes	No
Class 6:	Yes	No
Class 8:	Yes	No

13) Please tick those which your school provides

☐ music lessons ☐ dance lessons
☐ dining hall with lunch facilities ☐ swimming pool
☐ horse riding training ☐ gymnasium
☐ tennis courts ☐ football field/ cricket pitch
☐ AC classrooms

14) Please list major teacher training programmes that took place in your school in the last year:

Name / type of training	For which subject	For which class
•		
•		
•		
•		

16) Please tick all that is applicable to secure admission to the school:

☐ admission tests ☐ student's interview
☐ parents' interview ☐ first come first served or a draw of lots

17) Which of the following 'labs' does the school have?

	Maths lab	Language lab	Science lab
Class 4			
Class 6			
Class 8			

18) How much tuition fee does the school charge? Please fill in any one:

_____ per month _____ per term _____ per year

19) Please list 3-4 unique activities that your school recently conducted, which helped better student learning:

•
•
•
•

Appendix G - Summary Statistics of All Test Papers

3.G.1 AVERAGES AND STANDARD DEVIATIONS OF ALL MAIN STUDY PAPERS:

Paper	Subject	Class	Number of Students	Number of questions	Average	Standard Deviation
1	English	4	2645	23	11.36	4.74
1	English	6	2610	30	14.89	5.27
1	English	8	2500	35	19.63	5.40
2	English	4	2549	23	12.62	4.88
2	English	6	2511	30	16.10	5.24
2	English	8	2433	35	21.04	5.92
1	Maths	4	2645	16	7.79	3.37
1	Maths	6	2610	20	10.01	4.09
1	Maths	8	2500	25	11.41	4.68
2	Maths	4	2549	16	8.72	3.47
2	Maths	6	2511	20	9.45	3.63
2	Maths	8	2433	25	11.41	4.97
1	Science	4	2645	16	7.11	3.24
1	Science	6	2610	20	8.92	3.69
1	Science	8	2500	25	11.43	3.65
2	Science	4	2549	16	8.04	3.60
2	Science	6	2511	20	9.67	3.76
2	Science	8	2433	25	11.79	3.84

3.G.2 AVERAGES AND STANDARD DEVIATIONS OF ALL SECONDARY STUDY PAPERS IS AS FOLLOWS:

Subject	Class	Number of Students	Number of questions	Average	Standard Deviation
Maths	4	4786	22	7.51	2.99
Maths	6	4832	22	10.72	3.65
Maths	8	4747	22	13.63	3.70
Science	4	4786	20	6.41	2.79
Science	6	4832	20	9.10	3.17
Science	8	4747	20	11.05	3.32

Appendix H - Schools Considered

142 schools participated in this study. Out of these, there were 16 schools that were ranked below 50 in their respective cities. There were 3 schools that participated only in the secondary study. These 19 schools were not considered for the city-wise and board-wise comparisons (as it may be argued that they would pull down the city average). The break-up of the number of schools city-wise and board-wise are as follows:

	CBSE		ICSE		State Boards*		Others		Total Considered		Not Considered+		TOTAL	
Bangalore	6	1354	9	2076	7	1922			22	5352	4	616	26	5968
Chennai	11	2549	5	1084	13	3676			29	7309	8	1290	37	8599
Delhi	23	5204	1	220					24	5424			24	5424
Kolkata	5	1065	13	3223	1	131	1	31	20	4450	3	421	23	4871
Mumbai	3	666	13	2612	12	3800			28	7078	4	358	32	7436
	48		41						123	29613			142	32298

* Karnataka Board for Bangalore, Matriculation Board for Chennai, West Bengal Board for Kolkata and Maharashtra Board for Mumbai
\+ These are schools that were ranked below 50 in the survey and some that wrote only the secondary study paper.

