Gujarat State Board Examination Reform

Project C, Part C

Changes in Teacher Training - Formats and Approaches

Educational Initiatives Pvt Ltd
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This report would not have been possible without the help of a large number of people.

We would like to express our gratitude to one and all who have helped to successfully execute this study.

We would like to express our deep gratitude to the team from Gujarat Secondary and Higher Secondary Education Board and Michael and Susan Dell Foundation, for their support and guidance in the project.

Last, but not the least, we would like to acknowledge all the researchers and education boards across the world whom we have studied and referred to in our endeavour to bring about the present report.

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Educational Initiatives
TEAM

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Several studies show that Gujarat’s educational performance is not in line with its leadership position among states in other areas (NCERT, ASER and Educational Initiatives (EI)). Gujarat performance is slightly below national average, and the number of zero scorers is among the highest in India. (Student Learning Study, EI, 2010).

Education is slowly being recognised as critical among the electorate and the policy makers of the state. In 2011-12, the government of Gujarat in collaboration with Michael Susan Dell Foundation and Educational Initiatives (EI), planned and carried out a research study for Board Exam reform. One of the key requirements to reform is to ensure that teacher capacity is built to address the changes suggested by the reform (transition) plan at the classroom level. This report looks at the classroom training approaches used in different countries and also suggest requisite changes in the teacher training formats to equip the teacher to teach, where their teaching is focused more on ‘teaching for understanding’.

**How big is the challenge?**

1. Improving Learning is complex and increasing educational spending alone will not be the answer
2. The core problem in our system is ‘Rote Learning’
3. Current teaching learning processes focus on teaching for rote and not on acquisition of higher order skills
4. Pre-service and In-service teacher education is outdated and does not address teacher needs in a planned and systematic manner

**Why is it important to improve the quality of our teaching?**

1. *Teaching and not teachers seem to be the critical factor in improving student outcomes.* This is an important distinction that needs to be recognised. This often leads to an interpretation that the teachers have some special characteristic or quality, which can be identified by their qualification or training. Research in India shows teachers without formal qualifications and training also seem to perform well (Geeta Kingdon, 2010, Karthik Muralidharan, 2010). Hence, qualifications and training are not the issue but the quality of teaching.

2. *Methods teacher employ while teaching are important in determining the quality of teaching.* There are many examples of good teachers employing limited methods that, no matter how competently they are executed, could not lead to high levels of student achievement.

**What happens in classrooms of high performing countries?**

Video data, such as that collected in Trends in Mathematics and Science Study (TIMSS) provides a wealth of information about Maths lessons in classrooms that helps us discover new ideas about classroom teaching practices.

1. In all of the countries, eighth-grade mathematics was often taught through solving problems; at least 80 percent of lesson time, on average, was devoted to solving mathematics problems.
2. Eighth-grade mathematics lessons in all seven countries were organized to include some public, whole-class work and some private, individual or small-group work. During the time that students worked privately, the most common pattern across the countries was for students to work individually, rather than in pairs or groups.

3. On average, lessons in all of the countries included some review of previous content as well as some attention to new content.

4. At least 90 percent of lessons in all the countries made use of a textbook or worksheet of some kind.

5. Teachers in all of the countries talked more than students, at a ratio of at least 8:1 words, respectively.

6. While there were some shared general features, there was discernible variation across the countries in teaching eighth-grade mathematics. Distinctions included the introduction of new content, the coherence across mathematical problems and within their presentation, the topics covered and the procedural complexity of the mathematical problems, and classroom practices regarding individual student work and homework in class.

7. The conclusions from the TMSS videos show that no single method of teaching eighth-grade mathematics was observed in all the relatively higher achieving countries participating in this study, for example, while Japanese teachers focussed attention on patterns/relationships among ideas, facts and procedures, in Hong Kong most of the problems required practice of procedures. However a closer look revealed that mathematics teaching in high achieving countries appears to both 1. Attend to important mathematical relationships, and 2. Involve students in serious mathematical work.

8. The key for higher achievement seemed to lie in the teaching. In other words, more than the problems themselves, the key difference was in the way the teachers presented the problems. Teachers in high achievement countries changed about half the problems to think about patterns and the other half to practice procedures or recall information previously learnt.

Overall Recommendations

1. Gujarat is to plan for targeted teacher trainings that focus on the actual learning gaps found in students (based on Diagnostic test results of Project A) and also among teachers (based on Teacher Needs Assessment results of Project B) and how to overcome them.

2. The aim of the capacity building programme has to be about bringing a change, firstly in the level of understanding of the teachers and secondly in their practice.

3. A training plan for the year and next 5 years is to be made visible and transparent, so that teachers can apply and get selected based on their needs.

4. The training to cover subjects and classes incrementally over a 5 year period, so that in due course all of upper primary and secondary education teachers are equipped to handle a system that is focussed on teaching for understanding and development of higher order skills in students.

5. A teacher professional development system has to be built with teacher mentors at the state level and master trainers available at the district level, who are constantly updated in knowledge and skills.

6. The training content has to be standardised for teacher training so that teachers across all districts receive training of same quality. To avoid ‘transmission loss’ in the training programme, extensive use of videos that delivers important sections of the content has to be developed. Facilities like BISAG and online training modules that
are delivered over the internet should also be explored to ensure standard delivery of training.

7. Research and development of innovative methods involving experts in the field have to be considered to further the professional development of teachers.

8. Technology based solutions has to be considered to attain scale and provide individual attention to teacher needs. These could be in the form of a ‘video bank’ of sample demo classes; providing an e-learning and assessment system that the teacher can login at their own time and upgrade their skills; providing online learning course modules on different aspects of teaching-learning on the latest techniques; and helping teachers to call and discuss their classroom teaching-learning issues.

9. The training provided has to bring about a paradigm shift where teaching is geared towards understanding and development of higher order skills in students rather than mere rote memorisation. The training has to address the beliefs and attitudes of teachers to enable the transition towards teaching for understanding. The training also should have immediate relevance to the teacher in improving their subject content knowledge, pedagogical processes in classroom, planning their curriculum and strategies for assessment. e.g., exposure to techniques such as the ‘backward design’ model which allows establishing curricular priorities that leads to enduring understandings in the topics dealt with.

10. The trainings have to expose the teachers to classrooms in different countries and expose them to a variety of instructional strategies that can be adapted and applied as appropriate in their classrooms. e.g., through viewing TIMSS videos and videos of classrooms in different Indian states and Gujarat.

11. The training has to lead to capacity building methods that are participatory and develops a culture of shared learning. e.g., in the Japanese Lesson Study model, the practice of lesson study involves a group of teachers carefully planning a lesson on a particular topic with the aim of bringing to life a particular goal or vision (for example, a student-centered classroom). These teachers actually conduct the lesson which is both observed by other teachers and recorded for future reference. This is followed by a seminar in which the teachers discuss, dissect and share the learnings from the experiment.
Changes in Teacher Training - Formats and Approaches

I. Importance of Quality Education:

Most of the life changing innovations in the world have happened in the last two decades and the speed of innovations is going to be more intense as we advance into the 21st century. Nations that have the ability to innovate and produce new knowledge will lead the world. Nations’ progress is thus directly related to the education of its workforce. Research (Hanushek and Woesmann, 2007) indicates that quality (measured by cognitive skills) is more important than access (measured by years of schooling) in determining future income and contribution to economic growth.

II. The situation in Gujarat:

Gujarat is steaming ahead of rest of India with the highest growth rate in GDP (10-12%) in the last few years. This is one of the highest growth rates in the world and is equivalent only to China. The vibrancy and buoyancy of Gujarat’s economy is quite evident, which is supported by a strong entrepreneurial culture of its people and strong infrastructure focus of its policy makers. However, if the growth story has to continue, the state has to pay attention to the quality of education that is being received by its children.

Several studies show that Gujarat’s educational performance is not in line with its leadership position among states in other areas (NCERT, ASER and Educational Initiatives (EI)). Gujarat performance is slightly below national average, and the number of zero scorers is among the highest in India. (Student Learning Study, EI, 2010).

Education is slowly being recognised as critical among the electorate and the policy makers, as is evident from ‘Guntosav’, the main objective of which is to ensure quality education of students in Government schools and to increase awareness for quality in the education community.

In 2011-12, the government of Gujarat in a pioneering move decided to carry out a scientific and systematic research study into Board exams before initiating any large and far reaching systemic reforms on the board examinations. This was done in order to avoid the peril and risk of having the reforms plans fail or produce unanticipated outcomes. The research was carried out with the collaboration of Govt of Gujarat, Michael Susan Dell Foundation and Educational Initiatives (EI). EI planned and carried out the research study.

The study took a cohesive look at the examinations offered in different educational systems, secondary literature and research studies available on comparative study of examinations, the multiple effects and causes of particular assessment practices, views of educational planners, examination department personnel, schools, teachers and parents. A 5 year practical transitioning plan to move to an examination-system that is based on understanding, not rote is recommended by the study. One of the key requirements to reform is to ensure that teacher capacity is built to address the changes suggested by the transition plan at the classroom level. This report looks at the classroom training approaches used in different countries and also suggest requisite changes in the teacher training formats to equip the teacher to teach, where their teaching is focused more on ‘teaching for understanding’.

