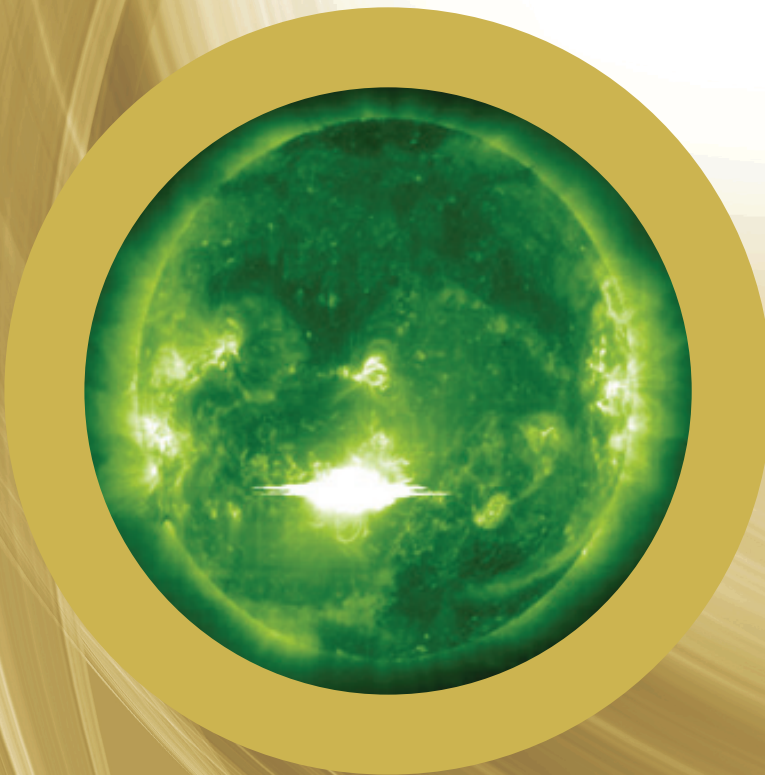


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Antimatter
Particles
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in Solar
Flares

SPECIAL ISSUE ON ASSESSMENT

To Our Contributors

School Science is a journal published quarterly by the National Council of Educational Research and Training, New Delhi. It aims at bringing within easy reach of teachers and students the recent developments in science and mathematics and their teaching, and serves as a useful forum for the exchange of readers' views and experiences in science and mathematics education and science projects.

Articles suitable to the objectives mentioned above are invited for publication. An article sent for publication should normally not exceed ten typed pages and it should be exclusive to this journal. A hard copy of the article including illustrations, if any, along with a soft copy should be submitted in CD. Photographs (if not digital) should be at least of postcard size on glossy paper and should be properly packed to avoid damage in transit. The publisher will not take any responsibility or liability for copyright infringement. The contributors, therefore, should provide copyright permission, wherever applicable and submit the same along with the article.

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Special Issue on Assessment



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EDITORIAL

Every year, children move up to higher classes by achieving certain level of learning, set as a prerequisite for the higher class. Achievement of learning can be measured using various methods called assessment. Assessment is the process of gathering information that accurately reflects how a student is achieving the curriculum expectations in a subject or course. Evaluation refers to the process of judging the quality of student learning on the basis of established performance standards. The primary purpose of assessment and evaluation is to improve student's learning. The present issue is a special issue that includes fundamental principles involved in assessment and establishes criteria with which evaluation can be done. It guides the development of high quality assessment tasks to improve performance standards.

In the article, "Examination Reforms", Sharad Sinha highlights the ways in which examination in school are conducted, and discusses various examination reforms required for the holistic development of the students.

The article, "Assessment in Science and Mathematics at the Elementary Stage", by AK Rajput provides information about specific characteristics of assessment in Science and Mathematics. It explains how collaborative assessment along with self-assessment cultivates the development of students' autonomy as lifelong learners. Furthermore,

taking advantage of technology proves to be very effective in this whole process. So, depending upon the need and nature of assessment, proper adaptations should always be welcomed.

The article, "Role of Assessment for Learning of Science at School Level" by Rachna Garg discusses how the role of assessment has changed over a period of time and how these changes affect the assessment practices. It also discusses how formative assessment, also called assessment of learning, improves learning. It helps the teachers to understand students' learning and their progress.

The article, "Use of Portfolio Assessment in Teaching of Science", by Indrani S. Bhaduri and Sreyoshi Bhaduri looks at portfolio assessment in the context of a science classroom. Portfolio assessment comes in play in this regard by providing a special dynamic mapping tool for learning process. This assessment tool may be adopted to successfully gauge the student's potential and commitment to learning of sciences.

In the article, "Analysis of CBSE Question Papers at the Higher Secondary Stage for the Years 2012 to 2014 (Mathematics)", AK Wazalwar describes various attempts that are being made to remove the rote learning among students and to equip them with the required skill-sets. The author attempts to see how learning the assessment of students, especially Board examinations, plays a vital

role in shaping transactional strategies in the classrooms.

In the article, "Analysis of CBSE Question Papers in Biology", the authors, Sunita Farkya and BK Tripathi have compared the items of the question papers in the years 2012, 2013 and 2014 on the basis of qualitative and quantitative parameters. The authors have also studied the changing trends in the type of questions asked for the proper evaluation of quality of students' learning.

It also discusses about paradigm shift in the methods of assessment and evaluation to be adopted time-to-time for making this process of assessment more transparent and efficient.

We sincerely hope that our readers would find the articles, features and news interesting and informative. Your valuable suggestions, observations and comments are always welcome to bring further improvement in the quality of journal.

ANALYSIS OF CBSE QUESTION PAPERS AT THE HIGHER SECONDARY STAGE FOR THE YEARS 2012 TO 2014 (MATHEMATICS)

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Introduction

It has been realised that education is the primary vehicle of upward economic mobility. This can be seen from the fact that, due to the pioneering entrepreneurial efforts of a few, India today is uniquely poised to become an intellectual powerhouse in the new 'knowledge' era. The areas of pharmaceuticals and biotech research, consulting and software development, promise hundreds of thousands of high-paying and fulfilling jobs—if, however, the Indian education system can produce students with the required skill-sets and attitudes. This is an immense challenge that the Indian education system faces, and needs to be tackled with fresh thinking. The conservative mentality that apparently seems to be progressive but has actually been colonial, needs to be discarded. The education system has the potential to create problem-solvers and rigorous thinkers. A lot of solutions for India's complex social problems will need to come from creative visionaries working singly and collectively.

The imperatives of the new knowledge society extend well beyond the world of software engineers and BPO professionals. The search and sifting of raw data and its step-wise conversion into useful knowledge—is now at the

heart of several traditional professions. It is not limited to elite professionals, such as managers, business consultants, doctors, researchers, economists and journalists. Pharmaceutical and used-car salespersons, real-estate agents, travel agents, advocates, couriers, retailers, and of course, personal secretaries—all require these skills to a substantial degree. These professions may have nothing in common other than the commonality of this process of 'information-sifting and evaluation'. Whether one calls this analytical thinking, critical thinking, lateral thinking, or problem-solving does not matter (indeed the skills needed are a composite of these). The point is that most of these types of thinking are required in most occupations today. Yet we are hard-pressed to find a single one of these activities that is expected from candidates who are appearing for examinations in Indian schools today, let alone the combination of these. The negative impact of this is already being felt—in a scarcity of skilled personnel.

Are our education and exam systems working to create such 'problem-solving' citizens?

A move has been made in this direction to improve the learning environments in different subject areas, particularly in mathematics, at school level. These concerns find a place in

the position paper of National Focus Group on Teaching of Mathematics which asserts that the main goal of mathematics education in schools is the mathematisation of the child's thinking. While learning mathematics, the learner should acquire the ability to think clearly and be able to pursue assumptions to logical conclusions. The learner develops an ability to handle abstractions and approach to problem-solving while learning mathematics.

Central Board of Secondary Education (CBSE) conducts examination for Class XII every year. Learning assessment of students especially, Board Examinations play an important role in shaping the transactional strategies in the classrooms.

In this paper, an attempt has been made to see whether the concerns of NCF-2005 have been reflected in the question papers of CBSE by analysing the CBSE question papers from 2012 to 2014.

Discussion

The learner at the higher secondary stage is expected to have acquired sufficient familiarity with the processes in mathematics, i.e.

- Formal problem-solving
- Use of heuristics
- Estimation and approximation
- Optimisation
- Use of patterns
- Visualisation
- Representation
- Reasoning and proof
- Making connections
- Mathematical communication

The reflection of the concerns of NCF-2005 can only be seen if the questions in the paper are based on these processes. For this purpose, CBSE question papers of the years 2012-2014 were analysed. Tables 1, 2 and 3 show the status of the types of questions asked based on different mental processes, in the question papers of the years 2012, 2013 and 2014 respectively. The different mental processes considered are: Recall, Application-based, Reasoning, Justification and Analysis and Value-based.

The information about these mental processes is presented in a consolidated form in Table 4. It also shows the weightage given to these processes.

Table 5 gives information about the weightage given to different types of questions like Long Answer (LA), Short Answer (SA) and Very Short Answer (VSA), in the question papers from 2012 to 2014.

Comments

From the tables, it can be seen that –

- The number of Recall type of questions along with the corresponding weightage of marks given to it, is seen to decrease from 2012 to 2014 (Table 4).
- An increase in the number of questions and the corresponding weightage of marks for Reasoning type questions can be seen through the years 2013-2014 (Table 4).
- As compared to the year 2012, Application-based questions find an increase in the year 2013 and then decreased in 2014.
- Very less weightage has been given on questions based on Justification and Analysis. However, an increase has been observed in such questions in 2013.

- There are no questions that require giving counter example for a given situation.
- There is a decrease in the weightage for the Recall type of questions with a corresponding increase in weightage in Reasoning, Application-based, Justification & Analysis and Value-based questions, from 2012 to 2014 papers.
- More emphasis on Short Answer type and Very Short Answer type questions can be seen, whereas no space has been provided for MCQ type questions (Table 5). It may be noted that NCF–2005 recommends designing of MCQ type questions that test the real understanding.
- Questions drawing knowledge of concepts from more than two areas need to be given space.

Conclusion

These points suggest that the questions based on the processes of Formal Problem Solving, Optimisation, Reasoning and Proof, Mathematical Communication and Values find a gradual increase in the weightage by the year 2014. This shows a growing tendency of framing questions that reflect the above-mentioned processes in the CBSE examinations. However, there is still scope left for the remaining processes.

Thus, it can be said that attempts are being made to move away from rote memorisation and produce thinking minds in mathematics, the prime concern of NCF–2005.

Table 1

Class XII Subject: Mathematics Year 2012 Maximum Marks: 100

Q. No.	Unit	Mental Process	Type of Question (LA/SA/VSA)	Marks
1.	11	Recall	VSA	1
2.	10	Recall	VSA	1
3.	10	Recall	VSA	1
4.	7	Recall	VSA	1
5.	7	Recall	VSA	1
6.	4	Recall	VSA	1
7.	3	Recall	VSA	1
8.	3	Recall	VSA	1
9.	2	Recall	VSA	1
10.	1	Recall	VSA	1
11.	6	Recall	SA	4
12.	13	Reasoning	SA	4

13.	11	Reasoning	SA	4
14.	10	Recall	SA	4
15.	9	Recall	SA	4
16.	9	Recall	SA	4
17.	7	Recall	SA	4
18.	6	Reasoning	SA	4
19.	5	Recall	SA	4
20.	4	Reasoning	SA	4
21.	2	Reasoning	SA	4
22.	1	Reasoning	SA	4
23.	11	Recall	LA	6
24.	13	Reasoning	LA	6
25.	12	Recall	LA	6
26.	7	Recall	LA	6
27.	8	Application-based	LA	6
28.	6	Application-based	LA	6
29.	3	Reasoning	LA	6

LA – Long Answer, SA – Short Answer, VSA – Very Short Answer

Table 2

Class XII Subject: Mathematics Year 2013 Maximum Marks: 100

Q. No.	Unit	Mental Process	Type of Question (LA/SA/VSA)	Marks
1.	2	Recall	VSA	1
2.	2	Recall	VSA	1
3.	3	Application-based	VSA	1
4.	4	Application-based	VSA	1
5.	4	Recall	VSA	1
6.	5	Reasoning	VSA	1
7.	9	Recall	VSA	1
8.	10	Reasoning	VSA	1
9.	10	Recall	VSA	1

ANALYSIS OF CBSE QUESTION PAPERS **AT THE HIGHER SECONDARY STAGE FOR
THE YEARS 2012 TO 2014 (MATHEMATICS)**

10.	11	Recall	VSA	1
11.	1	Justification & Analysis	SA	4
12.	2	Application-based	SA	4
13.	3	Value-based	SA	4
14.	5	Recall	SA	4
15.	5	Application-based	SA	4
16.	5	Reasoning	SA	4
17.	7	Recall	SA	4
18.	7	Recall	SA	4
19.	7	Recall	SA	4
20.	10	Application-based	SA	4
21.	11	Recall	SA	4
22.	13	Application-based	SA	4
23.	5	Recall	LA	6
24.	6	Reasoning	LA	6
25.	8	Recall	LA	6
26.	9	Recall	LA	6
27.	11	Application-based	LA	6
28.	12	Reasoning	LA	6
29.	13	Reasoning	LA	6