Appendix I - Raw and Standardised Average Scores for Different Papers in the Different Cities

City	Class	Number of Students	Raw Scores			Standardised Scores		
			English (average)	Maths (average)	Science (average)	English (average)	Maths (average)	Science (average)
Bangalore	4	1025	11.4	7.8	7.6	-0.1	-0.1	0.0
Chennai	4	1256	11.0	7.5	7.0	-0.2	-0.2	-0.2
Delhi	4	1001	12.5	8.9	8.0	0.1	0.2	0.1
Kolkata	4	864	12.5	8.3	7.9	0.1	0.0	0.1
Mumbai	4	1048	12.8	8.8	7.5	0.2	0.1	0.0
Bangalore	6	942	14.9	9.0	9.2	-0.1	-0.2	0.0
Chennai	6	1260	14.0	8.5	8.3	-0.3	-0.3	-0.3
Delhi	6	920	15.9	10.4	9.8	0.1	0.2	0.1
Kolkata	6	680	17.1	11.1	10.0	0.3	0.4	0.2
Mumbai	6	1319	16.2	10.3	9.6	0.1	0.1	0.1
Bangalore	8	860	19.5	10.7	11.5	-0.1	-0.2	0.0
Chennai	8	1214	18.9	10.0	10.8	-0.2	-0.3	-0.2
Delhi	8	893	20.8	12.2	11.7	0.1	0.2	0.0
Kolkata	8	697	22.1	13.1	12.3	0.3	0.4	0.2
Mumbai	8	1269	20.9	11.7	12.0	0.1	0.1	0.1

For the purpose of plotting graphs, a constant 0.4 was added to all the standardised scores. This was done to avoid to negative values appearing in the graphs.

Appendix J- Outlier Analysis

STANDARDISED AVERAGE SCORES ELIMINATING 2 HIGHEST AND 2 LOWEST SCORING SCHOOLS IN EACH CITY

City	Class	Scores with Outliers Removed			Original Standardised Scores		
		English (average)	Maths (average)	Science (average)	English (average)	Maths (average)	Science (average)
Bangalore	4	-0.04	-0.02	0.10	-0.11	-0.12	0.00
Chennai	4	-0.23	-0.21	-0.18	-0.21	-0.21	-0.16
Delhi	4	0.08	0.21	0.13	0.11	0.20	0.13
Kolkata	4	0.16	0.05	0.18	0.11	0.03	0.11
Mumbai	4	0.26	0.20	0.04	0.17	0.15	-0.02
Bangalore	6	-0.09	-0.13	0.05	-0.11	-0.19	-0.03
Chennai	6	-0.28	-0.33	-0.27	-0.27	-0.32	-0.27
Delhi	6	0.01	0.15	0.09	0.08	0.18	0.13
Kolkata	6	0.34	0.33	0.27	0.30	0.35	0.19
Mumbai	6	0.13	0.14	0.14	0.13	0.13	0.09
Bangalore	8	-0.19	-0.17	-0.03	-0.14	-0.16	-0.02
Chennai	8	-0.22	-0.28	-0.20	-0.25	-0.29	-0.21
Delhi	8	0.02	0.17	-0.02	0.08	0.17	0.02
Kolkata	8	0.34	0.33	0.18	0.31	0.36	0.19
Mumbai	8	0.16	0.07	0.15	0.11	0.06	0.09

Analysing this data or plotting it shows that the overall trends remain the same even when the outlying schools are removed.