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TABLE 1. ANALYSIS OF STUDENT PERFORMANCE IN CLASS 6 QUESTION PAIRS TESTING ‘LEARNING WITH UNDERSTANDING’ – EI’s Student Learning Study

<table>
<thead>
<tr>
<th>Rote based /Procedural Questions</th>
<th>% Correct</th>
<th>Understanding /Conceptual questions</th>
<th>% Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write the answer.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>713</td>
<td></td>
<td>25 × 18 is more than 24 × 18. How much more?</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td></td>
<td>A. 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B. 18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C. 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D. 25</td>
</tr>
<tr>
<td>What is the perimeter of this shape?</td>
<td></td>
<td>A thin wire 20 centimetres long is formed into a rectangle. If the width of this rectangle is 4 centimetres. What is its length?</td>
<td></td>
</tr>
<tr>
<td><img src="shape.png" alt="Shape" /></td>
<td></td>
<td>A. 5 centimetres</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. 6 centimetres</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. 12 centimetres</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D. 16 centimetres</td>
<td></td>
</tr>
<tr>
<td>The cost of the pickle is rupees_____..</td>
<td></td>
<td>The pickle should not be eaten after the month of _____. (write the month and the year)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>India</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>India</td>
</tr>
<tr>
<td>What made the whole earth shake?</td>
<td></td>
<td>Write two ways in which the lion tried to make the hare feel better at the end of the story.</td>
<td></td>
</tr>
<tr>
<td>A. an earthquake</td>
<td></td>
<td></td>
<td>India</td>
</tr>
<tr>
<td>B. an enormous fruit</td>
<td></td>
<td></td>
<td>India</td>
</tr>
<tr>
<td>C. the fleeing hares</td>
<td></td>
<td></td>
<td>India</td>
</tr>
<tr>
<td>D. a falling tree</td>
<td></td>
<td></td>
<td>India</td>
</tr>
</tbody>
</table>

1. **Improving Learning is complex and increasing educational spending alone will not be the answer:** It is sometimes assumed that the challenge of providing quality education is an easy one to meet – ‘just do the basics right and quality will be achieved’. But experience worldwide and in India suggests that this is not true. The US spending on education jumped roughly from 300 to 600 billion dollars between 1995 and 2007. However, its performance in TIMSS rose marginally in Maths and did not in Science. More closely in India, the case of Himachal Pradesh reveals that most of the inputs are in place, but outcome are not satisfactory. Parents and children are committed, buildings are in decent shape and used as learning aids. The Mid Day Meal is nutritious. Teachers have relatively positive relationships with the students. Yet, the quality of education as revealed by PISA 2009 showed that Himachal Pradesh is the second last among the 74 countries that participated.

2. **The core problem in our system is ‘Rote Learning’:** Rote learning can be characterized as one where there is an undue emphasis on memorization and students generally learn to memorise facts, formulae, use of procedures and can solve only problems that are straightforward and appear straight from the textbook. Switching from rote learning to ‘Learning with Understanding’ may be the key to removing our biggest educational bottlenecks. Some examples of rote and understanding questions are provided in the table 1 from Educational Initiatives’ Student Learning Study that assessed students from 19 states in 2010.

3. **Current teaching learning processes focus on teaching for rote and not on acquisition of higher order skills:** According to an article in Time Magazine, “in order to compete in the 21st Century, students need to be taught a curriculum that balances core knowledge, such as math, science and reading, with what educators call “portable skills,” such as critical thinking, making connections between ideas and knowing how to continue learning”. For providing portable skills to our students, our teaching- learning process has to shift from a focus on the acquisition of knowledge (as in memorising facts) to acquisition of process (logical reasoning, analytical thinking, creativity, learning to learn to support independent lifelong learning)

4. **Pre-service and In-service teacher education is outdated and does not address teacher needs in a planned and systematic manner:** A government document reports the following lacunae in in-service teacher education and professional development in India -
   - The current training approach is fragmented, often leading to a situation that teachers repeatedly attend the same training programme year after year.
   - Consequently, training often does not lead to capacity enhancement or content enrichment, or result in enhancing motivation levels of teachers to bring about changes in classroom practices.
   - The practice of developing an overall Training Plan, which delineates details of different training modules, does not exist, and needs to be introduced.
   - Focus needs to be given to introduce and sustain interactive, participatory and democratic training methods/ processes.
Teachers have one of the most demanding vocations in the world and in order to fulfil their important roles with excellence, they need training, motivation as well as regular mental, emotional and spiritual rejuvenation.

According to a research by Sanders and River in 1996, on an average, two students with average performance (50th percentile) will diverge by more than 50 percentile points over a three year period depending on whether they were assigned to a high performing teacher or low quality teacher.

However, teaching and not teachers seem to be the critical factor in improving student outcomes. This is an important distinction that needs to be recognised. There are misconceptions in the system that if teacher quality is improved, then the learning outcomes improve. This often leads to an interpretation that the teachers have some special characteristic or quality, which can be identified by their qualification or training. The Right to Education Act specified specific qualifications for teachers and also seem to approach the issue of teaching learning as ‘teacher quality’ without paying attention to the ‘quality of teaching’. Research in India shows teachers without formal qualifications and training also seem to perform well (Geeta Kingdon, 2010, Karthik Muralidharan, 2010). Hence, qualifications and training are not the issue but the quality of their teaching.

Teaching is considered a cultural activity i.e., we learn how to teach indirectly, through years of participation in classroom life, and we are largely unaware of some of the most widespread attributes of teaching in our own culture. There are many examples of good teachers employing limited methods that, no matter how competently they are executed, could not lead to high levels of student achievement.

If a doctor, lawyer, or dentist had 40 people in his office at one time, all of whom had different needs, and some of whom didn’t want to be there and were causing trouble, and the doctor, lawyer, or dentist, without assistance, had to treat them all with professional excellence for nine months, then he might have some conception of the classroom teacher’s job.

~ Donald D. Quinn
<table>
<thead>
<tr>
<th>Country &amp; Subject (no of videos)</th>
<th>List of TIMSS Videos available and their download link</th>
</tr>
</thead>
</table>
| **Australia Math (4)**          | Exterior Angles in a Polygon - [http://timssvideo.com/29](http://timssvideo.com/29)  
|                                 | Congruence - [http://timssvideo.com/27](http://timssvideo.com/27)  
|                                 | Data Collection and Representation - [http://timssvideo.com/33](http://timssvideo.com/33)  
|                                 | Ratios - [http://timssvideo.com/35](http://timssvideo.com/35)  |
| **Australia Science (5)**       | Fingerprints - [http://timssvideo.com/30](http://timssvideo.com/30)  
|                                 | Metals and Non-metals - [http://timssvideo.com/31](http://timssvideo.com/31)  
|                                 | Kidney Dissection - [http://timssvideo.com/34](http://timssvideo.com/34)  
|                                 | Energy Transfer - [http://timssvideo.com/93](http://timssvideo.com/93)  
|                                 | Force and Motion - [http://timssvideo.com/94](http://timssvideo.com/94)  |
| **Czech Math (4)**              | Exponents and Square Roots - [http://timssvideo.com/36](http://timssvideo.com/36)  
|                                 | Perimeter of a Circle - [http://timssvideo.com/64](http://timssvideo.com/64)  
|                                 | Exponents-2 - [http://timssvideo.com/41](http://timssvideo.com/41)  |
| **Czech Science (5)**           | Spines - [http://timssvideo.com/37](http://timssvideo.com/37)  
|                                 | Salts - [http://timssvideo.com/71](http://timssvideo.com/71)  
|                                 | Elementary Composition of Matter - [http://timssvideo.com/38](http://timssvideo.com/38)  
|                                 | Electrical Current - [http://timssvideo.com/40](http://timssvideo.com/40)  
|                                 | Density - [http://timssvideo.com/42](http://timssvideo.com/42)  |
|                                 | Changing Shape without Changing Area - [http://timssvideo.com/67](http://timssvideo.com/67)  
|                                 | Solving Inequalities - [http://timssvideo.com/49](http://timssvideo.com/49)  
|                                 | Solving Inequalities - [http://timssvideo.com/53](http://timssvideo.com/53)  |
| **Japan Science (5)**           | Combination Reactions - [http://timssvideo.com/46](http://timssvideo.com/46)  
|                                 | Digestion - [http://timssvideo.com/47](http://timssvideo.com/47)  
|                                 | Electrical Current and Heat - [http://timssvideo.com/52](http://timssvideo.com/52)  
|                                 | Air Compression and Expansion - [http://timssvideo.com/72](http://timssvideo.com/72)  |
| **Netherlands Math (4)**        | Graphing Linear Equations - [http://timssvideo.com/68](http://timssvideo.com/68)  
|                                 | Pythagorean Theorem - [http://timssvideo.com/54](http://timssvideo.com/54)  
|                                 | Surface Area - [http://timssvideo.com/55](http://timssvideo.com/55)  
|                                 | Equations - [http://timssvideo.com/56](http://timssvideo.com/56)  |
| **Netherlands Science (5)**     | Suspension and Emulsion - [http://timssvideo.com/73](http://timssvideo.com/73)  
|                                 | Moments of Force - [http://timssvideo.com/74](http://timssvideo.com/74)  
|                                 | Heart - [http://timssvideo.com/79](http://timssvideo.com/79)  
|                                 | Eye - [http://timssvideo.com/57](http://timssvideo.com/57)  
|                                 | Organ Donation - [http://timssvideo.com/75](http://timssvideo.com/75)  |
| **US Math (6)**                 | Graphing Linear Equations - [http://timssvideo.com/58](http://timssvideo.com/58)  
|                                 | Writing Variable Expressions - [http://timssvideo.com/80](http://timssvideo.com/80)  
|                                 | Exponents - [http://timssvideo.com/69](http://timssvideo.com/69)  
|                                 | Secants and Tangents - [http://timssvideo.com/70](http://timssvideo.com/70)  
|                                 | Interior angles of a polygon (from TIMSS 1995 Video Study) - [http://timssvideo.com/97](http://timssvideo.com/97)  |
| **US Science (5)**              | Weather - [http://timssvideo.com/76](http://timssvideo.com/76)  
|                                 | Polymers - [http://timssvideo.com/91](http://timssvideo.com/91)  
|                                 | Sunspots Pulleys - [http://timssvideo.com/59](http://timssvideo.com/59)  
|                                 | Rocks - [http://timssvideo.com/77](http://timssvideo.com/77)  
|                                 | Blood - [http://timssvideo.com/78](http://timssvideo.com/78)  |
| **Hong Kong Math (4)**          | Square Roots - [http://timssvideo.com/43](http://timssvideo.com/43)  
|                                 | Simultaneous Linear Equations - [http://timssvideo.com/44](http://timssvideo.com/44)  
|                                 | Polygons - [http://timssvideo.com/45](http://timssvideo.com/45)  
|                                 | Identity - [http://timssvideo.com/65](http://timssvideo.com/65)  |
| **Switzerland Math (4)**        | Factoring Quadratic Equations - [http://timssvideo.com/60](http://timssvideo.com/60)  
|                                 | Introducing Algebra- [http://timssvideo.com/61](http://timssvideo.com/61)  
|                                 | Pythagorean Theorem - [http://timssvideo.com/62](http://timssvideo.com/62)  
|                                 | Equivalence - [http://timssvideo.com/63](http://timssvideo.com/63)  |

*A list of 6 video descriptions are provided in Appendix A*
Although there are teachers using extraordinary methods in all cultures, the extraordinary is not what defines most students’ classroom experiences. Students’ day-to-day experiences are mainly determined by the methods most commonly used by teachers within a culture. Cross-cultural differences in these commonly used methods are termed the "teaching gap." (Stigler, Hiebert, 1999). Hence the methods teacher employ while teaching are important in determining the quality of teaching.