LA – Long Answer, SA – Short Answer, VSA – Very Short Answer

Table 3

Class XII		Subject: Mathematics	Year 2014	Maximum Marks: 100
Q.No.	Unit	Mental Process	Type of Question (LA/SA/VSA)	Marks
1.	1	Reasoning	VSA	1
2.	2	Recall	VSA	1
3.	3	Recall	VSA	1
4.	3	Recall	VSA	1

5.	4	Recall	VSA	1
6.	7	Reasoning	VSA	1
7.	7	Recall	VSA	1
8.	10	Recall	VSA	1
9.	11	Reasoning	VSA	1
10.	11	Reasoning	VSA	1
11.	1	Reasoning	SA	4
12.	2	Reasoning	SA	4
13.	4	Reasoning	SA	4
14.	5	Recall	SA	4
15.	5	Recall	SA	4
16.	6	Reasoning	SA	4
17.	7	Recall	SA	4
18.	9	Recall	SA	4
19.	9	Recall	SA	4
20.	11	Application-based	SA	4
21.	11	Recall	SA	4
22.	13	Reasoning	SA	4
23.	3	Value-based	LA	6
24.	6	Application-based	LA	6
25.	7	Reasoning	LA	6
26.	8	Recall	LA	6
27.	11	Reasoning	LA	6
28.	12	Application-based	LA	6
29.	13	Recall	LA	6

LA - Long Answer, SA - Short Answer, VSA - Very Short Answer

Table 4
Abstracts of Analysis of Each Question Paper
(Based on Tables 1, 2 & 3)

Total Marks: 100

Class: XII

Subject: Mathematics

Weightage to Mental Processes

S. No.	Mental Processes	No. of Questions			Marks allotted as per analysis		
		2012	2013	2014	2012	2013	2014
1.	Recall	19	14	14	52	44	42
2.	Reasoning	08	06	11	36	24	36
3.	Application-based	02	07	03	12	24	16
4.	Justification and Analysis	0	01	0	0	04	0
5.	Value-based	0	01	01	0	04	06

Table 5
Weightage to Different Types of Questions (2012–2014)

S. No.	Types of Questions	No. of Questions			Marks allotted as per analysis		
		2012	2013	2014	2012	2013	2014
1.	Long Answer (LA)	07	07	07	$7 \times 6 = 42$	$7 \times 6 = 42$	$7 \times 6 = 42$
2.	Short Answer (SA)	12	12	12	$12 \times 4 = 48$	$12 \times 4 = 48$	$12 \times 4 = 48$
3.	Very Short Answer (VSA)	10	10	10	$10 \times 1 = 10$	$10 \times 1 = 10$	$10 \times 1 = 10$

ASSESSMENT IN SCIENCE AND MATHEMATICS AT THE ELEMENTARY STAGE

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Introduction

Assessment defined as “the systematic process of gathering information about what a student knows, is able to do, and is learning to do” is an integral part of classroom instructions. Broadly, any activity or experience that provides information about student learning is also termed as assessment. This gives the teacher a clear idea about student’s progress through continuous observation of students in action and not only through formal tests, examinations and projects.

The major purposes of assessment are to look at the teaching strategies and improve learning, and to monitor student’s progress in achieving learning outcomes at the end of a class or course of studies. This nowhere should tend to evaluate and label student’s performance .

Learning is a natural process and takes place with varied and targeted experiences. This is more true in case of science and mathematics learning — these subjects are exploratory in nature. To assess students’ science and mathematics knowledge, skills and strategies, and attitudes, teachers require a variety of tools and approaches. They ask questions, observe

students engaged in a variety of learning activities and processes, and examine student work in progress. They also engage students in peer-assessment and self-assessment activities. The information that teachers and students gain from assessment activities informs and shapes what happens in the classroom; assessment always implies that some action will follow.

Preparation of Assessment for Learning

Since assessment is an integral part of instruction, teachers should plan it along with their plan for instructions in and outside classroom. They select assessment purposes, approaches and tools in conjunction with their choice of instructional strategies. In developing assessment tasks and methods, teachers determine —

- What is to be assessed?
- Why it is assessed?
- How the assessment data will be used?
- Who will gather the assessment information — teachers, students or other stakeholders?

- What type of activities or tasks will encourage students to demonstrate their learning in effective ways?
- How the learning progress be recorded and reported?

Characteristics of Assessment for Learning

Assessment provides important information about teaching and learning. It helps focus effort on implementing strategies to facilitate learning both inside and outside the classroom. The assessment in science and mathematics has some specific characteristics due to the nature of these subjects:

1. Conforms to the criteria that students know and understand, suits to their strengths
2. Integral to instructions
3. Based on meaningful tasks, science-learning processes and contexts
4. Based on a wide range of tools and methods and be multi-dimensional
5. Collaborative involving students in the process
6. Focused on strengths of learners and what they can do
7. Continuous and comprehensive
8. Make use of technology to ease the process

These seven characteristics of assessment have been explained below:

1. **Assessment for learning should be in conformity with the criteria that students know and understand, and suits to their strengths**

Before an assignment or test, the assessment criteria must be clearly established and made explicit to students so that students can focus

their efforts according to criteria. In most of the cases the students can themselves decide the assessment criteria in consultation with the teacher. Technically, such criteria are called rubrics, which are explained below.

Rubrics

The rubric developed for the purpose of assessment should be according to the task and the learning outcomes. The performance can be graded in multiple point scale and these points should be made part of the rubric. Each assessment task should test only those learning outcomes that have been identified to students. This means, for example, that laboratory skills tests need to be devised and marked to gather information about students' laboratory skills, not their ability to express ideas effectively in writing a laboratory report. In a task related to solving a problem, there can be various sub-tasks which reflect student's level of learning like, ability to describe the problem in mathematical terms, ability to cull out the unknowns, ability to connect known with unknown and find unknowns by using appropriate mathematical tools, and lastly to describe the solution in real life situation. These sub-tasks define different levels of learning and can be shown in the rubric.

2. **Assessment for learning should be integral to instructions**

As is evident from the definition of assessment, it provides answers to the questions like "What do I want my students to learn?" and "What can my students do to show they have learned it?"

So, the process of assessment depends on the objectives of the assessment. While studying science and mathematics, a child acquires/

builds up the following and the process of assessment should be accordingly decided:

- **Factual knowledge:** The fact-based recall may be termed as declarative knowledge which can directly be assessed by traditional methods. But simply memorisation of the declarative/factual knowledge related to science does not serve the higher purpose of science and mathematics education, i.e., fostering scientific attitude and development of reasoning. What is more important is whether students understand and are able to apply this knowledge. For example, by learning about deforestation, it is more important that they respond to and interpret what deforestation means for them personally and environmentally, and that they use appropriate terminology with ease to enrich their own writing—rather than reproduce—a definition of deforestation. Designing tools that test the application of declarative/factual knowledge is a big challenge that many teachers face.
- **Procedural/process knowledge:** Science and mathematics learning require skills to adopt/adapt applicable procedures/processes. Tools that are designed to test factual knowledge cannot effectively assess skills, strategies and processes. For example, rather than trying to infer student processes by looking at final products, teachers assess procedural knowledge by observing students in action, by discussing their strategies with them, and by gathering data from student reflections. For example, a child simplified a fraction $\frac{26}{65}$ as $\frac{26}{65}$ and answered $\frac{2}{5}$. Here the final outcome of the process is correct but the process itself is not correct. Science and mathematics are full of such procedures that provide

direct algorithms to solve problems. The assessment of procedures followed by a child to reach to a conclusion gives ideas to the teachers about the way child is thinking/learning.

- **Attitudes and habits:** Attitudes and habits are implicit in what students do and say. Assessment tools typically describe the behaviour that reflect attitude and habits of literate individuals. They identify attitudes and habits of mind that enhance science and mathematics-related language learning and use, and provide students with the means to reflect on their own internal processes. For example, rather than assigning global marks for class participation, teachers assess learning outcomes related to students' effective contributions to large and small groups.

Assessment for learning intends to inform students about their level of learning and to help them focus on important aspects of learning. The students focus only on those things which a teacher assesses. If teachers assess only the elements that are easiest to measure, students may focus only on those things. For example, if science and mathematics learning place a high value on collaboration, creativity and divergent thinking (learning outcomes that may be more difficult to measure), then assessment tools and processes must reflect those values. The ways teachers assess (what and how) inform students of what is considered important in learning.

3. Assessment for learning should be based on meaningful tasks and science and mathematics-learning processes and contexts

Assessment tasks in science and mathematics should be meaningful and contextual to a student. These tasks should worth mastering

for their own sake rather than tasks designed simply to demonstrate student proficiency for teachers and others. Through assessment, teachers discover whether students can use knowledge, processes and resources effectively to achieve purposes. Therefore, teachers design tasks that replicate the context in which knowledge will be applied in the world beyond the classroom.

Assessment tasks should therefore, test the way a child's understanding of a subject has deepened, and of his/her ability to apply learning but not to only test the information student possesses. They demonstrate to students the relevance and importance of learning. Performance-based tests are also a way of consolidating student learning. The teaching focussing on examination will be of less concern if assessment processes focus on assessment of student knowledge, skills and strategies, and attitudes.

4. Assessment for learning is based on wide range of tools and methods and be multi-dimensional

Assessment in science and mathematics must recognise the complexity and holistic nature of learning. To compile a complete profile of each student's progress, teachers gather data using many different means over numerous occasions through various tools.

Student profile is one of the tools which involves both students and teachers in data gathering and assessment. A student's profile gives a systematic idea of child's learning progress and also indicates her/his strengths and weaknesses. The assessment for learning includes observation of processes/procedures through classroom/ laboratory discussions among children, presentations and peer assessment. The details of some of the tools are given next:

- **Observation** of students is an integral part of the assessment process. It is most effective when focused on skills, concepts and attitudes. Without record keeping, however, observations and conversations can easily be forgotten. Making brief notes on index cards, self-stick notes, or grids, as well as keeping checklists, helps teachers maintain records of continuous progress and achievement.
- **Interviews** allow teachers to assess an individual's understanding and achievement of the prescribed student learning outcome(s). Interviews provide students with opportunities to model and explain their understandings. Interviews may be both formal and informal. Posing science-related questions during planned interviews enables teachers to focus on individual student skills and attitudes. Students reveal their thinking processes and use of skills when they are questioned about how they solved problems or answered science questions. Using a prepared set of questions ensures that all interviews follow a similar structure. It is important to keep a record of student responses and/or understandings.
- **Performance assessment / student demonstration:** Performance tasks provide students with opportunities to demonstrate their knowledge, thinking processes and skill development. The tasks require application of knowledge and skills related to a group of student learning outcomes. Performance-based tests do not test the information that students possess, but the way their understanding of a subject has been deepened, and their ability to apply their learning in a simulated performance. A scoring rubric that includes a scale for the performance of the task helps organise and interpret evidence. Rubrics allow for a

continuum of performance levels associated with the task being assessed.

- **Project reports:** Science journal writing provides opportunities for students to reflect on their learning and to demonstrate their understanding using pictures, labelled drawings and words. They can be powerful tools of formative assessment, allowing teachers to gauge a student's depth of understanding. In this document, direct questions/scenarios frame the science journal suggestions.
- **Rubrics/checklists:** Rubrics and checklists are tools that identify the criteria upon which student processes, performances or products will be assessed. They also describe the qualities of work at various levels of proficiency for each criterion. Rubrics and checklists may be developed in collaboration with students.
- **Visual displays:** When students or student groups prepare visual displays, they are involved in processing information and producing a knowledge framework. The completed poster, concept map, diagram, model, etc., is the product with which teachers can determine what their students are thinking.
- **Laboratory report:** Laboratory reports allow teachers to gauge the ability of students to observe, record and interpret experimental results. These tools can aid teachers in determining how well students understand the content.
- **Pencil-and-paper tasks:** Quizzes can be used as discrete assessment tools, and tests can be larger assessment experiences. These written tasks may include items such as multiple choice questions, completion of a drawing or labelled diagram, problem

solving, or long-answer questions. Ensure that both restricted and extended, expository responses are included in these assessment devices.

- **Research report/presentation:** Research projects allow students to achieve the learning outcomes in individual ways. Assessment should be built into the project at every stage, from planning, to researching, to presenting the finished product.

5. Assessment for learning is collaborative involving students in the process

Self-assessment of learning and making judgments about one self is important way of assessment for learning. This cultivates the development of students' autonomy as lifelong learners. It helps them make judgments about their own learning, and provides them with information for goal setting and self-monitoring.

Teachers increase students' self-assessment habits by:

- involving students in developing assessment criteria.
- involving students in peer assessment.
- having students use tools for reflection and self-assessment at every opportunity like self-assessment of portfolio items.
- establishing a protocol for students in order to reduce the dissatisfaction on teacher assigned marks or performance level.
- **Group/peer assessment:** Group assessment gives students opportunities to assess how well they work within a group. Peer assessment gives them opportunities to reflect on one another's work, according to clearly established criteria. During the peer assessment process, students reflect on

their own understanding in order to assess the performance of another student.