Appendix K - Board Data

Board	Class	Number of Students	Standardised Scores		
			English (average)	Maths (average)	Science (average)
Cambridge*	4	7	0.0222	-0.132	-0.557
CBSE	4	1928	0.026	0.0925	0.0464
ICSE	4	1692	0.2448	0.1037	0.1956
Tamil Nadu Matriculation Board	4	646	-0.311	-0.274	-0.239
Karnataka State Board	4	377	-0.448	-0.33	-0.206
Maharashtra State Board	4	544	-0.174	-0.095	-0.339
Cambridge*	6	12	-0.221	-0.481	-0.26
CBSE	6	1874	0.0324	0.0729	0.0363
ICSE	6	1552	0.2892	0.1574	0.2067
Tamil Nadu Matriculation Board	6	588	-0.431	-0.463	-0.389
Karnataka State Board	6	349	-0.411	-0.363	-0.23
West Bengal State Board*	6	40	1.119	1.5331	0.7777
Maharashtra State Board	6	706	-0.219	-0.053	-0.153
Cambridge*	8	12	0.0925	-0.59	-0.375
CBSE	8	1790	0.0531	0.1071	0.0008
ICSE	8	1488	0.1892	0.1548	0.178
Tamil Nadu Matriculation Board	8	613	-0.365	-0.483	-0.291
Karnataka State Board	8	318	-0.377	-0.242	-0.196
West Bengal State Board*	8	40	0.8814	1.4957	0.7866
Maharashtra State Board	8	672	-0.103	-0.152	-0.078

*Not analysed as numbers students in schools affiliated to this Board are very small.

For the purpose of plotting graphs, a constant 0.5 was added to all the standardised scores. This was done to avoid to negative values appearing in the graphs.

Appendix L – Subject-wise School Data

ENGLISH SCORES OF ALL SCHOOLS, CITY-WISE.

	Bangalore			Chennai			Delhi			Kolkata			Mumbai		
	School Code	Number of Students	English Average	School Code	Number of Students	English Average	School Code	Number of Students	English Average	School Code	Number of Students	English Average	School Code	Number of Students	English Average
1	S1	101	-1.37	S23	156	-1.21	S52	114	-0.85	S76	116	-0.69	S96	192	-0.89
2	S2	106	-1.07	S24	163	-0.91	S53	98	-0.49	S77	167	-0.63	S97	181	-0.68
3	S3	96	-0.71	S25	133	-0.81	S54	112	-0.45	S78	65	-0.59	S98	158	-0.51
4	S4	142	-0.69	S26	123	-0.79	S55	108	-0.32	S79	113	-0.53	S99	84	-0.42
5	S5	120	-0.50	S27	132	-0.73	S56	138	-0.26	S80	45	-0.08	S100	172	-0.40
6	S6	155	-0.38	S28	162	-0.58	S57	108	-0.21	S81	158	-0.08	S101	169	-0.15
7	S7	134	-0.29	S29	102	-0.57	S58	138	-0.20	S82	31	-0.04	S102	173	-0.15
8	S8	94	-0.24	S30	111	-0.56	S59	113	-0.17	S83	159	0.02	S103	99	-0.11
9	S9	133	-0.22	S31	46	-0.55	S60	97	-0.14	S84	117	0.16	S104	173	0.01
10	S10	108	-0.22	S32	125	-0.53	S61	100	-0.13	S85	87	0.29	S105	97	0.02
11	S11	92	-0.14	S33	134	-0.53	S62	145	-0.12	S86	111	0.43	S106	113	0.04
12	S12	129	-0.12	S34	109	-0.48	S63	120	-0.09	S87	101	0.44	S107	122	0.07
13	S13	164	-0.11	S35	131	-0.46	S64	115	-0.04	S88	57	0.44	S108	123	0.14
14	S14	93	-0.08	S36	145	-0.45	S65	99	-0.02	S89	154	0.54	S109	158	0.15
15	S15	151	-0.05	S37	125	-0.34	S66	93	0.01	S90	133	0.56	S110	189	0.15
16	S16	141	0.19	S38	164	-0.29	S67	122	0.16	S91	118	0.61	S111	122	0.22
17	S17	256	0.21	S39	136	-0.15	S68	125	0.25	S92	103	0.69	S112	119	0.26
18	S18	111	0.22	S40	134	-0.06	S69	128	0.27	S93	130	0.74	S113	118	0.36
19	S19	96	0.31	S41	150	-0.06	S70	110	0.30	S94	196	0.87	S114	119	0.47
20	S20	158	0.48	S42	107	-0.02	S71	117	0.37	S95	80	1.00	S115	86	0.50
21	S21	92	0.57	S43	130	0.04	S72	110	0.68				S116	112	0.55
22	S22	155	0.70	S44	171	0.07	S73	116	0.84				S117	105	0.61
23				S45	122	0.17	S74	144	1.04				S118	128	0.66
24				S46	108	0.21	S75	144	1.15				S119	147	0.80
25				S47	159	0.32							S120	98	0.87
26				S48	117	0.45							S121	96	0.89
27				S49	96	0.45							S122	41	1.32
28				S50	120	0.51							S123	142	1.33
29				S51	119	1.19									