### V. How is teaching different in high performing countries?

What happens in classrooms of high performing countries? What are the instructional methods that most teachers currently use? Are there alternative ways of teaching in different cultures, or is teaching pretty much the same everywhere?

Video data, such as that collected in Trends in Mathematics and Science Study (TIMSS) provides a wealth of information that helps us discover new ideas about classroom teaching practices. For the past 20 years, TIMSS has measured trends in mathematics and science achievement at the fourth and eighth grades. It has been conducted on a regular 4-year cycle since 1995, making TIMSS 2011 the fifth assessment of mathematics and science achievement trends. TIMSS researchers also analyzed textbooks; asked administrators, teachers, and students about their beliefs and practices; and videotaped teachers teaching typical lessons.

The TIMSS 1999 Video Study examined classroom teaching practices through in-depth analysis of videotapes of eighth-grade mathematics lessons. More ambitious than the earlier TIMSS 1995 Video Study, the TIMSS 1999 Video Study provided rich descriptions of mathematics teaching as it is actually experienced by eighth-grade students in seven countries. In addition to the United States, participating countries include Australia, the Czech Republic, Hong Kong SAR, Japan, the Netherlands, and Switzerland. Students in these countries were generally among the top-performing students on the TIMSS 1995 mathematics assessment.

TIMSS videos provide us with a unique way of peeping into other classrooms and hence the necessary information we need to examine our current practices and then improve them. Videos also capture if there are alternative ways of teaching compared to our current theories and practices of classroom teaching-learning. As the ideas are brought to the teacher through samples of actual classroom teaching, they are practical and can be immediately implemented in their own classrooms. It also can shake up the way teachers think and also let them reflect about their own classrooms.

The study included 638 eighth-grade mathematics lessons collected from all seven participating countries. This includes eighth-grade mathematics lessons collected in Japan in 1995 as part of the earlier study in 1995. In each country, the lessons were randomly selected.
to be representative of eighth-grade mathematics lessons overall. In each case, a teacher was videotaped for one complete lesson, and in each country, videotapes were collected across the school year to try to capture the range of topics and activities that can take place throughout an entire school year. Finally, to obtain reliable comparisons among the participating nations, the data were appropriately weighted to account for sampling design.

A. Similarities in teaching across the top countries: It is clear that all countries that participated in the video study shared common ways of teaching eighth-grade mathematics. Viewed from this perspective, some similarities given below are striking:

- In all of the countries, eighth-grade mathematics was often taught through solving problems; at least 80 percent of lesson time, on average, was devoted to solving mathematics problems.

- Eighth-grade mathematics lessons in all seven countries were organized to include some public, whole-class work and some private, individual or small-group work. During the time that students worked privately, the most common pattern across the countries was for students to work individually, rather than in pairs or groups.

- On average, lessons in all of the countries included some review of previous content as well as some attention to new content.

- At least 90 percent of lessons in all the countries made use of a textbook or worksheet of some kind.

- Teachers in all of the countries talked more than students, at a ratio of at least 8:1 words, respectively.

B. Differences in teaching across the top countries: While there were some shared general features, there was discernible variation across the countries in teaching eighth-grade mathematics. Distinctions included the introduction of new content, the coherence across mathematical problems and within their presentation, the topics covered and the procedural complexity of the mathematical problems, and classroom practices regarding individual student work and homework in class. A sample of these findings is summarized below.

- Introduction of New Content: Eighth-grade mathematics lessons in the Czech Republic placed a greater emphasis on reviewing previously learned content than those in all of the other countries except the United States; lessons in Japan placed a greater emphasis on introducing new content than those in all six of the other countries; placed a greater emphasis on practicing new content than those in the Czech Republic, Japan, and Switzerland.

- Topics: Eighth-grade mathematics lessons across the seven countries focused on a range of topics, from whole numbers and fractions to solving linear equations and trigonometry. Among the almost 15,000 mathematics problems identified and examined as part of this study, at least 82 percent of the problems per lesson, on average, focused on three topic areas: number, geometry, and algebra.

- Procedural Complexity: The level of procedural complexity of problems in Japanese eighth-grade mathematics lessons was different from that in the other countries. In
Japan, 39 percent of problems per lesson were of high procedural complexity, a greater percentage than in any of the other six countries. High complexity was defined as a problem that required more than four decisions by a student, and at least two sub-problems, to solve it, using conventional procedures.

- **Coherence Across Problems:** The relationship between one mathematics problem and the next in an eighth-grade mathematics lesson was different in Japan from that in the other countries. Analysis of the data revealed that, on average, Japanese eighth-grade mathematics lessons contained a higher percentage of problems per lesson that were mathematically related (42 percent) than lessons in any of the other countries. Moreover, Japanese lessons contained a lower percentage of problems per lesson that were repetitions (40 percent) than those in any of the other countries. In all of the countries except Japan, at least 65 percent of the problems per lesson, on average, were identified as repetitions of the preceding problem.

- **Coherence Within Problems... How problems were solved:** Teachers in Hong Kong SAR and Japan presented different types of mathematics problems to their eighth-grade classes than did teachers in the other countries. When mathematics problems were classified into three types of mathematical processes implied by the problem statement—using procedures, stating concepts, or making connections among mathematical facts, procedures, and concepts, in five of the six countries where data were available, a greater percentage of problems per lesson were presented as using procedures than either making connections or stating concepts (HK 84%, CZ 77%, US 69%, AU 61%, NL 57%). The exception to this pattern was Japan where there was no detectable difference in the percentage of problems per lesson that were presented as using procedures (41%) compared to those presented as making connections (54%).

Mathematical connections or relationships were emphasized least often in the Australian and U.S. eighth-grade mathematics lessons among the six countries where data were available. In these two countries respectively, on average 8 percent and less than 1 percent of problems per lesson that were initially stated as making connections led to classroom discussion of the problem that actually made the connections. The percentages in the other countries ranged from 37 to 52.

**C. Conclusions from TIMSS Videos:** The conclusions from the TMSS videos show that no single method of teaching eighth-grade mathematics was observed in all the relatively higher achieving countries participating in this study, for example, while Japanese teachers focussed attention on patterns/relationships among ideas, facts and procedures, in Hong Kong most of
the problems required practice of procedures. *However a closer look revealed that mathematics teaching in high achieving countries appears to both 1. Attend to important mathematical relationships, and 2. Involve students in serious mathematical work.* The importance of both of these features for facilitating students’ conceptual understanding and procedural fluency is corroborated by independent research on mathematics teaching and learning over the past 75 years.

*The key for higher achievement seemed to lie in the teaching.* In other words, more than the problems themselves, the key difference was in the way the teachers presented the problems. Teachers in high achievement countries changed about half the problems to think about patterns and the other half to practice procedures or recall information previously learnt.

For example, consider the problem. “Find a pattern for the sum of the interior angles of a polygon.” There are various pedagogical approaches to this problem that would highlight important mathematical relationships.

a. Students could use protractors to measure the sum of angles in various 3-sided, 4-sides and 5-sided polygons and then study the results. Or

b. Students could divide the polygons into triangles and study how many triangles can be formed into polygons with different number of sides.

c. Teachers, however, could step in and change the intent of the problem by telling students to find the sum of the angles by counting the number of sides, subtracting 2 and multiplying by 180.

When the teachers follow c and not a or b above, the problem would become one of practising an arithmetic procedure, rather than one which searches for patterns. The learning opportunities would be vastly different. (James W. Stigler and James Hiebert, Closing the Teaching Gap, Nov 2009).

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**VI. What is needed for an effective teacher development programme in Gujarat?**

While the educational systems the world over recognise the importance of the teacher, as is often evident by the resources spent on teacher capacity building, the issues often have been about building an effective model and mechanism that would develop and enhance the teachers’ capacity and provide them avenues for professional development.

For the teacher professional development programmes to be effective in improving the teacher’s classroom performance, the following must be ensured:

- Some accountability system by which the teacher accepts responsibility for the quality of student learning.
- Periodic Student and Teacher Assessment that evokes an

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To Improve Quality of Learning

It is essential to Know

An accurate picture of the status of learning today

WHERE WE ARE

A detailed set of goals of what is to be achieved

WHERE DO WE WANT TO GET
emotional response that may help stakeholders to act on it. The assessments would provide data based inputs on progress and gaps.

- Targeted teacher trainings that focus on the actual learning gaps found in students (and also among teachers) and how to overcome them – the problem has to be understood first before the solution.
- Training modules that are well structured and include motivational workshops as well as building strength in content and pedagogy.
- The entire training approach to be one of moving the system from rote learning to learning with understanding.
- A training plan for the year that is made visible and transparent, so that teachers can apply and get selected based on their needs.
- A teacher professional development system built with teacher mentors and master trainers who are constantly updated in knowledge and skills.
- Research and development of innovative methods involving experts in the field to further the professional development of teachers.
- Capacity building methods that are participatory and develops a culture of shared learning.
- Use of technology to attain scale and provide individual attention to teacher needs.

VII. Who should be covered in the teacher capacity building and Why?

Although the capacity of ALL teachers needs to be built, this report looks at capacity building of teachers from class 6 onwards. This is to enable the transition initiated by board exam reform for improving students learning.

When the board exam reform brings about a deeper change in the system by introducing evaluation of students for their understanding and not rote memorisation, this change cannot be brought about suddenly at the grade 10 level. The students need to learn and teachers need to teach for understanding from a much earlier grade level, for example grade 6. Teachers teaching all the subject areas should be covered in the training.