- **Self-assessment** is vital to all learning and, therefore, integral to the assessment process. Each student should be encouraged to assess her or his own work. Students apply known criteria and expectations to their work and reflect on results to determine their progress towards the mastery of a prescribed learning outcome. Participation in setting self-assessment criteria and expectations helps students to see themselves as scientists and problem-solvers. It is important that teachers model the self-assessment process before expecting students to assess themselves.

6. Assessment for learning focused on strengths and knowledge of learners

To assess what students have learned and can do, teachers need to use a variety of strategies and approaches, such as the following:

- Using a wide range of instruments to assess the multi-dimensional expressions of individual student's learning, avoiding dependence on recall after rote memorisation.
- Providing opportunities to learn from feedback and to refine their work.
- Examining variety of student's work in assessing any particular learning outcome to ensure that data collected are valid bases for making generalisations about student's learning.

Developing student profiles from outcome-referenced assessment, which compares a student's performance to predetermined criteria, and self-referenced assessment, which compares a student's performance to her or his prior performance.

- Avoid assigning zero marks for incomplete work as this does not communicate accurate information about the student's achievement of science and mathematics learning outcomes. Unfinished assignments may be caused due to personal or motivational problems that need to be addressed in appropriate and alternative ways.

7. Assessment for learning is continuous and comprehensive

Continuous assessment provides ongoing opportunities for teachers to review and revise instruction, content, process emphases and learning resources.

Managing classroom assessment

Assessment is one of the greatest challenges science teachers face. The practices that make science classrooms vital and effective—promoting student choice, assessing processes and assessing the subjective aspect of learning—make assessment a complex matter.

Systems and supports that may assist teachers in managing assessment include —

- dispensing with ineffectual means of assessment
- using time savers
- sharing the load
- taking advantage of technology
- establishing systems of recording assessment information

8. Using technology for assessment

Teachers need to question the efficacy, for example, of writing lengthy commentaries on summative assessment of student projects.

Detailed comments are best —

- provided as formative assessment, when students can make immediate use of the feedback.
- shared orally in conferences, which provide opportunities for student-teacher discussion. The time spent in assessment needs to be learning time, both for teacher and student.

Using time savers

Many effective assessment tools are time savers. Developing checklists and rubrics is time-consuming; however, well-written rubrics may eliminate the need to write extensive comments, and may mean that student performances can be assessed largely during class time. Some of the assessment tools in the professional literature related to science assessment may also be useful.

Sharing the load

While the ultimate responsibility for assessment rests with the teacher, student self-assessment also provides a wealth of information. Collaborating with students to generate assessment criteria is part of effective instruction. Two senior students may develop checklists and keep copies of their own learning goals in an assessment binder for periodic conferences. Students may be willing to contribute work samples to be used as models with other classes.

Collaborating with other teachers in creating assessment tools saves time and provides opportunities to discuss assessment criteria.

Taking advantage of technology

Electronic tools (e.g., audiotapes, videotapes, and computer software) can assist teachers in making and recording observations. Word

processors allow teachers to save, modify and reuse task-specific checklists and rubrics.

Formative and Summative Assessment

Assessment can be formative or summative.

- Formative assessment is based on data collected before an instructional sequence is completed. Its purpose is to improve instruction and learning by:
 - providing students and teachers with the information about students' progress in accomplishing prescribed learning outcomes.
 - evaluating the effectiveness of instructional programming content, methods, sequence, and pace.

Formative assessment majorly focusses on assessment for learning and as learning (discussed earlier in this paper).

- Summative assessment (evaluation) is based on an interpretation of the assessment information collected. It helps determine the extent of each student's achievement of prescribed learning outcomes. Evaluation should be based on a variety of assessment information. Summative assessment is used primarily to:
 - measure student achievement
 - report to parent(s) or guardian(s), students, and other stakeholders
 - measure the effectiveness of instructional programming.

Summative assessment provides useful information/data about what the student has learnt. This is called assessment of learning.

Establishing Systems for Recording Assessment Information

Collecting data from student observations is especially challenging for Senior Years teachers, who may teach several classes of students in a given semester or term. Teachers may want to identify a group of students in each class for observation each week. Binders, card files, and electronic databases are useful for record keeping, as are self-stick notes recording brief observations on student files, which can later be transformed into anecdotal reports.

Teachers may also want to develop comprehensive forms for listing the prescribed learning outcomes, and for recording data. Online opportunities for the creation of lesson or unit plan and selection of assessment strategies are also available on various web portals.

The above discussion is aimed at providing a holistic view of assessment of science and mathematics learning in elementary classes. The teachers and other users of this paper are expected to make appropriate adaptations according to their needs and the nature of assessment.

EXAMINATION REFORMS

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Introduction

Come the month of March and the temperature soars, so does the anxiety of students as examinations approach. This is followed by a mad rush to score more and more marks. This cycle is repeated every year. We have been brought up being told to study well, so that we score high in the examinations. The comparison among peers and their parents based on the examination marks is not only rampant in Indian society but throughout the world. The kids have been made to believe that the higher they score; higher are their prospects of getting employed.

Education is often linked to employment and earning livelihood. The problem today is that the examination system has also become a victim of consumerism. The personality of the student is often valued less or more on the basis of the marks scored by him/her in the examination. The grim side of the examinations is that instead of being used as a pedagogic tool they are being used for elimination of people opting for higher jobs or higher education. This accelerates a mad race and unhealthy competition in order to get highest marks/grades from primary classes onwards.

Instead of using education for a holistic balanced development of an individual enshrined with strong moral values, it is often being used to

obtain certificates for procuring good jobs. This defeats the very purpose of education.

Jiddu Krishnamurti points out that, 'There is no end to education. It is not that you read a book, pass an examination and finish with education. The whole of the life from the moment you are born to the moment you die is process of learning'. Assessment and evaluation are two words which are used synonymously. Evaluation in our education process remains the termination point ritual in our schools. The basic purpose of the examination is to identify the level the student has reached at a certain point of time. While evaluation may help to find out the improvement over a time period, it may also suggest the points on which attention is needed in order to further increase the level of attainment.

Various policy documents have highlighted the ways in which examination in school system be conducted/held. In fact, when we look back as to how examination evolved in our country we need to remember the ancient times when '*Gurukul*' education was followed. In this system, evaluation was based on day-to-day progress, behaviour and activities of the students as observed by the teacher. The pupil was considered as an individual, a human being in flesh and blood rather than merely a roll number as treated in present examination

system. This observation although subjective was highly reliable and valid because it observed the student keenly rather than observing at a specific point of time or time intervals.

In colonial era, the Britishers imposed what is termed as external examination. The wisdom of existing system to trust the teacher was questioned and this system was labelled as subjective.

With the Woods Dispatch of 1854, the '*Pathshalas*', the '*Madarsas*' and existing system of internal examination were undermined and gradually switched over to an external collective examination. The prerequisite to have an artificial qualification for pursuing higher education also added to the importance of external examination system. This system was systematic and step-wise and hence had an easier acceptability with the masses.

Post 1947, the university commission raised the concern that external examination is not the only one to assess students and the overall assessment throughout the year should be taken into the account. It recommended 1/3rd of total marks to be internally assessed.

In 1952, the Mudaliar Commission recommended that the certificates awarded to the students should also include the evaluation of personality attributes and the score/results of the school tests. All India Council for Secondary Education was created on the recommendation of the Mudaliar Commission. It focused on three issues namely science education, examination reform and In-service teacher education.

In a seminar convened at Bhopal in 1956, termed as National Seminar on Examination Reforms, it was recommended that 20 per cent marks should be for internal assessment. But, with its implementation in the states it was wrongly

used to boost marks rather than focusing on assessing throughout the year; this led to withdrawal of the scheme by the implementing states one by one.

Conclusions of almost every major committee constituted to review the education system from time to time, always pointed out that if we wish to move towards the goal of comprehensive educational reform then, reform in the examination system is a critical issue. It is widely accepted that the present examination system is the reflection of the way teaching- learning takes place. Efforts of policy-makers and teachers for improving classroom teaching- learning transaction remain futile for want of one time terminal examination system without accompanying examination reforms.

Before the National Policy on Education (NPE) 1986, the Narsimha Rao Committee was formulated. The most important aspect of Narsimha Rao Committee report on examination reform is that for each measure of examination reforms suggested by it gives the benefits that will yield to education.

The Kothari Commission was the basis for the development of the NPE 1966 and also that of the NPE 1986.

National Policy on Education 1986/1992

In the light of objectives of examination as stated in section 8.23 and 8.24 of NPE, examination reforms are the need of the hour.

8.23. Assessment and performance is an integral part of any process of learning and teaching. As part of Secondary Educational strategy – Examinations should be employed to bring about qualitative improvement in education.

8.24. The objective will be to recast examination system so as to ensure a method of assessment that is valid and reliable measure of student's development and a powerful instrument for improving teaching and learning. In functional terms, this would mean:

- i. The elimination of excessive element of chance and subjectivity.
- ii. The de-emphasis of memorisation.
- iii. Continuous and comprehensive evaluation that incorporates both scholastic and non-scholastic aspects of education.
- iv. Effective use of evaluation process by teachers, students and parents.
- v. Improvement in the conduct of examination.
- vi. The introduction of concomitant changes in instructional material and methodology.
- vii. Insertion of the Semester System from the secondary stage in a phased manner, and
- viii. The use of grades in place of marks.

The National Curriculum Framework (NCF-2005) traces the source of a wide range of systemic ills in the public examination system. The NCF attributes the social Darwinist ideology (which says that only the fittest should survive) of our system to the manner in which examinations are conducted. The ideology of social Darwinism is totally incompatible with the Constitution's vision which asks us to regard every child as a valued participant in the democratic order. If we were guided by the Constitution, we would nurture whatever potential a child has, rather than stigmatise millions by labelling them 'failed'. The NCF also criticises the examination system as an obstacle to curricular reform.

The NCERT's textbooks require a whole new approach to evaluation. These new textbooks

based on constructivist approach, encourage children to reflect on problems, to recognise multiple perspectives and promote critical thinking. The kind of learning such textbooks encourage cannot be evaluated through the ritual of our traditional examination system. Evaluation is an indispensable part of the educational process as some form of assessment is necessary to determine the effectiveness of teaching-learning processes and their assimilation by learners. Term-end examinations are largely inappropriate for the 'knowledge society' of the 21st century and its 'need for innovative problem solvers'. Questions if not framed well, "call for rote memorisation and fail to test higher-order skills like reasoning and analysis, lateral thinking, creativity and judgement. External exams make no allowance for different types of learners and learning environments and induce an inordinate level of anxiety and stress". (NCF – Position Paper on Examination Reforms)

This calls for a functional and reliable system of school-based evaluation.

Examination reforms depend for their success on teachers, especially on how much freedom they will be permitted to exercise and how their responsibility will be defined. This is where a huge systemic challenge lies buried. It consists of giving teachers the autonomy to teach and to equip them, through sensible training, with the capacity to cultivate in children the freedom and the desire to learn. The prevailing system obstructs both these freedoms by assigning a fixed number of periods and marks to each topic in the syllabus.

The NCERT's syllabus did not assign marks to topics, nor did it specify the number of periods within which a topic should be completed. To

do so would have been a violation of the NCF perspective according to which a teacher should have the freedom and the skills of time management so that knowledge can be experientially assimilated by children. The NCF also talks about letting individual children learn at their own different paces, instead of rushing them as a herd from topic to topic, breaking it up into topics and sub-topics, each carrying a specified label of marks and periods thereby, imposing a tight and arbitrary time-frame on teachers.

Whatever little scope there might be in this structure for creative teaching is further constrained by the poor quality of the questions asked. Typically, they are based on the textbook and can be answered correctly by memorisation. The practice of developing model answers further discourages originality and diversity.

Exam Reform: Why is it needed?

- Through examination assessment of learning has restricted itself to the test of cognitive abilities, which is largely inappropriate for the 'knowledge society' of the 21st century and its need for innovative problem-solvers.
- Exams do not serve the needs of Social Justice. Exam systems need to be more flexible. Just as we must ensure that education and assessment systems are fair to all social groups, we should ensure that they do not discriminate against particular kinds of learners. There is a lot of psychological data to suggest that different learners learn differently, and, hence, to test all learners through a written test of the same type in subject after subject is unfair to those whose verbal proficiency is superior to their writing skills, or those who work slowly but with deeper insight, or those who work better in groups than individually.

- Quality of question papers is such that they usually call for rote memorisation and fail to test higher-order skills like reasoning and analysis, let alone lateral thinking, creativity and judgment.
- There is no scope of assessment of non-cognitive abilities and traits.
- There is no flexibility of time, space, content, environment and individual personality traits. Based on a 'one-size-fits-all' principle, they make no allowance for different types of learners and learning environments. We are thus not looking at a micro-level picture of assessment at individual learner's performance per se, rather we look at assessment at a macro-level during assessment of learners as a group.
- Examinations are artificial situations created for the convenience of the system and not the individual learner. Given the time-bound and 'one short' nature, it is not surprising that exams in their current form induce anxiety.
- Lack of full disclosure and transparency in grading and mark/grade reporting.
- Absence of functional and reliable system of school-based assessment and evaluation system.

Examination reforms can address the above challenges for holistic development of child for 21st century catering to the needs of knowledge economy —

1. There should be more varied modes of assessment, including oral testing, group work evaluation, PowerPoint presentation, project work, performance in homework and assignments, participation in co-curricular activities and life skills imbibed by the learners.