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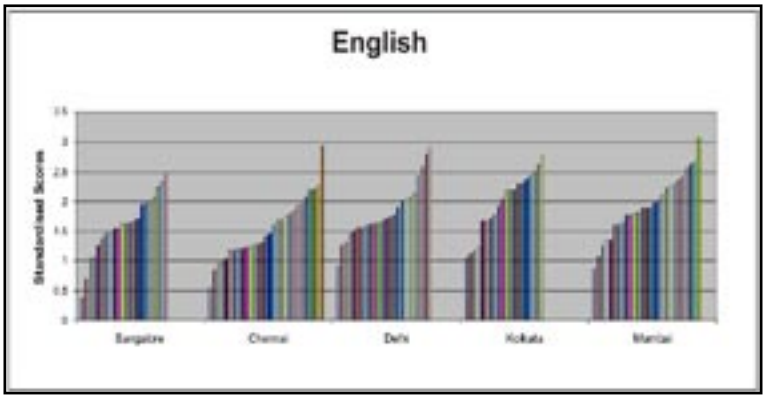
For the purpose of plotting graphs, a constant 1.25 was added to all the standardised scores. This was done to avoid to negative values appearing in the graphs.



Graph 11: Standardised performance of Schools in each city in English

MATHS SCORES OF ALL SCHOOLS, CITY-WISE.

	Bangalore				Chennai				Delhi				Kolkata				Mumbai		
	School Code	Number of Students	Maths Average		School Code	Number of Students	Maths Average		School Code	Number of Students	Maths Average		School Code	Number of Students	Maths Average		School Code	Number of Students	Maths Average
1	S1	101	-1.42		S23	163	-0.93		S52	114	-0.75		S76	116	-0.84		S96	192	-0.62
2	S2	106	-1.12		S24	156	-0.87		S53	108	-0.37		S77	65	-0.46		S97	181	-0.58
3	S3	96	-0.64		S25	132	-0.79		S54	98	-0.22		S78	31	-0.44		S98	84	-0.47
4	S4	142	-0.54		S26	123	-0.77		S55	145	-0.21		S79	167	-0.42		S99	173	-0.40
5	S5	134	-0.42		S27	133	-0.71		S56	138	-0.14		S80	113	-0.42		S100	158	-0.32
6	S6	94	-0.32		S28	125	-0.65		S57	97	-0.03		S81	45	-0.25		S101	172	-0.31
7	S7	120	-0.30		S29	162	-0.64		S58	108	0.00		S82	158	-0.08		S102	119	-0.21
8	S8	151	-0.25		S30	131	-0.48		S59	112	0.04		S83	159	-0.04		S103	113	-0.19
9	S9	155	-0.24		S31	109	-0.45		S60	120	0.05		S84	117	-0.01		S104	99	-0.14
10	S10	129	-0.22		S32	111	-0.42		S61	113	0.07		S85	133	0.07		S105	169	-0.10
11	S11	133	-0.15		S33	150	-0.40		S62	99	0.09		S86	87	0.25		S106	122	-0.09
12	S12	92	-0.10		S34	134	-0.40		S63	100	0.09		S87	118	0.30		S107	97	0.00
13	S13	108	-0.08		S35	145	-0.34		S64	93	0.13		S88	57	0.44		S108	122	0.09
14	S14	93	-0.05		S36	102	-0.26		S65	125	0.22		S89	154	0.47		S109	158	0.14
15	S15	164	0.04		S37	134	-0.25		S66	115	0.24		S90	111	0.56		S110	86	0.19
16	S16	111	0.05		S38	130	-0.23		S67	122	0.25		S91	101	0.65		S111	123	0.21
17	S17	141	0.07		S39	125	-0.22		S68	138	0.29		S92	130	0.77		S112	189	0.23
18	S18	158	0.21		S40	164	-0.21		S69	110	0.37		S93	103	0.88		S113	173	0.24
19	S19	155	0.21		S41	171	-0.20		S70	128	0.40		S94	196	1.02		S114	119	0.24
20	S20	256	0.30		S42	46	-0.13		S71	117	0.61		S95	80	1.51		S115	118	0.30
21	S21	96	0.35		S43	159	-0.03		S72	144	0.67						S116	112	0.47
22	S22	92	0.38		S44	107	0.05		S73	110	0.73						S117	128	0.50
23					S45	120	0.05		S74	116	0.80						S118	105	0.60
24					S46	136	0.07		S75	144	0.80						S119	41	0.72
25					S47	108	0.10										S120	96	0.76
26					S48	122	0.17										S121	147	0.95
27					S49	96	0.40										S122	98	1.01
28					S50	117	0.44										S123	142	1.39
29					S51	119	1.15												