VIII. What should be the approach for teacher capacity building?

- The aim of the capacity building programme should be to bring about a change, firstly in the level of understanding of the teachers and secondly in their practice.
- The training provided should bring about a paradigm shift where teaching is geared towards understanding and development of higher order skills in students rather than mere rote memorisation.
- The training should address the beliefs and attitudes of teachers to enable the transition towards teaching for understanding.
- The training should have immediate relevance to the teacher in improving their subject content knowledge, pedagogical processes in classroom, planning their curriculum and strategies for assessment.
- The trainings should expose the teachers to classrooms in different countries and expose them to a variety of instructional strategies that can be adapted and applied as appropriate in their classrooms.
- The trainings must enable the teachers to learn how to monitor what the students are experiencing, thinking and learning during a lesson so that they can constantly readjust their strategies to capitalize on every opportunity for students to learn.
• The trainings should build awareness in teachers such that they improve their teaching by treating it as an object of study, i.e., improving teaching by studying carefully what works and what doesn’t.

A. Topics: More specifically the training should cover the following areas:
1. Belief and Attitudes (1 day)
2. Subject Knowledge (3 days)
3. Pedagogical Practices (3 days)
4. Curriculum Planning (3 days)
   - Moving from facts to skill (0.5)
   - Six Facets of Understanding (0.5)
   - Establishing Curricular Priorities: Understanding by Design (1.0)
   - Determining Acceptable Evidence (1.0)
5. Assessment Methods (3 days)
   - Different types of Assessment (0.5)
   - Understanding good questions (0.5)
   - Lower order (mechanical) and higher order (conceptual) questions (0.5)
   - Art and Science of making good questions (0.5)
   - Using Rubrics for Evaluation (1.0)
6. Teaching as an object of Study: Lesson Study with Mock Sessions (2 days)

B. Classes and Subjects to be Covered in a 5 year Period: The training can be staggered to cover subjects and classes incrementally over a 5 year period, so that in due course all of upper primary and secondary education teachers are equipped to handle a system that is focussed on teaching for understanding and development of higher order skills in students.

<table>
<thead>
<tr>
<th>Class 10</th>
<th>Y1</th>
<th>Y2</th>
<th>Y3</th>
<th>Y4</th>
<th>Y5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 9</td>
<td>L, M, S, SS, E</td>
<td>L, M, S, SS, E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 8</td>
<td>L, M, S</td>
<td>L, M, S, SS, E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 7</td>
<td>M, S</td>
<td>M, S</td>
<td>L</td>
<td>SS</td>
<td>E</td>
</tr>
<tr>
<td>Class 6</td>
<td>M</td>
<td>M</td>
<td>S</td>
<td>L</td>
<td>SS, E</td>
</tr>
</tbody>
</table>

L-Language; M-Maths; S-Science; SS-Social Studies; E-English

C. Modality of Training:

i. Number of Training Days: The training will require that each teacher receives training for 15 days for enabling the transition to the new board exam format. To enable that all upper primary and secondary teachers across the state receive the training, the training has to be delivered at district level by master trainers who receive the training for the same prior to implementation for teachers.

ii. Training the Master Trainers: Developing an expert master trainer team across the 26 districts is the key to successful implementation of the training programme. From each district a team of 10 master trainers (2 per subject) should be identified making it a total of 260 master trainers. Master trainers will be selected from each district based on strict criteria. The master trainers can be identified from the BRCs, CRCs, DIET lecturers and experienced teachers. Master trainer selection will be based on performance in a selection test for subject and pedagogical knowledge. Candidates short listed through
the test will be further screened through an interview process in each district where their attitudes, ability to handle training, etc will be evaluated.

The final list of expert master trainers will undergo special training for the identified topics provided in the earlier section from teacher mentors. This training can be outsourced to external agencies that are able to provide the training. The training will provide the master trainers with the requisite knowledge and skills required for carrying out training of teachers.

iii. **Standardisation of Training Content**: The training content will be standardised for teacher training so that teachers across all districts receive training of same quality. One of the important issues in a multi layered training model is often the ‘transmission loss’ that happens at each stage, so that the teacher in the end does not get the training delivered to them as intended. To avoid such a scenario, extensive use of videos that delivers important sections of the content has to be developed. The videos will be supported by the activities that the Master trainer will carry out in the training workshops. Facilities like BISAG and online training modules that are delivered over the internet should also be explored to ensure standard delivery of training.

iv. **Providing Continuous Teacher Support**: Teachers should be provided a help forum where they can get access to model demo classes (delivered through BISAG or mediums like ‘youtube’), activity banks, video banks on student responses, etc. The teachers should send their queries by voicemail, email or online requests. The help forum should be handled at the state level or district level by a dedicated group of master trainers for each subject. Support from external agencies can be sought by the state to build the infrastructure and resources for providing continuous teacher support.

v. **Classroom Observations by Peer Teachers**: Teacher learning is the key to improve teaching. Unless the culture of teacher learning changes, improvement in teaching is not likely to happen. Listening to experts during special professional development workshop sessions provides teachers with the lead information but does not immediately translate to improved teaching. Effective teacher learning must be built into teacher’s daily and weekly schedules. Schools must become places where teachers, not just students, learn. An important aspect of teacher learning is when teachers open their classrooms to each other and where their teaching can become a shared object of study. In this environment teachers can plan different approaches together, test them in multiple classrooms, observe how the lesson is done in other classrooms, gather information on its effectiveness and revise the lesson accordingly. Japan’s teachers use such a model of peer work that is termed as ‘Lesson Study’ and which promotes excellence in teaching in Japanese classrooms.

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**IX. Relevance and Intent of Key Training Topics**

**A. Lesson Study: The Core of Japanese Professional Development**

Catherine Lewis, a leading educational researcher, has studied the practice of Lesson Study in the Japanese school education system. She was introduced to the practice when she realised that teachers all across Japan are very effective at teaching science. When she asked a large number of teachers where they learnt how to teach science, she got the same answer: “jugyou kenkyuu” - lesson study or research lessons.
Research Lessons, as Lewis describes them, are actual classroom lessons which share the following characteristics:

- Research Lessons are planned for a long time.
- Research Lessons are observed by other teachers.
- Research Lessons are designed to bring to life a particular goal or vision of education.
- Research Lessons are recorded.
- Research Lessons are discussed.

In essence, the practice of lesson study involves a group of teachers carefully planning a lesson on a particular topic with the aim of bringing to life a particular goal or vision (for example, a student-centered classroom). These teachers actually conduct the lesson which is both observed by other teachers and recorded for future reference. This is followed by a seminar in which the teachers discuss, dissect and share the learnings from the experiment.

As an example, Catherine Lewis describes in detail a research lesson on levers from the Komae School No 7 – a normal public school. The vision that was being implemented in this lesson was “letting students value friendship and yet build their own perspectives and ways of thinking.” In this context, the teachers chose to “introduce levers in a way that really motivates the student’s desire to learn, and that encourages and emboldens them to develop their own perspectives.”

In the process of planning the lesson, the teachers share various ways in which they have taught the lesson before and discuss which ways will help them reach their goal. They decide to challenge students by asking them to lift a 100 kg bag of sand, and then group the students with similar ideas together to put their thoughts into practice. The teachers have never tried this before, and wish to find out if this will help promote individual thinking.

On the day of the lesson, many teachers from the school observe: while the plan is put into action, teachers take note of how it goes, and record student interactions, questions, etc. After the lesson, a colloquium is organized where the teachers who planned and conducted the session speak about their experience and then open the forum for discussion. In this process, the lesson gets discussed in detail, and different points of view about what students learnt get shared.

Catherine Lewis has made an insightful analysis of the impact of such research lessons in Japan. She lists down nine ways in which research lessons have an impact. Four of these ways are very relevant to the Indian context:

i. **Individual Professional Development:** The feedback obtained from observers in a research lesson is a very valuable tool for professional development. Often, young teachers struggle with problems in the classroom that their more experienced colleagues can quickly help them with. The practice of observation and feedback provides an effective way of professional development. Coming from other teachers, this input is likely to be much more effective.

ii. **Teachers learning to see children:** A tremendous impact of Research Lessons is that teachers start to understand how their students think and behave in a classroom. Such an understanding helps developing parameters by which a teacher can judge the status of her class. In Japanese research lessons, data is often collected on student eagerness, student interaction, even aspects like moments of surprise in the students or excitement as evidenced by shining eyes! *This understanding is probably the most critical aspect of...*
teaching for understanding and has been largely treated as unimportant in Indian schools. Research lessons help the teacher build this understanding steadily through observation and discussion.

iii. Spread of new content and approaches: Research lessons allow for ideas and approaches to be quickly shared among teachers. School principals who have agonized over the fact that staff room interactions are rarely about teaching will notice that research lessons provide an invigorating forum for sharing and discussing ideas and teaching methods.

iv. Honouring the Central Role of Teachers: Finally, research lessons put the teacher at the centre of school education, honouring and emphasizing their primary role in ensuring that students learn. While textbooks are useful guides to teaching, the teacher is the best person to judge how much her students are learning and what she needs to do to improve it. Research lessons help focus resources for improvement at the point where they have the most impact: the teachers.

Relevance of Lesson Study for Gujarat:
Lesson Study is an interesting paradigm that seems to have a lot of relevance to the Gujarat situation. It focuses on improving the very aspects that trouble us the most.

• The use of Lesson Study will build a culture among Gujarat Teachers where they learn to approach the school as places where they will learn.
• This will also bring a shift in the way teaching is approached as an object that is to be studied and improved upon.
• The process is democratic, ongoing and builds on existing knowledge and wealth of experience among teachers.
• As the system is large, no centralised intervention alone will work. It is important that the system provides avenues where learning from each other takes place in an organised and systematic manner through a proven method.
• This will also provide accountability towards building a better classroom process through peer observation.