2. Do not expect everything of everybody in every subject; just as we allow students and schools some element of choice in choosing their subjects, they should have the choice of picking one of two levels within that subject.
3. Flexibility in when exams are taken. If it is accepted that learners learn at different paces we recommend that students be allowed to clear some subjects at the end of Class XI. This would not only reduce stress a year later but also make for better long-term learning—and cause very little inconvenience to exam boards.
4. Enhanced reporting of performance which takes into account the gradual progress made by the students.
6. Elimination of the term 'fail' on marksheets must be done. It can be replaced by phrases such as unsatisfactory or better needs, more work to attain desired standards.
7. There will always be some individual who cannot demonstrate such satisfactory completion of the examination. So number of chances must be provided to retake one or more examinations. There should be elimination of the pass/fail concept by permitting repeated retake.
8. School-based Continuous and Comprehensive Evaluation (CCE) should be promoted. Teachers should be comprehensively trained through pre-service and in-service teacher training programmes to understand the concept of CCE and affectively practise it in their classrooms.

Reducing Exam Anxiety

1. Periodicity of evaluation and assessment may be increased but duration of exams should be decreased. A lot of stress is related to the excessive length of the question papers and shorter exams leave time for deliberation.
2. Questions that required to draw on two or more areas of the syllabus would also allow more comprehensive testing within lesser time, education after all is about making lateral linkages or creating 'ecology of knowledge in the brain'.
3. A shift in emphasis from 'short answer' to MCQs designed to test real understanding of core concepts.
4. Students should be able to take the exam in their home school in order to reduce stress caused by unfamiliar environments.
5. A long-term move towards open book exams can be promoted with due weightage in overall grading as implemented by CBSE at secondary level.

Following the principle that examinations are an evil, if a necessary one, there should be no exams other than that are strictly and absolutely necessary.

Conclusion

It is an established fact that the performance of students is to a great extent determined by the way in which the curriculum is transacted in the school and in the classroom. If the students are facilitated, motivated and guided to learn in a healthy environment, examinations will not be perceived with the 'Day of Judgment' fear. But, the bitter fact is that the issue of classroom transaction is seldom discussed or highlighted. The point that is being made here is that we have reached a point of time when we should focus our attention on improving the reach of the curriculum, at the heart of which lies a teacher and institution development.

It should be clear from the above that examinations and curriculum transactions in India need serious re-examination, at the same time, it should be recognised that exam reform has the potential to lead educational reform.

Reforming exams alone will attain very little unless it is accompanied by other basic reforms: improvement of pre-service and in-service teacher training, teacher quality and teacher-student ratio.

In the present education system, teachers, instead of assisting learning, spend most of their time in assessing learning. Instead of enabling and equipping students to learn, schools have taken on the function of examining and screening out on the basis of those examinations. So, the need of the hour is to make possible changes in whole education system. Our education system needs examination reforms. Format of exams must be changed. Marks should be given for performance of overall academic year. It should be given on the observable attributes of student, on his/her performance in co-curricular activities, on performance in class test, on

attendance. We need to look at the holistic assessment of a learner which also include Life Skills, Attitudes and Values, Sports and Games as well as Co-curricular activities. The CCE scheme aims at addressing these in a holistic manner.

It is time that parents should stop living their dreams through their children. Helplines have established that more than the fear of examinations, it is the fear of failing parental expectations that is enhancing the stress profile for children. We should also understand that stress is a part of daily existence. In fact, the ability to perform under pressure will make students stand in good stead as they get ready to enter the world of work. To completely isolate them from challenging situations would only result in the insulation of students from the realities of the world, rendering them unfit to face competition later in life. The solution lies in bringing about a more responsive and responsible work culture in schools. An empowered teaching community is vital to all attempts at transforming education through curriculum transactions and examination reforms.

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USE OF PORTFOLIO ASSESSMENT IN TEACHING OF SCIENCE

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Assessment is imperative in the teaching-learning process. The effect and efficiency of an educational endeavour rests on appropriate assessment. An effective assessment looks into whether or not the objectives of the learning process have been fulfilled. Assessment of the teaching-learning process is thus, in essence, a key into understanding not only the students' potential and gauge the increment in the knowledge base, but can also be used to identify the factors which may enhance learning in a classroom environment. This paper looks at portfolio assessment in the context of a science classroom.

Teaching of Sciences

Objectives of Education

Education can be seen as a tool to understand the world we live in. While seeking to educate in classrooms, a teacher invariably begins by formulating certain pre-determined objectives. These might be in the form of scholastic objectives: seeking to enhance the students' know-how; or it may also be in the form of setting of certain acceptable moral, social and behavioural life lessons for the young learners. An academic year, thus, in many ways reflects its fiscal counterpart. The education provider, at the end of the 'term', seeks to determine the return on 'investment', the investment pertaining to the hours, effort and principles directed to engage the pupil in the learning environment. Assessment is thus a record of this return on investment, for an academic setting. As can be expected, the assessment should provide a holistic view of the efficiency and effect of the educational practices. As with any measurement, the dimensions of the depth

and degree of accuracy in understanding the system and performance, would rely on the tool used for the same. Portfolio assessment comes in play in this regard by providing a special, all encompassing, dynamic mapping tool for the learning process. With the aid of portfolio assessment, we can envision a better understanding of not only whether or not objectives for a certain educational pursuit were achieved, but also, how effective the achievement has been for the individual learner and how efficiently can it be modified to cater to the entire classroom for a better performance.

A Peep into the 'Science Classroom'

The study of science, whether for life, technology or society, is the study for understanding, appreciating and creating awareness. Science learning relates to developing sensitivity in the child while relating with the environment. It is developing 'awareness' in the child. It is apt then that 'Scientia', in essence, is derived from the Latin word for 'knowledge'. A demarcation of classrooms as 'science-stream' or 'non-science-stream' can be considered a tad

Neanderthal as an attempt at segregation. For any classroom, by virtue of it being a learner's haven, is dealing in essence with a cycle of creation, assimilation and dispersion of 'knowledge' or 'science'. Thus, a student of social sciences, say one who dwells with history, is in effect engaging in an activity which would draw semblance with a student who is learning about single-celled organisms. However, for the purpose of elaborating upon the merits of the portfolio assessment on a particular closed set, one could distinguish a science classroom, in its traditional sense and highlight upon the benefits, as pertaining to the same.

So what is assessment? In traditional terms, one can view assessment as the 'end' score evaluation at the completion of a cycle. In schools, we have tests: unit tests, class tests, mock tests, mid-term tests and the list go on.

Thus, each test marks the end of an important chapter, in the student's book of learning. But, what do each of the assessments seek to measure? Are we measuring the learner's knowledge base or the potential to learn? Are we monitoring the learner's comfort ability in grasping of concepts or are we measuring whether or not the learner has grasped? Are we binary in our pass/fail decision making procedure or do we allow for the gray to reason with the white and choose a side. Are we seeking to understand whether the child can rote learn facts and figures in an evening and produce them the morning after, or are we trying to gauge if the child understands the approach and is brave enough to reason with it and challenge it, if necessary? Are we trying to understand how many person-hours the teacher spent in explaining a concept, or are we trying to look at how well the teacher taught a concept given a time frame? True assessment is subjective,

given the boundaries, defined by: who? why? when? what? and how? we want to assess a scenario with regards to.

In understanding portfolio assessment with regards to science education, one can relate it to the quintessential scientific 'job', of that of a doctor. A portfolio assessment can be seen, in essence as an account about this particular doctor, from a close friend and colleague. It is an evolving, somewhat subjective, opinion about the doctor, from his days as a freshman pursuing his MBBS continuing to the day he performs his first open heart surgery, the day he loses his first patient through to the present. It is a dynamic conversation which deals with inputs on the person's learning path, through the individual crests and troughs that may be added to the curve, as a result of personal experiences.

Constructing Education and Identifying the Need for Relevant Assessment

As has been discussed, scientific training is not about teaching an individual the facts and figures, it is in fact to engage the pupil to be interested enough, to search for the aforementioned data and then reason the numbers and trends. The 21st century educators have been imparted with the task to create learners, who are willing to seek the truth, at the cost of 'unlearning' previous hypotheses, given enough reason and facts.

"You can define a straight line; what use is that to you if you've no idea what straightness means in life?"

— Seneca, *Letters from A Stoic*

While new discoveries abound and previous norms are challenged on a regular basis, a learner has to be equipped with the tools to take well-informed decisions based on evidences. A 'scientific temperament' in this regard, would

be to view the happenings in the world as experiments and formulate hypotheses based on existing knowledge based assumptions. Then, building upon the hypotheses, until the explanations gain coherence.

In such a dynamic teaching-learning universe, there needs to be an assessment tool which is adaptive, intuitive and ever evolving. An assessment system, which enlists the learner's capabilities and capacities and builds upon it, is thus an excellent approach to evaluation of both teaching and learning. The portfolio assessment is a tool which seeks to do just that.

Portfolio Assessment: A Viability

"Most learning is not the result of instruction. It is rather the result of unhampered participation in a meaningful setting. Most people learn best by being 'with it,' yet school makes them identify their personal, cognitive growth with elaborate planning and manipulation."

— Ivan Illich

Assessment can be traditionally summed as being formative or summative in nature. While the former answers the assessment for learning, the latter caters to assessment of learning. Portfolio assessment can be seen to be as an intermediate of the two, given that it sums up the performance of the student in the classroom, and qualifies the student for the next, but also gives an idea of the process of formation of the knowledge base.

In portfolio assessment, the learner is given ownership of the learning process. Thus, the individual is empowered, given that she/he can seek to tackle problem-based questions and form a deeper understanding of a concept, rather than merely understanding utilisation of

a tool to some day tackle a real world problem. Portfolio assessment can also be seen as a dialogue between the learner and the facilitator or the teacher. The learner engages in dealing with a problem and imparts to it personal approaches, based on an existing knowledge base, the facilitator then seeks to build upon this base by giving inputs and feedback to the learner, based on her/his attempts to arrive at a solution. The learner, in this entire process, creates a portfolio of collected evidences of learning, all the tasks which she/he had to undergo to finally make a decision, and also documenting 'how, when, why and where' those decisions were arrived at. These documentations are also supported by the artifacts that may have been created in the process of learning. This type of an assessment methodology gives insight into the students' exercise of mental facilities, it can seek to educate the facilitator on the weak points and strong points of the pupil, so that both may seek to efficiently and effectively learn.

Conclusions: Portfolio Assessment, Utopia versus Practicable Reality

Portfolio assessment, while it can be a boon in the teaching-learning system, comes with its fair share of banes. The subjectivity of the assessment, in a competitive educational 'market' wherein grades make or break career decisions and life choices, can be a factor too overwhelming, to quite ignore. A teacher can mould the learner in the direction she/he wants. A student engaged in learning from a mediocre teacher, would then not truly benefit from this system at all.

The second-most noteworthy critique of the portfolio assessment is the resource allocation for assessment. In a developing nation, such

as India, do we really have the wherewithal to cater to creating, maintain and giving individually catered feedback in our 'brimming to the full' classrooms? Would that not be a plea to teachers who in fact perform sub-optimally? Are we equipped with education for the educators to individually respond and provide dialogue in a portfolio based system? If not, can we afford to provide it to all our educators? The third concern that portfolio assessment raises is that of student mobility. This may be seen as an extended case of subjectivity versus objectivity in assessment. If a student transfers mid-way through her/his learning, would a variation in the personality of the portfolio assessors provide hindrance to the learning graph of the child?

It may thus be concluded, that as an assessment tool, portfolio assessment may be adopted to successfully gauge the student potential and commitment to learning of sciences. However, it would be better to view portfolio assessment as not only an evaluative measurement indice, but an education tool to formulate a dialogue and discussion based teaching-learning environment in the classrooms of the 21st century.

As is said about the success of every tool, it is not solely the tool but the one wielding it, who contributes to a successful and intelligent measurement. The impetus, as always, lies with the educator.

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ROLE OF ASSESSMENT FOR LEARNING OF SCIENCE AT SCHOOL LEVEL

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For being able to do effective assessment, it is desirable that science educators have adequate knowledge of the role that assessment plays in science education. This article discusses how the role of assessment has changed over a period of time and how these changes have impacted the assessment practices. It describes how the assessment practices have been influenced by developments in psychology and philosophy in the last one century. The benefits of using Assessment for Learning (AfL) of science and the various challenges which need to be overcome to reap these benefits are also explained.

Historical Perspective

For centuries, formal education was not accessible to all, except a select few. In older times, the young followed the traditional-occupations which they learned 'hands-on' while being on the job. Only a small number of young had formal education under a *guru* or master to become a master themselves. Their education consisted primarily of learning religious scriptures and their interpretation. There was a scarcity of manuscripts; hence, students were forced to learn the scripts by heart. Under these circumstances, the assessment of students was done by making them recite or answer the questions orally or questioning each other. They were expected to give 'right' answers to the questions which were mostly familiar to them. The assessment of learning was based on the ability of the student to learn by heart and to be able to recall it verbatim. Disputing the arguments put forward by others was also

an important method of assessment (Willbrink, 1997). In India, there are many legends of *vaad-vivad* (argument and counter-argument). Some students were also trained for the martial arts. They were also assessed on the basis of practical demonstration of the skills acquired by them.