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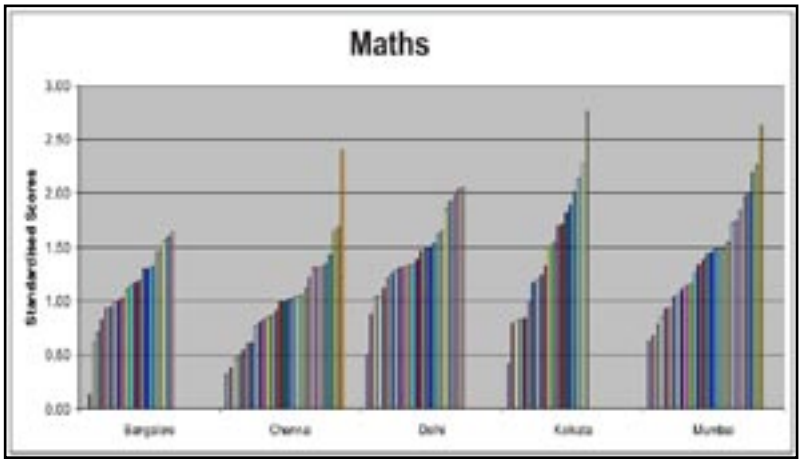
For the purpose of plotting graphs, a constant 1.25 was added to all the standardised scores. This was done to avoid to negative values appearing in the graphs.



Graph 12: Standardised performance of Schools in each city in Maths

SCIENCE SCORES OF ALL SCHOOLS, CITY-WISE.