Challenges:
Every principal/teacher who has tried implementing a change in teaching culture and methods (to enable students to learn with understanding) knows just how difficult it can be. With the pressures of teaching in a school, comes a natural resistance to new and alien ideas. And yet, it is this resistance that must be overcome to create the Art of Transformation. The original article is available at [www.lessonresearch.net/aera2000.pdf](http://www.lessonresearch.net/aera2000.pdf), in which Dr. Lewis further analyses conditions which help Research Lessons flower.

B. Establishing Curricular Priorities: Understanding by Design (UbD)
‘Understanding by Design’ or ‘Backward Design’ model, is one of the most effective curriculum designs that is focused on learning with understanding. The model has been introduces by Jay McTighe and Grant Wiggins.

Traditionally teachers start curriculum planning with interesting activities and completing the syllabus rather than having any clear idea on the end goals, i.e., what understanding the students have to get at the end of the unit. In the backward design model, the teacher starts with the end in mind, which is the desired results, and then does the curricular planning to reach there. No activity is added to the lesson plan for activity sake unless it forms an important curricular step in reaching the end result.

Why is understanding important? Understandings make sense of facts, skills, and ideas: they tell us what our knowledge means; they ‘connect the dots’. Understanding is developed
through “uncoverage” of complex ideas, by involving students in active questioning (essential/unit/entry point questions) and through activities that challenge students to practice trying out their ideas and rethinking what they knew.

UbD is a curriculum design that challenges the student—through a knowledge base - to see what is worth understanding, and what needs further explanation. It moves beyond a simple activity oriented approach. It moves beyond the coverage oriented approach. It is developed through a focus on material that is worthy of understanding.

UbD is a backward design model that is comprised of the following three stages:

I. Identifying desired results
II. Determining acceptable evidence
III. Planning learning experiences and instruction

Instead of the conventional thinking of activities first and then planning the assessment, this approach looks at the goals to be accomplished, thinking about assessment of those goals and then planning the unit along with the learning experiences and instruction.

The first phase of curricular design deals with teachers identifying the desired results from the unit by determining what is worthy of understanding. As a part of this, the teacher must consider both the overall and specific expectations outlined by the curriculum specified by the board or ministry.

Establishing the Curricular Priorities: The priorities are established through a useful framework that is illustrated through the image of three concentric circles...

The innermost circle represents the ‘enduring’ understandings that will anchor the unit. The term "enduring" refers to acquiring a deep understanding of big ideas, and concepts that students will carry with them through their lifetime. Enduring understandings are usually at the heart of the discipline, needing uncoverage and potentially engaging for the learners. In other words, these are important understanding or big ideas that we want the students to ‘get inside of’ and retain it even after forgetting many other details.

The middle circle represents the ‘important to know and do’ from the unit being taught. These include important knowledge covering facts, formulae, principles and skills Processes, strategies, and methods are addressed in this circle.

The outer circle represents the knowledge that is ‘worth being familiar with’ in order to complete the unit of study. The students can obtain this knowledge usually by themselves from the content of the unit or information available to them in daily life. The teacher need not emphasize these in the unit.
Relevance of UbD planning for Gujarat:

- Teachers usually handle a unit with the focus to complete the syllabus and often will say that every information that is provided in the textbook for the unit as equally important. The issue of teacher not being able to prioritise leads to cramming of all information – important and not so important for the student.
- By establishing curricular priorities as ‘enduring’, ‘important to know and do’ and ‘worth being familiar with’, the teacher is able to ensure that enough amount of lesson time is spent on the critical parts of understanding, knowing and doing in the topic. It allows the student to acquire the relevant knowledge and separate it out from irrelevant information.
- When teachers understand to identify the ‘enduring understandings’ in an unit, this often leads to teachers themselves attaining conceptual clarity.
- UbD will enable the teacher to move towards ‘learning for understanding’.

C. Understanding Good Questions

The results from TIMSS 1999 video study point out that the questions teachers provide in the classroom is a key aspect of classrooms in high achieving countries. The types of questions teachers ask influence what and how students study, read, practice, etc. The questions a teacher asks should match with what she expects students to learn. Assessment should be linked to the goals of a unit, and should be used by her for feedback.

Questions can be differentiated based on their format (multiple choice, free response, open ended), type (recall, conceptual, application), mode of administration (written, oral, group work) and structures (fill in the black, match the following, short answer, essay).

Questions can be differentiated based on the depth of understanding it checks for. Given below are examples which check for presence or absence of the different facets of understanding.

<table>
<thead>
<tr>
<th>Examples</th>
<th>Presence</th>
<th>Absence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain</td>
<td>A 7th class student can explain why there is much lighter at 5am in Kolkata than in Goa.</td>
<td>What is the difference between the Equatorial Circumference and Polar Circumference example</td>
</tr>
<tr>
<td>Interpret</td>
<td>A child reads the weather chart in the newspaper and says “Its going to be cold in Delhi”</td>
<td>A student knows the grammar rules in Sanskrit, but cannot understand a full sentence.</td>
</tr>
<tr>
<td>Apply</td>
<td>A young couple compares the terms of various home loan schemes and chooses one.</td>
<td>A physics prof / teacher cannot change a fuse.</td>
</tr>
<tr>
<td>Perspective</td>
<td>A 10th class girl completes a talk on the anti-conversion bill saying it is a complex issue with different viewpoints.</td>
<td>A student refuses to accept that there can be another viewpoint on the issue of Indo-Pak relations apart from what he believes.</td>
</tr>
<tr>
<td>Empathy</td>
<td>A student answers insightfully how she would feel in the heroine’s shoes.</td>
<td>A primary teacher can’t see why her children are taking so much time to do single digit addition</td>
</tr>
<tr>
<td>Self Knowledge</td>
<td>A teacher takes extra time with a group of weaker children to explain the lesson after class.</td>
<td>A principal believes that use of computers will solve all the learning problems in her school.</td>
</tr>
</tbody>
</table>
Questions can be identified as not good when:

a. the learning outcomes addressed by the question is trivial
b. it tests a different skill than the one intended
c. the concept and language is not appropriate for the age and ability
d. there is ambiguity in terms of testing outcomes and instructions
e. a question checks for too many outcomes
f. questions are picked up verbatim from the text
g. there is use of a number of negatives in the question
h. the outcome of one question influences the outcome of another question in the same paper
i. there is a position pattern for answers
j. the correct answer is obvious and irrelevant clues are provided.

and many more...

Teachers should be trained to design questions, administer the tests and handle the reading of assessment reports all of which are considered important to carry out a standardised assessment. Teachers should also learn to design variety of questions of different types in a given topic. This is illustrated in the example below:

### Topic Reading Comprehension

**Class 10**

Sub topics: Literal Comprehension (LC); Extended Reasoning (ER)

Sub skills under each sub topic are mentioned below each question.

#### 150-Year-Old Lost Ship Found in Arctic

Canadian archaeologists have found a ship abandoned more than 150 years ago in the quest for the fabled Northwest Passage and which was lost in the search for the doomed expedition of Sir John Franklin.

Marc-Andre Bernier, chief of the underwater archaeology service with Parks Canada, the federal body conducting the Arctic survey, said the “HMS Investigator, abandoned in the ice in 1853, was found in shallow water in Mercy Bay along the northern coast of Banks Island in Canada’s western Arctic. “The ship is standing upright in very good condition. It’s standing in about 11 metres of water,” he said. “This is definitely of utmost importance. This is the ship that sailed the last leg of the Northwest Passage.”

In 1847, it was believed that Sir John Franklin and his 1845 expedition to the North-West Passage had met with tragedy. The fears prompted a flurry of rescue efforts from Britain and the U.S. The Investigator was one of many American and British ships sent out to search for the HMS Erebus and the Terror, vessels commanded by Franklin in his ill-fated search for the Northwest Passage in 1845.

Captained by Robert McClure, the Investigator sailed in 1850. During the mission, the Investigator sailed into the strait that now bears his name and realised that he was in the final leg of the Northwest Passage, the sea route across North America. In a twist of fate, before McClure could be the first to sail the Passage, the Investigator encountered impenetrable pack ice and was forced to face the winter in Prince of Wales Strait. Once freed, McClure attempted the Passage a second time. The Investigator however, faced heavy ice once again. Hoping to find a safe anchorage as winter approached, McClure navigated his ship into a large bay he dubbed the Bay of Mercy on the north coast of Banks Island. Unfortunately, pack ice failed to clear from the Bay during the summer of 1852 and by the spring of 1853 the crew’s situation became dire.

The Investigator was eventually abandoned. The crew, led by Captain McClure, left behind a cache of equipment and provisions on the shore of what is now a part of Aulavik National Park. “This was the ship that confirmed and nailed the discovery of that passage,” said Marc-Andre Bernier. Environment Minister, Jim Prentice said the British government has been notified that one of their naval shipwrecks has been discovered, as well as the bodies of three sailors.

The rest of the crew were later evacuated by the HMS Resolute.

Glossary: *HMS: used in the names of the ships belonging to the British Navy, it stands for His/Her Majesty’s Ship*

1. **According to the passage, which of these came CLOSEST to crossing the Northwest Passage?**
   A. Terror
   B. HMS Erebus
   C. HMS Resolute
   D. The Investigator
   Ans D.

2. **This is definitely of utmost importance.**
   The underlined word in the line above is REFERRING to "__________".
   A. the 11 metre deep water level
   B. the upright position of the ship
   C. the discovery of HMS Investigator
   D. the condition in which the ship was found
   Ans D.

3. **Choose the option that REPRESENTS the events CORRECTLY.**
   i) HMS Erebus sails out
   ii) HMS Investigator sails out
   iii) Fate of HMS Erebus is unknown
   A. I - I - III
   B. III - II - I
   C. II - I - III
   D. I - III - II
   Ans. D.

4. Judging by the title, "150-Year-Old Lost Ship Found in Arctic" and the contents of the passage, in which of these are we MOST LIKELY to find this passage?
   A. a travel brochure
   B. a news item in a magazine
   C. a college textbook on geography
   D. a book on shipping routes of the world
   Ans. B

5. Who among the following is LIKELY to be responsible for officially informing countries about the discovery?
   A. Jim Prentice
   B. Marc-Andre Bernier
   C. Canadian archaeologists
   D. Officials at Aulavik National Park
   Ans: A

6. Which of the following can be CONCLUDED from the passage?
   A. The Investigator was a ship owned by the Americans.
   B. The expedition of Sir John Franklin was finally tracked down.
   C. Efforts to find the Investigator were never carried out in the past.
   D. Some areas close to the Northwest passage are covered by ice most times.
   Ans D.