There have also been records of use of assessment for selection for particular positions. 'The first known examinations were those for entry into the Chinese imperial civil service that date to 2000 BCE. These exams were an essential requirement for those wishing to achieve political or economic power' (Miller, 2006, p. 3). In India, about 1500 years ago, Chanakya's *Arthashastra* mentions about assessment of a candidate for a ministerial position. 'Different methods of assessing a candidate for ministerial positions have been spelt out in the *Arthashastra* including: observation, performance appraisal, assessment by those who knew him, interviewing, and other forms of testing' (Rao & Juneja, 2007, p. 3).

In the eighteenth and nineteenth centuries, examinations began to be used by many European nations for recruitment to army, civil services and various other government positions. Since one's future career depended on the outcome of these examinations, most students started giving importance to what would ultimately be tested (Willbrink, 1997).

In medieval times, schools and universities started coming up in Europe. In these institutions, students were grouped together not as per their age but as per their learning abilities. They remained in the same grade for quite different durations. The students were assessed in comparison to the peers who were at the same levels of learning; though not necessarily of same age. Assessments were a regular feature and students were punished for committing blunders. Gradually, a system of competition and reward replaced the system of punishment to motivate students. The students were ranked according to merit, and elaborate systems were introduced to maintain the record of students' performance (Willbrink, 1997). With the development of paper and print technology, mass production of books started becoming possible. This also paved way for the written tests being used for the assessment of students. 'The written examination first appeared in Europe in the sixteenth century, when it was used to supplement the viva-voice examination' (Klassen, 2006, p. 822).

With industrial revolution and urbanisation emerged the need to prepare a large number of people for specific jobs. This resulted in graded schools where the students of almost same age were grouped together in same grade for a fixed duration of stay. An important implication was that students were now assessed with peers of same age not with peers at same learning levels as in earlier times. In graded schools,

examinations were conducted for promotion of students to higher grade and to rank them on the basis of merit. In the nineteenth century, the ranking systems were gradually replaced with marking system. 'Quantification of marks was a major turning point in the nature of examinations since it led to the formulation of factual, categorical, narrowly focussed questions' (Klassen, 2006, p. 822). Questions were phrased in a manner that did not allow different interpretations and the students were expected to give right answers. Hence, knowing the right answers to questions was extremely important.

Influence of Psychology and Philosophy of Science

By the turn of the twentieth century, schools started playing an important role in society, and assessment of students' achievement became a significant dimension of schooling. Around this time, developments in philosophy and psychology started influencing the pedagogical and assessment practices in schools. For the major part of the twentieth century, the behaviourist learning theories prevailed, which, in turn, were influenced by empiricism. As per these theories, it is thought that a student's mind is like a '*tabula rasa*' (a blank slate) on which knowledge can be transferred through student's senses. What the student learns is an exact replica or a subset of information imparted to the student and no further processing of information occurs in the mind. Hence, the student's knowledge is simply a record of what was received through her/his senses. It is expected that when the student is assessed, this information will come out unchanged. This belief led to the assessment practices that valued factual recall of what was imparted to the student.

An implication of behaviourist view is that knowledge can be 'atomised', that is, it can be broken into small steps. Learning occurs by assimilating atomised bits of knowledge which are presented to the student in a sequential and hierarchical order. Student must attain mastery over a learning objective before moving on to the next learning objective. To ensure mastery over a learning objective till the desired level, precise standards of measurement are required. The test items are designed to test one skill at a time and are mostly based on rote recall. Generally, the test items are familiar to the students and rehearsed by them. The levels of learning are communicated through scores or grades (Shepard, 2000).

During the last few decades of the twentieth century, criticism of behaviourism started mounting. Cognitive psychology started replacing behavioural psychology and developments in philosophy of science made an impact on education. Gradually, behaviourism diminished and constructivist learning theory became dominant. Today, the mind of a student is not seen as a blank slate. It is now believed that the learner comes with existing mental structures, also called preconceptions or prior knowledge. New information is actively reconstructed by the learner to accommodate and assimilate it into existing mental structures. It is also believed that the learner constructs knowledge within a social context. So, the new learning is shaped by prior knowledge as well as the social context of the learner. As a result, when the learner is assessed, what comes out as test answers is frequently different from the knowledge that was imparted.

Due to this changed view of how learning takes place, changes in pedagogical processes as well as assessment practices are required

in science. The pedagogy consistent with constructivist approach requires a learner-centred environment. To assess the learning, it is required to assess how well the learner has integrated knowledge with her/his existing mental structures. The measurement approach to assessment, where assessments are used only to give grades, is not consistent with constructivist pedagogy; rather it acts as a barrier to it.

The aims of science education are also refined in accordance with the advancements in science, demands of fast changing world and the changed views of how learning takes place. Science education should enable the learner to know the facts and principles of science, acquire the science process skills, nurture curiosity and creativity, develop a historical and developmental perspective of science, relate to the environment, cultivate scientific temper, and imbibe values (NCERT, 2006). To be able to assess if the aims of science education are being achieved, the traditional assessment practices are no longer sufficient to gather evidences of students' learning as these are generally based on lower levels of cognition. The assessment practices now require not just the assessment of learners' understanding of facts and concepts in science, but also, the acquisition of science process skills, higher order thinking skills, problem-solving skills and scientific attitude.

In the 1970s and 1980s, criticism of traditional assessment practices started coming up and alternative forms of assessments were suggested (Gardner, 1985; Duschl & Gitomer, 1997; Gitomer & Duschl, 1995; Erickson & Meyer, 1998; Tamir, 1998). Some of these are concept maps, practical assessment, portfolio, individual student or group interviews, discussions, projects, peer and self-assessments, reflective

journals, observations. To collect the evidence of students' learning in science, a variety of assessment tasks are used and the evidences collected are analysed systematically. Multiple assessments give a more comprehensive understanding of students' learning. To put these recommendations in practice, assessment done by science teachers in classrooms is seen as a viable option.

Assessment for Learning (AfL) of Science

After the landmark study of Black and William (1998), focus started shifting from assessment *of* learning to assessment *for* learning (AfL), that is, from assessment to prove learning to assessment to improve learning. This is often called formative assessment. It may be defined as 'The process used by teachers and students to recognise and respond to students' learning in order to enhance that learning, during the learning' (Bell & Cowie, 2001, p.8, cited in Bell, 2007, p.972).

If assessment has to play the role of supporting and enhancing learning of science, it cannot be a periodic event, as has been the practice. Rather, assessment has to be ongoing, integral part of teaching-learning process in science. In fact, good assessment tasks can be interchangeable with good learning tasks.

When the assessment is used for learning of science, it helps in creating a learning culture in the classroom where teachers and learners are partners in finding out what works, what does not work for learning to take place and what next steps need to be taken to enhance learning.

It helps the teacher to understand students' learning and their progress. If the assessment

is done in the form of an interactive manner, it provides opportunity to the teachers to gain insight about how the students' learning may be extended. The assessment can itself be used to scaffold next steps and to create learning experiences in science. It helps to develop higher order thinking skills in science. Assessment for learning enables the teachers to identify individual learning needs of learners, particularly in diverse classrooms and design the learning experiences as per their specific needs.

In science, alternative frameworks are widespread and are highly resistant to change (Driver et al., 1994). Assessment for learning helps in finding out if the learners are holding any alternative frameworks. Once aware, the teacher may design learning experiences for the learners to challenge their existing frameworks and help them to modify their concepts as per the scientifically accepted concepts.

Formative assessment also provides opportunities to teachers to reflect upon and improve the pedagogical practices followed by them. The learners are actively involved in the process of assessment which helps them to take responsibility of their own learning. The constant feedback to the learners about their learning is an integral part of learning experience leading them to self-correction and improvement.

Many researchers have tried to determine the importance of formative assessment for the learning of science (Wenglinsky, 2000; Marzano, Pickering & Pollock, 2001). Black and William (1998) reviewed the research recorded in 578 articles and found 'There is a body of firm evidence that formative assessment is an essential component of classroom work and that its development can raise standards of

achievement. We know of no other way of raising standards for which such a strong *prima facie* case can be made' (Black & Wiliam, 1998, p.147, cited in Hammerman, 2009).

Challenges Ahead and Way Forward

Even though pedagogical practices are moving towards constructivist approaches, changes in assessment practices are still lagging behind, resulting in a mismatch. The benefits of using assessment for learning of science are manifold; still it is not at all simple to implement it in classrooms, particularly on a large scale. There are many challenges which need to be overcome as reported by many researchers (Sadler, 1998; Tunstall & Gipps, 1996; Perrenoud, 1991). In the context of developing countries like India, the challenges are even greater, such as, large number of students per class, non-academic demands on teachers' time, infrastructural woes, etc.

To make assessment part of classroom learning, many changes are needed, such as, changes in pedagogical practices followed in science classrooms, the way teachers interact with learners in the classrooms, how they define learners' success. To create a culture in the classroom for successful integration of assessment in learning of science, the learners need to be socialised into learning in groups so that they become participant-learners in group learning situations in classrooms and beyond classrooms. They need to learn to develop their competencies as part of a social group by developing their ability to work with others, communicating their ideas, presenting logical explanations and arguments, providing justification in support of evidences, explaining their reasoning, by giving and receiving feedback.

To be able to use assessment to enhance learning of science in classrooms, changes are needed in the form and content of assessment. There is an urgent need to develop imaginative new assessment practices for science classrooms. How the feedback about the performance is given to the learner is also important. Feedback to the learner still continues to be just the reporting of right and wrong answers. Lot of research is needed into finding ways of feedback which helps learners to self-correct and improve without denting their confidence and motivation.

All stakeholders, particularly the policy-makers and parents, need to be educated about the difference in purposes of large scale public examinations and the assessments for learning (AfL) of science in classrooms. Despite the developments in the understanding of how learning takes place and how assessments may help in the learning of science, the reality is that most stakeholders still hold the belief that assessment means test or examination separate from learning where the levels of learning are communicated through scores or grades. This traditional view of assessment stems from their beliefs about learning and assessment based on behaviouristic approaches. These beliefs are so much entrenched in the minds of teachers, learners, parents and policy-makers that these continue to affect the present assessment practices in science classrooms. Many teachers believe that assessments are official events separate from instruction (Bliem & Davinroy, 1997). They want their assessments to be objective and often worry about the subjectivity involved in making more holistic assessments. To be able to reap the benefits of assessment for learning of science, a shift in the mindset of all concerned, particularly the teachers, is required. The science teachers need to be

provided opportunities during pre-service and in-service teacher training to reflect upon and modify their views on assessment. To be able to use assessment to enhance learning of science in classrooms, an understanding of goals of science learning, the purpose of assessment and the tools of assessment are required. The teachers need to be highly skilled and have a deep knowledge of subject matter to be able to ask right questions at the right time. There is also a need to recognise and value the different learning styles of learners.

Since it is believed that science learning is contextual, the outcome of various assessment practices also depends upon the context. Globally, researchers are carrying out researches in classroom on assessment for learning of science. However, there is a need for teachers to do research on assessment in

the context of their own classrooms and share it with the larger teacher community so that they learn from each other's practical experiences. More researches are needed to support the validity and reliability of various assessment practices being used in science education. There is also a need to explore the use of assessment for learning of science in new ways.

There should not be an uncritical acceptance of any prevailing assessment practices. Rather, there should be a continuous reflective dialogue amongst all stakeholders, particularly teachers, learners and parents, to improve the assessment practices. The quality of science education is directly linked to the quality of assessment. Hence, there is a need to make continuous efforts for improving the assessment practices being followed in science classrooms.

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ANALYSIS OF CBSE QUESTION PAPERS IN BIOLOGY

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Quantitative and qualitative analysis of CBSE question papers in the subject Biology was done for the years 2012, 2013 and 2014. Questions asked in the question papers under the study were analysed on several parameters, including mental processes, form of question, difficulty level, content, marking scheme, time allotted for reflection, etc. A changing trend has been observed in the questions in the question papers from the years 2012 to 2014 that the assessment of rote memorisation has been replaced by the assessment of higher order thinking skills. It was observed that in the year 2013, value-based questions were introduced with a weightage of 7 per cent, which got reduced to 4 per cent of the total marks in the year 2014.

Introduction

Examination system in India, especially in school education, has largely been a paper-pencil test. Set of questions of theoretical nature are textbook-centric therefore, promote testing of rote memorisation and, to some extent, theoretical understanding of a learner. Consequently, overpowering the examination system does not encourage the inventiveness and creativity. In science, questions are usually framed for testing cognitive learning and outcomes of a learner based on Bloom's taxonomy of cognitive domains (Bloom et al., 1956; Anderson and Krathwohl, 2001). However, such a mode of assessment has been questioned on the ground that child's overall assessment is not being undertaken (NCERT, 2003, 2001, 2000, 1971). The National Curriculum Framework (NCF) 2005 and NFG position paper on examination reform (2005) have brought paradigm shift in our understanding and its implications towards the assessment of student's overall performance.