	Bangalore			Chennai			Delhi			Kolkata			Mumbai		
	School Code	Number of Students	Science	School Code	Number of Students	Science Average	School Code	Number of Students	Science Average	School Code	Number of Students	Science Average	School Code	Number of Students	Science Average
1	S1	101	-1.31	S23	132	-1.05	S52	114	-0.83	S76	116	-0.97	S96	192	-0.93
2	S2	106	-0.93	S24	156	-0.86	S53	138	-0.35	S77	167	-0.57	S97	181	-0.73
3	S3	96	-0.56	S25	163	-0.83	S54	145	-0.27	S78	113	-0.57	S98	84	-0.60
4	S4	142	-0.49	S26	123	-0.63	S55	108	-0.25	S79	31	-0.37	S99	158	-0.42
5	S5	155	-0.29	S27	125	-0.62	S56	98	-0.18	S80	65	-0.37	S100	173	-0.34
6	S6	134	-0.28	S28	133	-0.61	S57	120	-0.11	S81	45	-0.02	S101	169	-0.28
7	S7	94	-0.17	S29	102	-0.49	S58	108	-0.11	S82	87	0.01	S102	172	-0.27
8	S8	120	-0.17	S30	131	-0.38	S59	113	-0.09	S83	159	0.01	S103	113	-0.16
9	S9	151	-0.10	S31	111	-0.37	S60	97	-0.05	S84	158	0.04	S104	99	-0.09
10	S10	129	-0.05	S32	162	-0.34	S61	112	-0.02	S85	117	0.06	S105	119	-0.03
11	S11	92	0.03	S33	150	-0.29	S62	138	0.00	S86	118	0.25	S106	123	-0.01
12	S12	93	0.03	S34	125	-0.27	S63	99	0.05	S87	154	0.36	S107	189	0.00
13	S13	133	0.06	S35	171	-0.26	S64	100	0.06	S88	133	0.40	S108	86	0.04
14	S14	108	0.09	S36	145	-0.23	S65	125	0.08	S89	57	0.44	S109	122	0.08
15	S15	164	0.17	S37	134	-0.20	S66	115	0.14	S90	130	0.47	S110	97	0.21
16	S16	155	0.28	S38	46	-0.18	S67	122	0.20	S91	101	0.53	S111	122	0.22
17	S17	158	0.31	S39	164	-0.16	S68	110	0.24	S92	111	0.66	S112	173	0.23
18	S18	141	0.32	S40	134	-0.15	S69	93	0.24	S93	103	0.76	S113	158	0.26
19	S19	111	0.38	S41	109	-0.13	S70	128	0.33	S94	80	0.78	S114	112	0.30
20	S20	256	0.46	S42	159	-0.03	S71	117	0.44	S95	196	0.80	S115	118	0.31
21	S21	92	0.50	S43	107	-0.01	S72	110	0.49				S116	119	0.52
22	S22	96	0.56	S44	130	0.02	S73	116	0.53				S117	128	0.52
23				S45	136	0.11	S74	144	0.73				S118	96	0.57
24				S46	122	0.21	S75	144	0.79				S119	105	0.60
25				S47	108	0.25							S120	41	0.66
26				S48	120	0.27							S121	147	0.67
27				S49	96	0.29							S122	98	0.98
28				S50	117	0.38							S123	142	1.00
29				S51	119	1.10									

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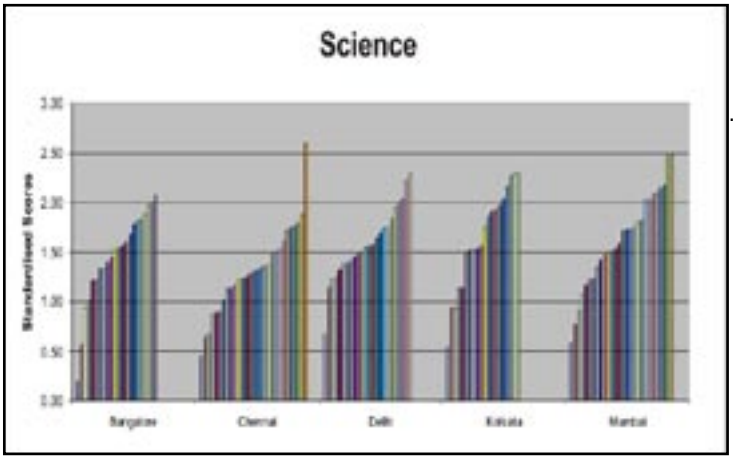

Graph 13: Standardised performance of Schools in each city in Science5.0.23

Appendix M – Class-wise and Subject-wise difference in performance of Boys and girls