7. Captain Robert McClure's attempts to manoeuvre HMS Investigator across North America tells us that he was ____________.
   A. confused
   B. persistent
   C. distracted
   D. unreasonable
   Ans. B
Skill: ER - Distinguishes facts from opinions and understands moods/ tones/ emotions in texts
8. Which of these would the crew of the Investigator have felt by the year 1853?
A. puzzled
B. devastated
C. defensive
D. indifferent
Ans B.

Skill: (ER) Deduces, predicts, interprets information in texts
9. McClure probably dubbed the large bay as the 'Bay of Mercy' because he___________________________.
A. thought that it would be the way to go back home
B. thought that the winter in the bay would be less severe
C. hoped that it would safely lead him to other ships
D. hoped for a sheltered place to spend the winter
Ans – D

Skill: (ER) Appreciates and evaluates information in texts
10. Based on the information from the passage, which of the following STATEMENTS is TRUE?
A. The HMS Investigator was abandoned when it started sinking into the deep sea.
B. The crew of HMS Investigator was compelled to spend three winters in the cold Arctic.
C. The crew of HMS Investigator left behind a cache of equipment and provisions for their colleagues.
D. The HMS Investigator was abandoned close to where Sir John Franklin met with a tragedy.
Ans- B

Skill: (ER) Appreciates and evaluates information in texts
11. Whose name and profession is INCORRECTLY matched?
A. Jim Prentice - politician
B. Sir John Franklin - explorer
C. Robert McClure - captain
D. Marc-Andre Bernier - sailor
Ans - D

Relevance of ‘understanding good questions’ for Gujarat:
The analysis of board exam questions in Gujarat (as mentioned in part A of the report) showed that one of the main issues was in the quality and type of questions that were included in the test paper.

International experience shows that when the teacher is able to provide questions that will provoke thinking as well as questions that enable practice of content taught, the learning achieved is high. Gujarat will not be able bring about a shift to higher order learning unless the teachers understand the differences between various types of questions, how to make good questions and use them appropriately to facilitate deeper understanding of the topic for the student.
D. A Sample Module on Subject Knowledge
Mathematics Subject Knowledge Training- key ideas in major topics
Maths is often viewed as a set of rules and formulae, which are rarely related to the students’ life. As a result, a question often heard in classrooms is, “But why are we learning this?” Many of the Mathematics ideas that children learn - even abstract ideas - are closely linked to each other and to the real world. Often, in the race to teach the routine Mathematical procedures within a stipulated time, the broader aims of teaching Mathematics take a backseat. As a result students enter secondary school with at best a procedural fluency in the topics on which the secondary curriculum is built. Lack of a firm grasp of the fundamentals leads to a fear of Mathematics, and the student tends to disconnect from the subject. It is therefore important for the secondary school teacher to be able to help students connect Mathematics to everyday life and help them see it as a vehicle for developing higher order thinking skills like logical reasoning, problem solving. For this the teacher should have
• A deep understanding of the key ideas in the topics- including real-life applications, connection to other topics and disciplines etc. (e.g. relating graphs to equations)
• This includes having an understanding of topic ‘strands’ that run across class levels
• Have methods of pre-assessing understanding of important middle school topics, as well as how to address the gaps that exist
• Be able to teach ‘problem solving’ as an approach across different topics
• This module will try to equip the teacher in the above areas and will include sessions that cover-
  • The essential prerequisite understandings (eg. proficiency in integer operations for algebra) required to master secondary school mathematics, with emphasis on the possible shortcomings that may be there in these and how to address these.
• The key ideas covered in the main strands of Mathematics in the framework of real life applications and in relation to other strands/higher mathematics.
  o Numbers – number systems and relationships among them – effective use of estimation techniques, number properties and shortcuts
  o Algebra – Conceptual understanding of different uses of variables, using symbolic algebra to represent and solve problems, find relationships among quantities. To emphasize on the generalization and modeling aspects of algebra rather than pure manipulation of symbols
  o Geometry – Deductive reasoning and how to develop it. Use deductive reasoning to prove results in geometry.
  o Measurement: In the context of real life applications - Measurement more than a set of formulae to calculate area/volume
  o Concepts of Data Interpretation and Trigonometry.
  o Problem Solving: Devise strategies based upon known facts and concepts to solve problems in unfamiliar situations.
  o Integrate learning with real life experiences

E. (a sample module on pedagogy)
Tools for Science teaching- Models, Experiments and technology tools
Teacher-centred methods such as lecture method (chalk & Talk), result in low involvement level of students in the classroom. These methods can not only be boring, but also have severe limitations in terms of helping students learn key science skills and concepts. The following types of tools and approaches are critical for an effective science teacher-
• Activities and experiments that can be conducted easily in the classroom or even at home, that excite the student and ‘hook’ him into learning the topic
• Physical and virtual models to understand various physical phenomena (e.g. a 3D model is a must to understand planetary phenomena, and a blackboard drawing can never do justice to it).
• Getting students to pose hypotheses, and conduct simple experiments to verify these hypotheses, and reflect on the results of these experiments

There is ample evidence worldwide to show that a hands-on approach to learning science, when combined with careful reflection, develops students’ science concepts and also ‘science process’ skills.

Keeping the above in mind, this module covers-
1. Hands-on activities and simple experiments that can help the child make simple observations, and examine patterns.
2. Guidance on physical models that can be used to illustrate different physical phenomena.
3. Examples of virtual tools available free online that can help students to visualize complex physical phenomena, and links to such resources
4. Questioning and facilitation techniques to guide students to construct understanding by interpreting their experiences in a scientific manner

Relevance of training on subject content and pedagogy for Gujarat:
Teachers like any other adults often carry a number of misconceptions and make common errors which usually get passed on to students. Strengthening the subject knowledge and understanding of pedagogy will enable the teachers to directly strengthen their output in classroom processes.

X. Overall Recommendations

1. Gujarat is to plan for targeted teacher trainings that focus on the actual learning gaps found in students (based on Diagnostic test results of Project A) and also among teachers (based on Teacher Needs Assessment results of Project B) and how to overcome them.
2. The aim of the capacity building programme has to be about bringing a change, firstly in the level of understanding of the teachers and secondly in their practice.
3. A training plan for the year and next 5 years is to be made visible and transparent, so that teachers can apply and get selected based on their needs.
4. The training to cover subjects and classes incrementally over a 5 year period, so that in due course all of upper primary and secondary education teachers are equipped to handle a system that is focussed on teaching for understanding and development of higher order skills in students.
5. A teacher professional development system has to be built with teacher mentors at the state level and master trainers available at the district level, who are constantly updated in knowledge and skills.
6. The training content has to be standardised for teacher training so that teachers across all districts receive training of same quality. To avoid ‘transmission loss’ in the training programme, extensive use of videos that delivers important sections of the content has to be developed. Facilities like BISAG and online training modules that are delivered over the internet should also be explored to ensure standard delivery of training.
7. Research and development of innovative methods involving experts in the field have to be considered to further the professional development of teachers.
8. Technology based solutions has to be considered to attain scale and provide individual attention to teacher needs. These could be in the form of a ‘video bank’ of sample demo classes; providing a e-learning and assessment system that the teacher can login at their own time and upgrade their skills; providing online learning course modules on different aspects of teaching-learning on the latest techniques; and help line for teachers to call and discuss their classroom teaching-learning issues.

9. The training provided has to bring about a paradigm shift where teaching is geared towards understanding and development of higher order skills in students rather than mere rote memorisation. The training has to address the beliefs and attitudes of teachers to enable the transition towards teaching for understanding. The training also should have immediate relevance to the teacher in improving their subject content knowledge, pedagogical processes in classroom, planning their curriculum and strategies for assessment. e.g., exposure to techniques such as the ‘backward design’ model which allows establishing curricular priorities that leads to enduring understandings in the topics dealt with.

10. The trainings have to expose the teachers to classrooms in different countries and expose them to a variety of instructional strategies that can be adapted and applied as appropriate in their classrooms. e.g through viewing TIMSS videos and videos of classrooms in different Indian states and Gujarat.

11. The training has to lead to capacity building methods that are participatory and develops a culture of shared learning. e.g, in the Japanese Lesson Study model, the practice of lesson study involves a group of teachers carefully planning a lesson on a particular topic with the aim of bringing to life a particular goal or vision (for example, a student-centered classroom). These teachers actually conduct the lesson which is both observed by other teachers and recorded for future reference. This is followed by a seminar in which the teachers discuss, dissect and share the learnings from the experiment.
Samples

Sample 1
Country: Australia
Subject: Maths
Topic: Congruence,
Duration: 47 mins
Grade: 8
Class size: 26
Source: http://timssvideo.com/27

Brief Description of the Video: A high school lesson, dealing with the concept of congruence in an Australian classroom. Teacher–student discussions, hands on activity, teaching style and classroom behavior can be observed. This video is the second lesson in congruence and a clear sense of purpose and easy flow from the first lesson into the second can be seen.

Process flow line followed by the teacher: The teacher begins the class with a recap in the form of 10 quick questions on the previous lesson. She has the students self evaluate their work and reinforces concepts which are not well understood.

Then she gives an activity sheet to the students and makes them do it in groups. The activity consists of
- each student drawing a triangle
- writing out clear steps as to how it was done
- read out the steps to others in the group so that they follow the steps and draw the same triangle
- investigate if the instructions help in the construction of a congruent triangle
- refine the instructions so that the other person is able to draw an identical triangle with the minimum number of steps.

She then goes around the class observing what the students do, and engaging with each group in discussions. Through these discussions she clarifies the notions of the students and helps them state their observations in formal mathematical language. (Eg – how she leads the child who talks about horizontal and vertical lines to realize that she was in fact specifying the angle between the two lines.)