A question paper includes a set of items created on the basis of syllabus following a blueprint. The regulatory authority responsible to conduct examination develops the blueprint with the help of experts. Answers to these questions after judgment can demonstrate the achievement of certain level of learning in the learners. As learners are encouraged to achieve more in the examinations; the cognitive challenge of items in the question paper may influence students' study strategy for examinations considerably (Alison, Clarissa and Wenderoth, 2008). In the present scenario, learners appear in the examinations to get quantitative learning outcome and achieve certain levels of qualification standards. Answers presented by learners reveal the knowledge, understanding, competencies and skills acquired by them.

Major shortcoming observed in the type of questions in a question paper is that they mainly test the recall of memorised information and overlook the assessment of higher order thinking skills like understanding comprehension with associated competencies

such as reasoning, analysis and critical thinking (NCERT, 1999). Thus, the analysis of a question paper is very important to arrive at meaningful conclusion of the accuracy of the approach adopted to examine degree of achievements or learning outcomes in learners. Analysis records quantitative and qualitative data of each item that helps in further improvement keeping in view not only certain factors for overall development of learning but also to limit the stress about the examinations and keeping it reasonable throughout by creating the marking guidance.

Central Board of Secondary Education is one of the oldest and largest boards in school education in India, established in 1929. It has more than 16,000 affiliated schools in India and 24 other countries of the world. The board is committed to provide stress-free learning environment and evaluation procedure. Being the largest board of the council of the board of school education, it has huge beneficiaries as it reaches out to public domain at large that includes schools, teachers, students and parents, national and international bodies, etc. All CBSE-affiliated schools follow a uniform curriculum with a flexible scheme of studies suitable to the needs of each and every student. Despite the geographical variations, students of CBSE-affiliated schools take benefit in common sharing and privileges concerning curriculum, assessment and academic advances.

NCF-2005 recommends an evaluation procedure that can critically examine the learners' acquaintance with the subject matter without any psychological pressure, stress or fear for board examinations. It also promotes integration of various evaluation procedures with classroom life by encouraging transparency and internal assessment. Specific measures suggested by NCF-2005, include changing the

typology of questions in the question paper, so that reasoning and creative ability replace rote memorisation, as the basis of evaluation. Assessment provides the degree of achievement of learning outcomes by a learner at a particular stage. Analysis of a question paper is important to know paradigm shift in the evaluation procedure for truthful judgment of the learner's achievement.

Broad curricular expectations as mentioned in NCF-2005 are as under:

1. To achieve scholastic and academic development of a learner.
2. To develop innovative problem-solvers.
3. To develop higher order skills like reasoning, analysis, lateral thinking, creativity and judgment as a substitute of rote memorisation among learners.
4. To inculcate values among learners.

The subject Biology has emerged as one of the separate disciplines of science at higher secondary level. Biology is study of life and life responds in many different ways. Although the nature of biology and nature of physical sciences share many common aspects, however, focus of biology creates unique philosophical, methodological and ethical premises on which biology should be understood and assessed (Kloser, 2012). The curriculum in Biology should provide learners with sufficient conceptual clarity of biological phenomena which will provide the basic understanding required to further learn about the intricacies of the concepts by developing higher order thinking skills (Handelsman et al., 2004; Knight, 2010). Curricular expectations in Biology Education outlined in the syllabus for secondary and higher secondary classes-2005 are as follows:

1. Identify basic principles behind various concepts and theories.

2. Build upon the perceptiveness of basic tools and techniques used in concepts to analyse various issues.
3. Stimulate critical and creative thinking in Biology.
4. Develop the creative skills of drawing sketches, etc.
5. Develop innovative problem-solving abilities to solve problems related to life situations.
6. Widen skills to illustrate linkages of elementary aspects of Biology with complex phenomena.
7. Connect biological concepts to real life problems.
8. Apply biological discoveries/ innovations in everyday life.
9. Integrate and interrelate the biological concepts with other areas of knowledge by underlying common principles.
10. Develop understanding of contribution of scientists that led to critical and important discoveries in Biology.

To ascertain whether the above objectives have been dealt within the classroom, a proper evaluation scheme is required. Thus, keeping in view the objectives of Biology Education with respect to assessment and evaluation, the analysis of Biology question papers of CBSE for years 2012, 2013 and 2014 is presented next. The analysis of individual questions may provide an insight about its validity for assessment of a learner, in view of the type of learners under different learning environments, more efficiently. It will also provide the quantitative data and scope for further improvement of the question paper.

Analysis Methodology

Qualitative and quantitative analysis of three sets of question papers of CBSE for years 2012, 2013 and 2014 was done on the basis of below mentioned indicators:

- (i) If there is any repetition of identical questions year after year.
- (ii) If there is any ambiguity/inadequate phrasing in question-stem.
- (iii) Is the question really doing appropriate assessment of learner's competency in understanding of core concepts rather than knowledge of textbooks?
- (iv) If the question paper shows uniformity with respect to syllabus, does it mean that questions were covered from the whole syllabus uniformly?
- (v) Do the questions in the question paper categorise as : level of difficulty, topic area, form of questions; and competency being evaluated.
- (vi) Judgemental marking convenience to provide full disclosure of transparency in grading and marks/grade reporting.
- (vii) Does framing of any question involve more than one concept that assess the understanding of related core concepts?
- (viii) Length of question paper *versus* time, giving enough opportunity for thoughtful reflections by learners.

Following criteria were fixed for meeting the quantitative analysis of the question papers in the study. The question papers for the years 2012, 2013 and 2014 were analysed to find out the following:

- (i) Weightage given to questions assessing each of the mental processes — learners' competency to recall, provide reasoning, think critically, interpret, problem solving, and creative skills — in the question paper were established by calculating marks allotted against number of items in each category of the mental processes.
- (ii) Weightage given to the questions covered from the content under the syllabus was calculated by the data gathered from the number of questions asked from each unit under syllabus with respect to marks allotted to it.
- (iii) Weightage given to questions under different difficulty levels, including easy, average and difficult type of questions, was calculated by categorising the number of questions asked from each type of the difficulty level with respect to marks allotted to them.
- (iv) Weightage given to the forms of questions including the number of very short answer type (VSA), short answer type I (S-I), short answer type II (S-II) and long answer (LA) type of questions in the question paper and marks allotted in each category.

Results and Discussion

A detailed qualitative and quantitative analysis of question papers based on the above mentioned indicators and criteria for years 2012, 2013 and 2014 is depicted in the document as *Annexures I, II and III* respectively.

1. Weightage to mental processes: Analysis of the question papers on the basis of percentage of marks allotted against number of questions included from each category of the mental process following Bloom's taxonomy in

cognitive domain, *i.e.*, recall, reasoning, critical thinking, interpretation, problem-solving and Dave's in psychomotor domain, *i.e.*, creative skills. Results presented in Fig. 1 clearly indicate that the allocation of marks was highest in reasoning type of questions followed by questions to assess recall, interpretation and creative skills in the question paper in the year 2012. Very less weightage of only 6 per cent was given to assess critical thinking of a learner. In 2013, the highest weightage of 32 per cent was given to reasoning type of questions, followed by 31 per cent to recall type, 8.6 per cent to interpretation and 11.5 per cent to creative skills. Little weightage of 7 per cent was given to assess problem-solving ability in learners in the year 2013. To assess critical thinking ability, only 3 per cent of marks were allocated in the year 2013. The trend changed in 2014, when recall type of questions were replaced by reasoning and critical thinking in which marks allocated were 38.5 and 31.5 per cent respectively, followed by problem-solving, creative skills and interpretation. Value-based questions were given due weightage of 7 per cent in the years 2012 and 2013, which was reduced to 4 per cent in 2014. Besides, in 2013, value-based questions were asked under the category LA type of questions which were more open-ended and assessed learner's competency to comprehend in daily life situations. However, in the year 2014, the value-based questions were framed under the category S-II type of questions.

2. Weightage to content: Fig. 2 shows the analysis on the basis of weightage given as the percentage of marks allotted to the questions included from each unit of the textbook (for content areas) in the question paper. It is obvious from the data presented in Fig. 2, that the content coverage was more or less uniform.

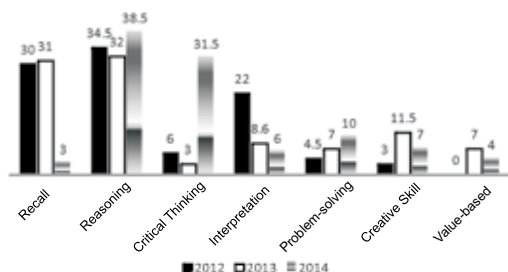


Fig 1. Analysis on the basis of % marks allotted against various mental processes

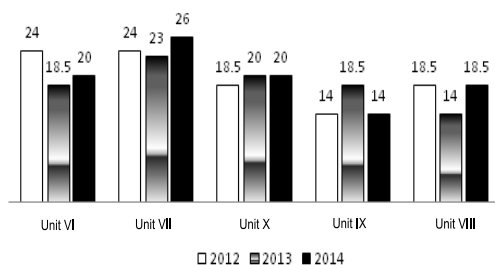


Fig 2. Analysis on the basis of % marks allotted against each Unit

3. Weightage to the form of question

Weightage given to the form of question was as per blueprint prescribed by the board in all question papers under the study. Four categories of questions viz., very short answer type question (VSA), short answer type question category I (S-I), short answer type question category II (S-II), long answer type question (LA) were included by 11.4 per cent, 28.57 per cent, and 38.57 per cent in the

question papers of the years 2012, 2013 and 2014 respectively. Out of the total questions under LA category, 7.14 per cent of marks was allotted to value-based questions in 2012 and 2013, while the weightage was reduced in 2014 and only 4.28 per cent under S-II category was allocated to value-based questions.

4. Weightage to the difficulty level of questions:

The data presented in the table below, reveal that the questions with high difficulty level are given more weightage followed by average and easy levels in the question papers of all the three years. The percentage of marks allotted to difficult questions were 38.57 per cent, 44.28 per cent and 57.14 per cent respectively and easy questions were 31.42 per cent, 25.71 per cent and 7.14 per cent respectively in the years 2012, 2013 and 2014. Here, a trend may be seen from the year 2012 to 2014 that the weightage given to high difficulty level questions is increasing and low difficulty level questions is decreasing.

5. Comments regarding estimated time (site example)

Estimated time to answer all questions in question paper for year 2013 seems appropriate with little exception. It also gives learners time to rethink all questions for appropriate reflection of knowledge.

Difficulty Level of Questions

S. No.	Difficulty level	% marks allotted as per analysis		
		2012	2013	2014
1.	A	38.57	44.28	57.14
2.	B	30	30	35.71
3.	C	31.42	25.71	7.14

A-Difficult; B-Average; C-Easy

6. Other observations

- (i) **Repetition of questions:** No question has been observed to be repeated from years 2012, 2013 to 2014.
- (ii) **Inadequate information in question stem:** In the year 2013, question number 5 in SET 1, the information was insufficient in the question-stem. The question was framed as "What is the importance of MOET?", instead full form of MOET may be written in the question-stem. The question may be written as "What is the importance of multiple ovulation and embryo transfer (MOET)?"
- (iii) Almost uniform weightage has been given to the whole syllabus. Questions were asked uniformly from the entire content area.
- (iv) **Paradigm shift in the assessment procedure:**
- Question paper of the year 2012 includes mostly recall type of questions which are replaced by questions based on different mental abilities like reasoning, critical thinking, etc., in 2013 and 2014.
Attempt has been made to include some questions, about 19 per cent, from application in daily life in the years 2013 and 2014, however, it was about 13 per cent in 2012. It indicates that attempt has been made to assess conceptual understanding of the core concepts rather than the knowledge components.
 - Value-based questions based on mental ability of recalling, reasoning and interpreting the facts, were introduced in 2013 and 2014.
 - A recall type of question was asked from textbook of Class XI under very short answer type of question of 1 mark (Q#7), in 2014.

- In the year 2014, comparatively more choices were given in the individual questions to answer them.

7. Merits

- Most of the recall type questions are related to application in daily life, such as Q#13, 15, etc., in the year 2013, and Q#2, 23, 24, etc., in the year 2014.
- Questions are designed as per marking convenience. Marks are allotted so appropriately for good grade reporting. For example, Q#3, 15, 19, 28, etc., in the year 2013.
- Some questions assess understanding of more than one concept such as Q#6, 9, 12, etc., in the year 2013.
- Questions which assess learner's skills to illustrate linkage of simple aspects of Biology with complex phenomena have also been included, such as Q#1 and 6.
- Questions which assess creative skills of a learner based on mental ability of recalling in the question paper under analysis, have also been included.
- Several open-ended questions were a part of the paper in the year 2012, such as Q#7 and 17; and few in the year 2013, such as Q#26, which assess the learner's ability to comprehend. Due weightage has been given to such questions in the question paper of 2014.
- Questions to assess understanding about the contribution of scientists that led to critical and important discoveries in Biology have also been included in the year 2014, such as Q#12.

8. Limitations

- Some questions assessing memory are being included in question paper of 2013, such as Q#29, where the marking scheme too is not very clear in both the choices. In this case, grade reporting may not be fair.

- Several open-ended questions are a part of the paper in the year 2012, such as Q# 7 and 17; and few in the year 2013, such as Q# 26, which may lead to unfair marking as it is subjective.
- Less weightage for open-ended questions in 2013, hence no assessment of learner about the ability to comprehend.
- No space /weightage for MCQs in question papers of 2012, 2013 and 2014.