Subject	Class	Papercode	Sex	n	Avg %	SD %	Difference	z test value	Significant?*
ENGLISH	4	14w	Boys	1513	48.9%	20.5%	-1.3%	-1.68	
		14w	Girls	1310	50.2%	20.5%			
	4	14x	Boys	1399	54.9%	21.4%	0.5%	0.62	
		14x	Girls	1309	54.4%	20.8%			
	6	16w	Boys	1524	49.5%	17.9%	0.5%	0.71	
		16w	Girls	1330	49.0%	17.1%			
	6	16x	Boys	1441	53.1%	17.3%	-0.2%	-0.33	
		16x	Girls	1290	53.3%	17.6%			
	8	18w	Boys	1425	56.0%	15.2%	0.1%	0.18	
		18w	Girls	1289	55.9%	15.5%			
	8	18x	Boys	1414	59.0%	17.2%	-1.6%	-2.49	
		18x	Girls	1240	60.7%	16.5%			
MATHS	4	24w	Boys	1513	49.8%	21.5%	2.9%	3.68	SIGNIFICANT
		24w	Girls	1310	47.0%	20.1%			
	4	24x	Boys	1399	55.6%	22.6%	2.6%	3.15	SIGNIFICANT
		24x	Girls	1309	53.0%	20.6%			
	6	26w	Boys	1524	52.0%	20.8%	4.8%	6.32	SIGNIFICANT
		26w	Girls	1330	47.2%	19.4%			
	6	26x	Boys	1441	49.4%	18.8%	4.6%	6.66	SIGNIFICANT
		26x	Girls	1290	44.8%	17.0%			
	8	28w	Boys	1425	48.2%	19.4%	5.8%	8.21	SIGNIFICANT
		28w	Girls	1289	42.4%	17.3%			
	8	28x	Boys	1414	48.4%	20.6%	6.5%	8.56	SIGNIFICANT
		28x	Girls	1240	41.9%	18.6%			
SCIENCE	4	34w	Boys	1513	44.9%	20.8%	1.4%	1.82	
		34w	Girls	1310	43.5%	19.4%			
	4	34x	Boys	1399	51.0%	22.7%	2.2%	2.58	
		34x	Girls	1309	48.8%	22.1%			
	6	36w	Boys	1524	45.0%	19.1%	1.2%	1.80	
		36w	Girls	1330	43.8%	17.5%			
	6	36x	Boys	1441	48.2%	19.6%	0.7%	0.92	
		36x	Girls	1290	47.6%	17.8%			
	8	38w	Boys	1425	47.2%	14.8%	3.1%	5.58	SIGNIFICANT
		38w	Girls	1289	44.1%	13.8%			
	8	38x	Boys	1414	48.3%	16.1%	2.9%	4.83	SIGNIFICANT
		38x	Girls	1240	45.4%	14.5%			

***at 1% level of significance**

Unless otherwise stated all significant tests are at 5% level of significance

SUMMARY OF PERFORMANCE BASED ON ABILITY AND ITEM DIFFICULTY

THE ABOVE DATA IS SUMMARISED FROM THE DETAILS BELOW - ANALYSED FOR THE TWO MATHS CLASS 6 PAPERS.

Maths 6 Paper 1

	BOYS	n=1524
21%	27%	40%
29%	56%	69%
57%	88%	90%

	GIRLS	n=1330
17%	21%	41%
25%	48%	67%
46%	78%	86%

	DIFFERENCE	
5%	6%	-1%
4%	7%	2%
11%	10%	4%
Difficult		easy

n 2854

Maths 6 Paper 2

	BOYS	n=1441
17%	26%	44%
23%	51%	71%
46%	79%	88%

	GIRLS	n=1290
16%	26%	40%
20%	44%	67%
36%	71%	85%

	DIFFERENCE		
weak	1%	0%	5%
	4%	7%	3%
strong	10%	8%	2%
	Difficult		Easy

n 2731