On observing that the students have come up with just 2 of the 4 methods she has in mind, she prods them on to “think of alternative ways to construct the same triangle”. All along she questions them and leads them to answers.

On completing the activity she consolidates the findings and lists down the 4 different sets of 3 measurements each of which completely determine a triangle. A high degree of engagement can be observed in the students in the class.

Then she moves on to reinforcing the concepts with the help of practice problems from the text book.
Key Points on Teacher Approach to the Topic:

- The teacher let the students explore, hypothesise, verify, go back and refine and arrive at the result by successive revisions. All along she was encouraging students to construct their own knowledge and at no point did she ‘hand down anything’.

- In making all the students answer the revision questions on paper, and not going for an approach where the class gives the answers as a whole she ensured that each child thinks through the questions and recapitulates the concepts. She completed an assessment on the previous lesson very effectively and quickly by having the students evaluate their own work and explained one of the mistakes again.

- When some students showed her their work and asked her “Is this right?” or “Will this work?”, she asks them to try it out and see if it works. Here we see the teacher refusing to classify the work as right and wrong and encouraging the spirit of enquiry and experimentation. She also sends out the clear message that errors are part of the learning process and that learning happens through these errors.

- Throughout the class, the teacher invited the students to speak and gently questioned them and there by leading them to think and realize things. This was very evident where she helped the student who was talking of a horizontal and vertical line to see that she was in fact talking of angles.

- The teacher went around the class, interacting with each student, probing and guiding them. In trying to teach the concept by actually making the students “do” some activity, and discussing about it, the teacher was able to ensure that each child engages in the class. She was able to build up the interest and enthusiasm of the students and an atmosphere encouraging discussions. This will ensure that true learning happens.

Sample 2
Country: USA
Subject: Maths
Topic: Secants and Tangents
Duration: 45 mins
Grade: 8
Class size: 15
Source: http://timssvideo.com/70

Brief Description of the Video: This eighth grade mathematics lesson focuses on the measurement of angles formed by secants and tangents intersecting with a circle. It is the fourth lesson in a six-lesson unit on this topic. The lesson is 45 minutes in duration. This is an advanced eighth grade geometry class, in the US.

Process flow line followed by the teacher: The teacher begins the class by asking 3 questions to refresh the concepts taught in the previous class. She asks the students to state the 3 key results in their own words. These results are used in proving the day’s results as well.

She then clearly outlines the day’s lesson in terms of the different cases that they would be dealing – secants and tangents intersecting on the circle, two secants intersecting inside the circle and outside the circle. Then she methodically considers cases one by one.

It appears that the students have already been given activity sheets which cover different cases and they have made some measurements and tabulated them. The teacher invites the
students to share the reasoning that they used to find the different angles (with specific measures) and then asks them to generalize with the measure of the angle \(x\). She then helps them generalize and formulates the results such as “when two secants intersect outside the circle, the angle between them is one half of the difference of the intercepted arc.”. She then gives problems that call for application of the results discussed.

**Key Points on Teacher Approach to the Topic:**

- There is very little the teacher is actually teaching – instead is just eliciting responses from the students, asking right questions and leading them to think. Also she invites alternate methods to solve problems and appreciates the students when they come up with a much easier method than she herself had. So there is an air of openness and participation from the students.
- Instead of handing down the results, the teacher actually makes the students consider different cases, make the measurements/calculations of unknown angles and from the pattern emerging generalizes to state the theorem. She effectively moves from the specific case to the general one.
- The teacher also tries to integrate the different results taught and draws attention to the similarities and patterns in them – For example the cases when two chords intersect inside the circle the angle between them is half of the sum of the degree measures of the intercepted arc, and when two secants intersect outside the circle, the angle between them is half the difference of the intercepted arcs. When arriving at new results she draws attention to the emerging patterns and leads the students to think what the result should be if it should fit the pattern.
- Throughout the class the students lead the discussion and the teacher just serves as a facilitator to direct their thinking. Also she keeps asking them to explain why they did a certain step.

**Sample 3**

**Country:** Netherlands

**Subject:** Maths

**Topic:** Pythagoras Theorem

**Duration:** 50 mins

**Grade:** 8

**Class size:** 25

**Source:** [http://timssvideo.com/54](http://timssvideo.com/54)

**Brief Description of the Video:** A high school lesson, dealing with the Pythagoras Theorem in a Dutch classroom. Discussions, effective use of models, teaching style and classroom behavior can be observed. This is the first lesson on Pythagoras theorem.

**Process flow line followed by the teacher:** The teacher begins the class by building up a background to the theorem by asking about Pythagoras and then she asks the students what they know about the theorem. She then goes on to talk about the types of triangles in an effort to help students place the lesson in the correct context. She successfully drives the point that Pythagoras theorem is applicable only to right angled triangles.

She then goes on to demonstrate the theorem by means of an activity. For this she poses the problem of finding the area of a square that is inscribed in another square. From there she leads on to an activity involving cutting and realigning of shapes from which the Pythagoras theorem emerges. She then formally states the result and goes on to solving problems using
these. During the problem solving she gives the student a free reign and lets them solve the problems at their own pace. The problems as seen in the shots of the text book do not seem to be the routine plug in the values and solve kind. They seem to emphasise the thought process that concluded in the theorem rather than the theorem itself.

**Key Points on Teacher Approach to the Topic:**

- The teacher places the lesson in a proper background – some discussion about Pythagoras, some about types of triangles all help the students to get a perspective of the lesson.
- The way she was using terms and at the same time not giving them too much importance – She was using the terms like hypotenuse and formal statements frequently enough for the students to familiarize themselves with these, but was not giving undue importance to these.
- Instead of stating the result at the outset of the lesson and trying to verify it or prove it, the teacher does an activity from which the result emerges. Then she states the result so that the students see the truth of the result for themselves rather than have it handed down to them.
- The teacher does not attempt to solve problems on the board once she is finished with the lesson. Instead she asks them to solve a particular exercise from the book. Both the problems and the approach seen in solving them emphasise problem solving skills and the thought process involved in the demonstration rather than on the result itself. The teacher lets the students take the initiative in solving these problems and helps them along. So though there is some noise in the class, the students are actively involved in solving the problems much more than when it is solved on the black board.

**Sample 4**

**Country:** Japan  
**Subject:** Chemistry  
**Topic:** Electrolysis of water and its reverse  
**Duration:** 51 mins  
**Grade:** 8  
**Class size:** Around 30 students  
**Source:** [http://timssvideo.com/52](http://timssvideo.com/52) (File name: JP4 Electrical current and heat.mpg)

**Brief Description of the Video:** A high school lesson, from start to finish, dealing with the topic of Electrolysis of water and the Chemical Synthesis of water in a Japanese classroom. Teacher –student discussions, practical demonstrations, teaching style and classroom behavior can be observed. This video has apparently been taken in the middle of a unit, so there are references to past lessons that are relevant, and a learning path for the immediate future too.

**Process flow line followed by the teacher:** The teacher began the class with a quick recap in the form of checking a Homework assignment, so students could link to the previous lesson. She then introduced the day’s topic with a link to the assignment, by asking them to consider the reverse of the reaction of electrolysis of water. She asked the students to gather in groups and discuss whether the reverse of electrolysis of water into hydrogen and oxygen was possible. i.e. whether water could be formed using hydrogen and oxygen.

Qns she posed: If yes, then how would you do it? If no, then why couldn’t you do it?
She instructed students to present their answers at the end of the discussion, in the form of a summary. Students were actually encouraged to participate in discussion! It was the opposite of ‘Don't talk!’ Students were so used to doing this, that they were not causing unnecessary noise, ruckus. She then made all the students record their thoughts on this reverse process in their notebooks. After discussing their thoughts, she went on to show them a practical demonstration. She used an induction coil, canned oxygen, iron and HCl to produce hydrogen, etc. to generate water.

She then asked students to list down in very short bullet points what they had learned in that lesson. She picked out 3 students to write down their summary to share with the class. She went around checking students’ summaries, and then at the end of the lesson gave technical names for both the types of reactions and said that they would be focusing on chemical combinations in the next set of lessons.

**Key Points on Teacher Approach to the Topic:**

- The whole lesson revolved around VERY practical demonstrations of electrolysis. At every stage, she involved the students - in setting up the apparatus, as well as asking them qns about different points of the experiment that they were conducting. She kept engaging the students to think about different aspects during the process.
- At the beginning of the class, the teacher encouraged the students to check each other's assignments - this showed trust, both on the part of the teacher, as well as the students.
- During the discussion, she went around the class, checking rather silently what each group was doing. One of the students asked her whether water could be made by simply mixing the gases in the apparatus. The teacher recognised it as one kind of thought and asked him to put it down in his notebook.
- The entire tone of the class was one of a discussion - where students are free to express themselves, but the lesson is being steered quite deliberately by the teacher. Not once was there an instance where the teacher said ‘That’s incorrect’ or anything to that effect to a student.
- Such approaches open up the classroom to a place of engagement, discussion and greater learning. All these techniques employed can be implemented in classrooms in India, and may result in high engagement.

**Sample 5**

**Country:** Australia  
**Subject:** Chemistry  
**Topic:** Energy transfer and Energy transformation  
**Duration:** 1 hr 14 mins  
**Class size:** Around 25-30 students  
**Grade:** 8  
**Source:** [http://timssvideo.com/93](http://timssvideo.com/93) *(File name: AU4 Energy Transfer.mpg)*

**Brief Description of the Video:** A high school lesson, from start to finish, dealing with the topic of Energy transfer and Energy transformation in an Australian classroom. Teacher – student interactions, practical demonstrations, teaching style and classroom behavior can be observed.

**Process flow line followed by the teacher:** She started off the lesson with an example of heat being transferred from one’s foot to the tiles on a cold winter morning in the bathroom.
She seemed to go over the same thing over and over again, first herself, then asking students repeatedly (maybe unnecessarily) to explain energy transfer. She then went on to strike a match and used that example to show energy transformation. Although she used 4 examples, the only engagement with students were prompts for one-word answers mostly.

She had set up 9 activities of different energy transfers and energy transformations with 9 work stations in the classroom. The brief for student grouping, etc took up around 10 mins of the class. Each student was given a worksheet to fill out - this worksheet also asked for mainly one-word responses.