Conclusion

Currently, there is a continuing need for assessment practices in Biology that encourage learning of disciplinary knowledge and develop critical thinking skills in learners (Bird, 2014). A quick growth in the knowledge in the subject has raised challenges to develop assessment practices that provide students with the skills and knowledge to find, analyse, synthesise and

apply information to new situations and problem-solving goals particularly in the subject (Brewer & Smith, 2011).

The contemporary practices adopted for evaluation are attempting to fulfil the objectives of Examination Reforms 2005. However, efforts are being made continuously by the board to improve and meet the requirements to fulfil those objectives. A shift in the method of assessment and evaluation is visible in the analysis of the question papers. This shift has impacted the blueprint and the question paper and finally the type of questions included in the question paper. The study reveals a shift in assessment questions increasing from recall type of questions to questions from higher order thinking skills, from the year 2012 to 2014. However, research-based efforts are needed to make fair, transparent, fearless and learner-friendly assessment and evaluation practices in Biology.

Annexure I CBSE QUESTION PAPER ANALYSIS FOR Class XII – 2012

SET 1

Max Marks: 70

Duration: 3 hrs

S. No. of the question	Unit of syllabus	Mental process — recall/higher mental abilities such as problem-solving, critical thinking, interpretation, reasoning.	Text-book based or not	Type of question LA S-I/S-II VSA/ OT	Marks allotted	Estimated difficulty level A-Difficult B-Average C-Easy	Estimated time reqd (minutes)	Remarks specificity and simplicity of language, task specification, scope of the question, language errors, within syllabus, quality of diagram and sketch, absence of inadequate instructions, etc.
1.	VI	Reasoning	YES	VSA	01	C	2	
2.	VIII	Reasoning	YES	VSA	01	B	2	

3.	VII	Reasoning	YES	VSA	01	C	2	
4.	X	Reasoning	YES	VSA	01	B	2	
5.	VI	Recall	YES	VSA	01	C	2	
6.	IX	Recall	YES	VSA	01	A	2	
7.	VII	Interpretation	YES	VSA	01	A	2	Open-ended, less marking, less timing
8.	X	Reasoning	YES	VSA	01	C	2	
9.	VI	Creative Skill	YES	S-I	02	A	4	
10.	VI	Recall	YES	S-I	02	B	4	
11.	VIII	Reasoning	YES	S-I	02	A	4	
12.	IX	Reasoning	YES	S-I	02	A	4	
13.	X	Recall	YES	S-I	02	C	4	Application in daily life
14.	VI	Reasoning	YES	S-I	02	B	4	
15.	VIII	Recall	YES	S-I	02	B	4	Open ended; choice is being given
16.	VII & IX	Recall	YES	S-I	02	A	4	
17.	VI & X	Reasoning	YES	S-I	02	B	4	Open-ended, less marking, less timing
18.	VIII	Recall	YES	S-I	02	A	4	
19.	VII	Reasoning	YES	S-II	03	A	6	Choice given
20.	VI	Interpretation	YES	S-II	03	B	6	
21.	VIII	Interpretation	YES	S-II	03	C	6	
22.	VII	Recall	YES	S-II	03	B	6	
23.	IX	Reasoning	YES	S-II	03	C	6	Application in daily life
24.	VIII	Recall	YES	S-II	03	A	6	Application in daily life

25.	VII	Recall	YES	S-II	03	C	6	Application in daily life
26.	X	Interpretation	YES	S-II	03	C	6	Choice is being given
27.	IX	Problem-solving	YES	S-II	03	A	6	
28.	X	Interpretation	YES	LA	05	B	20	Choice is being given, part of question is open ended
29.	VI	Reasoning	YES	LA	05	A	20	
30.	VII	Critical thinking	YES	LA	05	A	20	Choice is being given

Annexure II

CBSE QUESTION PAPER ANALYSIS FOR Class XII – 2013

SET 1					Max Marks: 70		Duration : 3 hrs	
S. No. of the question	Unit of syllabus	Mental process — recall/ higher mental abilities such as problem-solving, critical thinking, interpretation, reasoning, etc.	Text-book based or not	Type of question LA S-I/S-II VSA/ OT	Marks allotted	Estimated difficulty level A-Difficult B-Average C-Easy	Estimated time reqd (minutes)	Remarks specificity and simplicity of language, task specification, scope of the question, language errors, within syllabus, quality of diagram and sketch, absence of inadequate instructions, etc.
1.	VI	Critical thinking	YES	VSA	01	A	2	
2.	VIII	Interpretation	YES	VSA	01	B	2	
3.	VII	Recall	YES	VSA	01	C	2	

4.	VII	Reasoning	YES	VSA	01	B	2	
5.	VIII	Reasoning	YES	VSA	01	C	2	Inadequate language instruction
6.	IX	Critical thinking	YES	VSA	01	A	2	
7.	X	Recall	YES	VSA	01	C	2	
8.	X	Recall	YES	VSA	01	C	2	
9.	VI	Reasoning	YES	S-I	02	A	4	
10.	VI	Recall	YES	S-I	02	B	4	
11.	VIII	Problem-solving	YES	S-I	02	A	4	
12.	VIII	Interpretation	YES	S-I	02	A	4	
13.	IX	Recall	YES	S-I	02	C	4	Application in daily life
14.	IX	Recall	YES	S-I	02	B	4	
15.	IX	Recall	YES	S-I	02	B	4	Application in daily life; choice is being given
16.	X	Recall	YES	S-I	02	C	4	
17.	X	Reasoning	YES	S-I	02	B	4	
18.	X	Reasoning	YES	S-I	02	C	4	
19.	VI	Creative skill	YES	S-I	03	A	6	
20.	VII	Interpretation	YES	S-I	03	B	6	
21.	VII	Problem-solving	YES	S-I	03	C	6	
22.	VII	Recall	YES	S-I	03	B	6	
23.	IX	Reasoning	YES	S-I	03	C	6	Application in daily life
24.	VIII	Recall	YES	S-I	03	A	6	Application in daily life

25.	IX	Reasoning	YES	S-I	03	C	6	Application in daily life
26.	X	Reasoning	YES	S-I	03	C	6	
27.	X	Reasoning	YES	S-I	03	A	6	
28.	VI	Creative skill	YES	LA	05	B	20	Choice is being given in half part of question
29.	VIII	Recall, reasoning	YES	LA	05	A	20	Choice is being given
30.	VII	Value-based	YES	LA	05	A	20	

LA = Long answer question having 5 marks, S-I = Short answer question having 2 marks, S-II = Short answer type question having 3 or 4 marks, VSA= Very short answer type question having ½ or 1 mark, OT= Objective type question.

Annexure III

CBSE QUESTION PAPER ANALYSIS FOR Class XII – 2014

SET 1

Max Marks: 70

Duration: 3 hrs

S. No. of the question	Unit of syllabus	Mental process — recall/ higher mental abilities such as problem-solving, critical thinking, interpretation, reasoning, etc.	Text-book based or not	Type of question LA S-I/S-II VSA/ OT	Marks allotted	Estimated difficulty level A-Difficult B-Average C-Easy	Estimated time reqd (minutes)	Remarks specificity and simplicity of language, task specification, scope of the question, language errors, within syllabus, quality of diagram and sketch, absence of inadequate instructions, etc.
1.	VI	Recall	YES	VSA	01	B	2	
2.	VII	Reasoning, interpretation	YES	VSA	01	A	2	Interpretation
3.	VIII	Reasoning	YES	VSA	01	B	2	
4.	IX	Reasoning	YES	VSA	01	A	2	
5.	X	Reasoning	YES	VSA	01	C	2	

6.	X	Reasoning	YES	VSA	01	A	2	
7.	I	Recall	YES	VSA	01	C	2	From textbook of Class 11
8.	X	Reasoning	YES	VSA	01	B	2	
9.	VI	Critical thinking	YES	S-I	02	A	4	
10.	VII	Problem-solving, critical thinking	YES	S-I	02	B	4	
11.	VII	Problem-solving, critical thinking	YES	S-I	02	A	4	Choice has been given
12.	VII	Recall, Reasoning	YES	S-I	02	A	4	
13.	VIII	Reasoning	YES	S-I	02	B	4	Application in daily life
14.	IX	Reasoning	YES	S-I	02	A	4	
15.	IX	Reasoning	YES	S-I	02	A	4	Application in daily life
16.	X	Critical thinking, creative skill	YES	S-I	02	B	4	
17.	X	Reasoning	YES	S-I	02	B	4	
18.	IX	Critical thinking	YES	S-I	02	A	4	
19.	VI	Reasoning	YES	S-II	03	A	6	
20.	VI	Reasoning	YES	S-II	03	B	6	
21.	VII	Creative thinking	YES	S-II	03	A	6	Choice has been given
22.	VII	Value-based	YES	S-II	03	B	6	Difficult language

23.	VIII	Recall, reasoning	YES	S-II	03	C	6	Application in daily life
24.	VIII	Critical thinking	YES	S-II	03	A	6	Application in daily life
25.	IX	Problem-solving, critical thinking	YES	S-II	03	A	6	Application in daily life
26.	X	Interpretation, reasoning	YES	S-II	03	B	6	Choice is being given
27.	X	Recall, reasoning	YES	S-II	03	A	6	
28.	VI	Recall, creative skill	YES	LA	05	B	20	Choice is being given in half part of question
29.	VII	Reasoning, critical thinking	YES	LA	05	A	20	Choice is being given
30.	VIII	Reasoning, creative thinking	YES	LA	05	A	20	Choice is being given

LA = Long answer question having 5 marks, S-I=Short answer question having 2 marks, S-II = Short answer type question having 3 or 4 marks, VSA= Very short answer type question having ½ or 1 mark, OT= Objective type question.

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SCIENCE NEWS



The fossil bones of *Australornis lovei* have been collected from the greensand deposits of Southern Island of New Zealand. The fossils are expected to be 58 million years old. These deposits are believed to have formed shortly after the event of mass extinction of the dinosaurs and many marine organisms. They may have been formed in the deep waters of a very warm sea off the coast of Zealandia — the continental fragment New Zealand rests upon.



Australornis lovei was about 70–85 cm in length and weighed 1.5–2 kg. The bird has been named

after its discoverer — Mr Leigh Love, an amateur fossil collector from Waipara, New Zealand.

This discovery is important for our understanding of early evolution of birds. The bird had similarities with two species from the late Cretaceous from the Antarctic Peninsula. Thus, this discovery highlights the links between Antarctica and New Zealand in the late Cretaceous and early Paleocene.

Device to capture energy from infrared emission of earth to outer space: A new mode of renewable energy

When the sun sets on a remote desert outpost and solar panels shut down, what energy source will provide power through the night? A battery, perhaps, or an old diesel generator! Perhaps something strange and new!

Physicists at the Harvard School of Engineering and Applied Sciences (SEAS) envision a device that would harvest energy from earth's infrared emissions into outer space. Heated by the

sun, our planet is warm compared to the frigid vacuum beyond. Thanks to the recent technological advances, the researchers say, that heat imbalance could soon be transformed into direct-current (DC) power, taking advantage of a vast and untapped energy source.

“It’s not at all obvious, at first, how you would generate DC power by emitting infrared light in free space toward the cold,” says principal investigator Federico Capasso, the Robert L. Wallace Professor of Applied Physics and Vinton Hayes Senior Research Fellow in Electrical Engineering at Harvard SEAS. “To generate power by emitting, not by absorbing light, that’s weird. It makes sense physically once you think about it, but it’s highly counter-intuitive. We’re talking about the use of physics at the nanoscale for a completely new application.”

Challenging convention: Capasso is a world renowned expert in semiconductor physics, photonics and solid-state electronics. Capasso and his research team are proposing something akin to a photovoltaic solar panel, but instead of capturing incoming visible light, the device would generate electric power by releasing infrared light.

“Sunlight has energy, so photo-voltaic make sense; you’re just collecting the energy. But it’s not really that simple, and capturing energy from emitting infrared light is even less intuitive,” says lead author Steven J. Byrnes, a post-doctoral fellow at SEAS. “It’s not obvious how much power you could generate this way, or whether it’s worthwhile to pursue, until you sit down and do the calculation.”

As it turns out, the power is modest but real. As Byrnes points out, “The device could be coupled

with a solar cell, for example, to get extra power at night, without extra installation cost.”

Two proposed devices — one macro, one nano:

To show the range of possibilities, Capasso’s group suggests two different kinds of emissive energy harvesters: one that is analogous to a solar thermal power generator, and the other that is analogous to a photovoltaic cell. Both would run in reverse.

The first type of device would consist of a ‘hot’ plate at the temperature of the earth and air, with a ‘cold’ plate on top of it. The cold plate, facing upward, would be made of a highly emissive material that cools by very efficiently radiating heat to the sky. Based on measurements of infrared emissions in Lamont, Oklahoma (as a case study), the researchers calculate that the heat difference between the plates could generate a few watts per square meter, day and night. Keeping the ‘cold’ plate cooler than the ambient temperature would be difficult, but this device illustrates the general principle: differences in temperature generate work.

“This approach is fairly intuitive because we are combining the familiar principles of heat engines and radiative cooling,” says Byrnes.