Example: 1 activity had an induction coil connected to a milli-ammeter (she kept calling it a milli-AMPmeter for some reason). Students needed to move a magnet in the induction coil and see that electrical energy was recorded. One activity malfunctioned, and the teacher was occupied in trying to fix it. She spent almost 15 mins on this.

By the middle of the class, it appeared that there were too many activities happening, and so some students were conducting the activities incorrectly. The teacher went around asking for more one-word answers; an incorrect answer was responded to with a 'No, not that energy', or a repeat of the same question.

At the end of the lesson, the teacher briefly asked students to identify the activities that were energy transfers and the ones that were energy transformations, again stressing on the difference between transfer and transformation repeatedly.

**Key Points on Teacher Approach to the Topic:**
- There were plenty of practical demonstrations in the class, however, the effectiveness of all of them can be questioned. In a class, the number of activities, choice of activities, how they are conducted in class, and the discussion revolving around the activities are far more important than the activities themselves.
- Almost 20 mins into the class, the teacher asked students to describe an energy chain, before writing it on the board - this was the first time students were encouraged to think independently, but that too to represent their understanding of what she had just explained.
- There was not much discussion and maybe too much time and effort given to simply stress on the difference between these two terms. Half the number of activities, and half the time would have been more than sufficient for this topic. The class wasn't challenging enough - the main stimulus was the set of activities, but the final effect of all those activities was not substantial enough, given the aim of the lesson.
- Time spent in class, and effort put in to engage with students needs to be leveraged wisely in order to ensure that true learning takes place in the classroom. The learning goals should be very clear at the beginning of the year in order to allocate time and effort based on priority of the learning goals.
Sample 6
Country: Netherlands
Subject: Biology
Topic: Working of the eye
Duration: 40 mins
Class size: Around 24 students
Grade: 8
Source: http://timssvideo.com/57 (File name: NL4 Eye.mpg)

Brief Description of the Video: This eighth-grade science lesson is a review for the end-of-year test on biology. Topics include the eye, stimulus and response, and animal behavior. It is the eighth lesson in a sequence of eight lessons on the sensory system and behavior. The lesson is 40 minutes in duration. There are 24 students in the class.

Process flow line followed by the teacher:
The first 10 mins of the class was spent in picking up the threads of the previous class, but the teacher got right into it (and had saved a previously drawn figure on the blackboard).

He kept asking students short questions during the explanation. He used the analogy of a camera and its parts while teaching the iris, the ciliary muscles, and the lens. Although he didn’t use the parts of the camera to introduce different parts of the eye, he used it more like an application to test their immediate understanding.

He asked students to independently reason out where the body would have to expend more energy when the eye needs to focus on something close compared to something at a distance.

Then the teacher distributed worksheets for the class to work on, linked to the units they had done before this class, as well as the current class. While students were doing their assignments, the teacher went around to each desk and checked on the students - discussing some points that they couldn’t understand, but mainly encouraging them to find the relevant information from the textbook and reason out the answers on their own.

This was followed by the teacher distributing graded reports on a previous assignment that students had submitted, and an explanation of how the reports have been graded.

Key Points on Teacher Approach to the Topic:
• The teacher used analogies to explain parts of the topic quite effectively; the use of simple analogies scaffolds the learning process and helps students construct their own knowledge.
• He encourages them to think independently in order to answer a question. The learning would be enhanced if students were encouraged to discuss among themselves and come up with predictions and information to defend their predictions.
• The teacher gives students a clear picture about how they are going to be assessed, what they will be assessed on, and they are encouraged to focus on areas that are important in terms of understanding, not just memorizing. There is buy-in from the students on the curriculum that they need to learn and tests are not a source of apprehension. This encourages students to perceive tests as another task – one that will test for understanding.
TOPIC: LIFE PROCESSES

Skill: Understanding
1. Our bodies are continuously growing. Small particles from the digested food are assembled to form large complex particles that make up the body material. When does this assembly of large complex particles occur in the body?
   A. only immediately after eating food
   B. only immediately after digestion of food
   C. only immediately before digestion of food
   D. It occurs all the time in our bodies.

Skill: Understanding
2. Urea is produced in the liver and transported to the kidneys, from where it is eliminated from the body in urine. Is the statement given below true or false?
   Urea must be removed from the body because it is a waste substance in the body.
   A. False - urea occurs naturally in the body and therefore cannot be called a waste.
   B. True - it is a waste which at high levels can prevent normal functioning of the body.
   C. True - it is highly soluble in water and therefore can make you drink more water.
   D. False - it is produced in the liver and therefore cannot harm tissues in other parts.

Skill: Understanding
3. Which of the following plays the MOST IMPORTANT role in the upward movement of sap in very tall plants?
   P. pulling force due to transpiration
   Q. gravitational force
   R. root pressure
   A. only P
   B. only Q
   C. only R
   D. only Q and R

Skill: Understanding
4. If the temperature of the environment increases beyond 35 °C, why does the rate of photosynthesis decrease?
   A. because the plant cannot take in any air from the atmosphere
   B. because the plant cannot absorb any water from the soil
   C. because the enzymes in the cells slowly stop functioning
   D. because the chlorophyll production in the cells stops

Skill: Recall/Mechanical
5. In our body, where does the digestion of complex food components to simpler molecules occur?
   i) mouth  ii) stomach  iii) small intestine
   A. only in ii
   B. only in i and ii
   C. only in ii and iii
   D. all - i, ii and iii
Skill: Recall/Mechanical
6. The left ventricle has thicker muscular walls than the right ventricle. Why is this?
   A. Unlike the right ventricle, the left ventricle has to pump blood to organs far from the heart.
   B. Unlike the right ventricle, the left ventricle has to filter the blood in addition to pumping.
   C. The left ventricle gets deoxygenated blood and the right ventricle gets oxygenated blood.
   D. The left ventricle receives larger amounts of blood from the lungs than the right ventricle.

Skill: Recall/Mechanical
7. The production of ______ can be used to monitor the rate of photosynthesis in a plant.
   A. carbon dioxide
   B. water
   C. oxygen
   D. nitrogen

Skill: Application
Answer the two questions below. When both kidneys of a person do not work properly, the toxic metabolic wastes can be removed by the use of a dialysis machine. A simple diagram of how it works is shown here.

8. Why is glucose added to the solution flowing in at W?
   A. to provide energy for the process of dialysis
   B. to prevent diffusion of blood glucose into the dialysis fluid
   C. to add glucose into the blood flowing back into the patient
   D. to prevent the evaporation of water from the solution

Skill: Application
9. Of the four fluids marked W, X, Y and Z, which are the two fluids that contain urea?
   A. only Y
   B. only X
   C. only X and Y
   D. only Y and Z
Skill: Application
10. Which of the graphs MOST likely represents the effect of light intensity on the rate of photosynthesis?

![Graph A](image1.png)  ![Graph B](image2.png)  ![Graph C](image3.png)  ![Graph D](image4.png)

**TOPIC: TRIGNOMETRY**

Skill: Recall
Q.1
X is the one of the interior acute angles of a right angled triangle. Which of the following relations is correct?

- A. \( \sin (90^\circ - X) = \cos X \)
- B. \( \sin (90^\circ - X) = \tan X \)
- C. \( \sin (90^\circ - X) = \sec X \)
- D. \( \sin (90^\circ - X) = \cot \)

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Skill: Recall
Q:2
\( \sec \theta = \frac{2}{\sqrt{3}} \). Which of these could be the value of \( \theta \)?

- A. 30°
- B. 45°
- C. 60°
- D. 90°
Skill: Recall and Procedure

Q: 3
In a right angled triangle, measure of $\angle B = 90^\circ$. $AC = (x + y)$ units and $AB = (x - y)$ units. What is $\sin A$?

- **A.** $2\sqrt{xy}$
- **B.** $\sqrt{\frac{2xy}{(x + y)}}$
- **C.** $\frac{2\sqrt{xy}}{(x + y)}$
- **D.** $\frac{(x - y)}{(x + y)}$

Skill: Recall and Procedure

Q: 4
In the triangle shown below, $AC = 5\sqrt{2}$ cm and $\tan \theta = 1$.

![Triangle Diagram]

Which of these is the length of $AB$?

- **A.** $5\sqrt{2}$ cm
- **B.** $5\sqrt{2}$ cm
- **C.** 5 cm
- **D.** 25 cm
Skill: Conceptual Understanding
Q:5
Shown below are two triangles with some of their measures shown.

\( \angle R = \angle N \). From the figure we see that \( \tan R = \frac{3}{5} \). What is \( \tan N \)?

- A. \( \frac{3}{5} \)
- B. \( \frac{3}{10} \)
- C. \( \frac{5}{10} \)
- D. (We cannot find without knowing length of LM.)

Skill: Conceptual Understanding
Q:6
Which of these is positive?

- A. \( \sin 10^\circ - \cos 10^\circ \)
- B. \( \cos 25^\circ - \sin 25^\circ \)
- C. \( \sin 35^\circ - \sin 65^\circ \)
- D. \( \tan 25^\circ - \tan 85^\circ \)

Skill: Conceptual Understanding
Q:7
What is the length (in metres) of the side PQ of the rectangle shown below?
Skill: Conceptual Understanding

Q: 8

PQRS is a quadrilateral with dimensions as below.

What is \( \cos \theta \)?

- A. \( \frac{9}{15} \)
- B. \( \frac{12}{13} \)
- C. \( \frac{13}{14} \)
- D. \( \frac{14}{15} \)

Skill: Conceptual Understanding

Q: 9

\( \alpha \) is an acute angle. \( \sin \alpha + \cos \alpha \)

- A. is greater than 1.
- B. is less than 1.
- C. is equal to 1.
- D. (We cannot say any of these as it depends on value)

Skill: Conceptual Understanding

Q: 10

If \( 2x \) is an angle between \( 0^\circ \) and \( 90^\circ \), and \( \cos 2x = 0.719 \), which of the following could be the value of \( \cos x \)?

- A. 1.438
- B. 0.927
- C. 0.360
- D. 0.035
Gujarat State Board Examination Reform