The second proposed device relies on temperature differences between nanoscale electronic components — diodes and antennas — rather than a temperature that you could feel with your hand.

“If you have two components at the same temperature, obviously you can’t extract any work, but if you have two different temperatures you can,” says Capasso. “But it’s tricky; at the level of the electron behaviours, the explanation is much less intuitive.”

“The key is in these beautiful circuit diagrams,” he adds. “We found they had been considered before for another application — in 1968 by J.B. Gunn, the inventor of the Gunn diode used in police radars — and been completely buried in the literature and forgotten. But to try to explain them qualitatively took a lot of effort.”

Simply put, components in an electrical circuit can spontaneously push current in either direction; this is called electrical noise. Gunn’s diagrams show that if a valve-like electrical component, called a diode, is at a higher temperature than a resistor, it will push current in a single direction, producing a positive voltage. Capasso’s group suggests that the role of the resistor could be played by a microscopic antenna that very efficiently emits the earth’s infrared radiation towards the sky, cooling the electrons in only that part of the circuit.

The result, says Byrnes, is that “you get an electric current directly from the radiation process, without the intermediate step of cooling a macroscopic object.”

According to the paper, a single flat device could be coated in many of these tiny circuits, pointed at the sky, and used to generate power.

Technological challenges — and

promise: The optoelectronic approach, while novel, could be feasible in light of recent technological developments — advances in plasmonics, small-scale electronics, new materials like graphene, and nanofabrication. The Harvard team says strength of their research is that it clarifies the remaining challenges.

“People have been working on infrared diodes for at least 50 years without much progress, but recent advances such as nanofabrication are

essential to making them better, more scalable, and more reproducible,” says Byrnes.

However, even with the best modern infrared diodes, there is a problem. “The more power that’s flowing through a single circuit, the easier it is to get the components to do what you want. If you’re harvesting energy from infrared emissions, the voltage will be relatively low,” explains Byrnes. “That means it’s very difficult to create an infrared diode that will work well.”

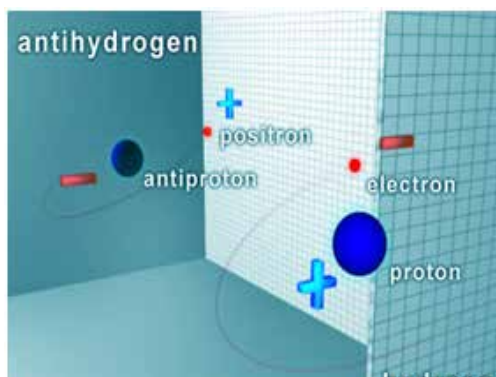
Engineers and physicists, including Byrnes, are already considering new types of diodes that can handle lower voltages, such as tunnel diodes and ballistic diodes. Another approach would be to increase the impedance of the circuit components, thereby raising the voltage to a more practical level. The solution might require a little of both, Byrnes predicts.

Speed presents another challenge. “Only a select class of diodes can switch on and off 30 trillion times a second, which is what we need for infrared signals,” says Byrnes. “We need to deal with the speed requirements at the same time we deal with the voltage and impedance requirements.”

Anti-hydrogen Atoms Created in CERN

Current theories predict that the Universe could just as easily be made of antimatter as of matter and don’t explain why our Universe is made up exclusively of the latter. If scientists find small differences in the properties of matter and antimatter, they would contradict the present paradigm and might help solve the riddle.

Nevertheless, it is possible to produce significant amounts of anti-hydrogen (a positron bound to an antiproton) in experiments by mixing positrons and low energy antiprotons.



The spectra of hydrogen and anti-hydrogen are predicted to be identical, so any tiny difference between them would immediately open a window to new physics, and could help in solving the antimatter mystery.

With its single proton accompanied by just one electron, hydrogen is the simplest existing atom, and one of the most precisely investigated and best understood systems in modern physics. Thus, comparisons of hydrogen and anti-hydrogen atoms constitute one of the best ways to perform highly precise tests of matter/antimatter symmetry.

Matter and antimatter annihilate immediately when they meet, so besides creating anti-hydrogen, one of the key challenges for physicists is to keep anti-atoms away from ordinary matter.

To do so, experiments take advantage of anti-hydrogen's magnetic properties and use very strong non-uniform magnetic fields to trap anti-atoms long enough to study them. However, the strong magnetic field gradients degrade the spectroscopic properties of the anti-atoms.

To allow for clean high-resolution spectroscopy, the physicists developed an innovative set-up to

transfer anti-hydrogen atoms to a region where they can be studied in flight, far from the strong magnetic field.

"Antihydrogen atoms having no charge, it was a big challenge to transport them from their trap. Our results are very promising for high-precision studies of antihydrogen atoms, particularly the hyperfine structure, one of the two best known spectroscopic properties of hydrogen. Its measurement in antihydrogen will allow the most sensitive test of matter/antimatter symmetry," said Dr Yasunori Yamazaki of RIKEN in Japan, the senior author of a paper published in the journal *Nature Communications*.

European Hunter-gatherers had Dark Skin, Blue Eyes

Two Mesolithic male skeletons, labelled La Brana-1 and La Brana-2, were discovered in a deep subterranean cave at the La Brana-Arintero site in León, Spain, in 2006. The individuals were dated to about 7,000 years ago.

Researchers led by Dr Carles Lalueza-Fox of Evolutionary Biology Institute in Barcelona focused first on La Brana-1 because it was in a better condition.

Surprisingly, an analysis of the hunter-gatherer's genetic material showed that he had blue eyes.

"But the biggest surprise was to discover that this individual possessed African versions in the genes that determine the light pigmentation of the current Europeans, which indicates that he had dark skin," said Dr Lalueza-Fox, who is the senior author of a paper published in the journal *Nature*.

When compared to today's Europeans, La Brana-1 was found to be most closely genetically related to modern-day people in Sweden and Finland.

The findings also show that the man had a common ancestor with the settlers of the Upper Paleolithic site of Mal'ta, located near Lake Baikal in Siberia, Russia.



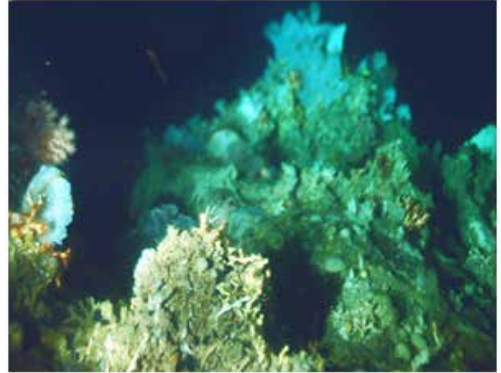
"These data indicate that there is genetic continuity in the populations of central and western Eurasia. In fact, these data are consistent with the archaeological remains, as in other excavations in Europe and Russia, including the site of Mal'ta, anthropomorphic figures – called Paleolithic Venus – have been recovered and they are very similar to each other," said Dr Lalueza-Fox.

Interestingly, a significant number of gene variants associated with pathogen resistance in modern Europeans were already present in this hunter-gatherer.

First Coral Reef of Greenland Discovered

A chance discovery of coral reef in Cape Desolation, or Cape Brill, a cape south of the city

of Ivittuut in Greenland has been made by a team of marine scientists. The reef is present at depth of about 900 m in the area with strong water currents. The exact age of reef is still unknown but looking at the age of nearby Norway coral colony it can be expected that the coral reef may start developing little time after the end of ice age.

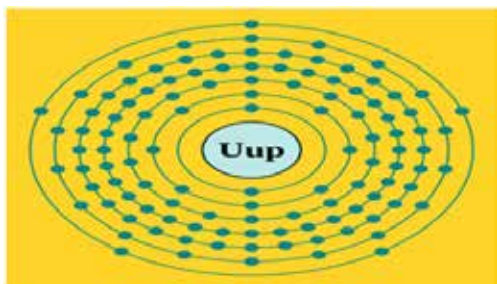


The reef is formed by a species of cold-water coral called the eye-coral (*Lophelia pertusa*). It harbours plenty of different marine creatures, including sponges, hydroids, polychaetes, crustaceans, bryozoans and echinoderms.

According to the scientists, the discovery of a reef near Greenland was not entirely unexpected. "There are coral reefs in the countries around Greenland and the effect of the Gulf Stream, which reaches the west coast, means that the sea temperature get up to about 4 degrees Celsius, which is warm enough for corals to thrive," explained team member Ms Helle Jørgensbye, a PhD student from DTU Aqua, Denmark. "In addition to the comparatively warm temperature, a coral reef also needs strong currents. Both these conditions can be found in southern Greenland."

Confirmation of Ununpentium as 115th Member of Periodic Table

First observed in 2003, the element 115 has yet to be named officially, but it is temporarily called *Ununpentium*, or Uup. It is also known as *eka-bismuth*. The name *Ununpentium* is derived from the digits 115, where 'un-' represents Latin 'unum' and 'pent-' represents the Greek word for 5.



The scientists conducted their experiments at the GSI research facility in Germany. Their findings confirm earlier measurements performed by physicists at the Joint Institute for Nuclear Research in Dubna, Russia and scientists at the Lawrence Livermore National Laboratory in the United States.

In the experiment, Professor Rudolph and his colleagues bombarded a thin film of americium-243 with calcium-48 ions which appeared as an X-ray 'fingerprint' of *Ununpentium*. In their experiments, they have also gained access to data that give them a deeper insight into the structure and properties of super-heavy atomic nuclei.

Experts at the International Union of Pure and Applied Chemistry will review the new results to decide whether new experiments are necessary before the element 115 gets an official name.

Perfluorotributylamine: A commonly used chemical found to be a prominent green house.

Perfluorotributylamine is the most radiatively-efficient chemical found to date, breaking all other chemical records for its potential to affect climate. Radiative efficiency describes how effectively a molecule can affect climate. This value is then multiplied by its atmospheric concentration to determine the total climate impact.

Perfluorotributylamine has been in use since the mid-20th century for various applications in electrical equipment and is used in thermally and chemically stable liquids marketed for use in electronic testing and as heat transfer agents.

There are no known processes that would destroy or remove perfluorotributylamine in the lower atmosphere so it has a very long lifetime, possibly 500 years, and is destroyed in the upper atmosphere. "Perfluorotributylamine is extremely long-lived in the atmosphere and it has a very high radiative efficiency; the result of this is a very high global warming potential. Calculated over a 100-year timeframe, a single molecule of perfluorotributylamine has the equivalent climate impact as 7,100 molecules of carbon dioxide," said lead author Dr Angela Hong, from the University of Toronto. Carbon dioxide is used as the baseline for comparison since it is the most important greenhouse gas responsible for human-induced climate change.

"Global warming potential is a metric used to compare the cumulative effects of different greenhouse gases on climate over a specified time period," said Dr Cora Young, also from the University of Toronto.

Time is incorporated in the global warming potential metric as different compounds stay

in the atmosphere for different lengths of time, which determines how long-lasting the climate impacts are.

Glasgow Research Team Proves the Existence of only Four Basic Emotions instead of Six

A commonly-held belief, first proposed by Dr Paul Ekman, supports that there are six basic emotions — happiness, sadness, fear, anger, surprise and disgust — which are universally recognised and easily interpreted through specific facial expressions.

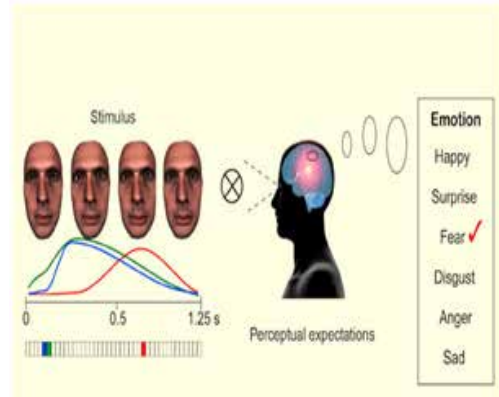
But the Glasgow team challenges this view. The researchers claim that while the facial expression signals of happiness and sadness are clearly distinct across time, fear and surprise share a common signal — the wide open eyes — early in the signalling dynamics. Similarly, anger and disgust share the wrinkled nose. It is these early signals that could represent more basic danger signals. Later in the signalling dynamics, facial expressions transmit signals that distinguish all six 'classic' facial expressions of emotion.

"Our results are consistent with evolutionary predictions, where signals are designed by both biological and social evolutionary pressures to optimise their function," said Dr Rachael Jack, who is the first author of a paper published in the journal *Current Biology*.

"First, early danger signals confer the best advantages to others by enabling the fastest escape. Secondly, physiological advantages for the expresser — the wrinkled nose prevent inspiration of potentially harmful particles, whereas widened eyes increase intake of visual information useful for escape — are enhanced when the face movements are made early."

"What our research shows is that not all facial muscles appear simultaneously during facial expressions, but rather develop over time supporting a hierarchical biologically-basic to socially-specific information over time."

Dr Jack with colleagues used special techniques and software called Generative Face Grammar platform to synthesise all facial expressions.



The platform uses cameras to capture a three-dimensional image of faces of individuals specially trained to be able to activate all 42 individual facial muscles independently. From this, a computer can then generate specific or random facial expressions on a 3D model based on the activation of different Actions Units or groups of units to mimic all facial expressions.

By asking volunteers to observe the realistic model as it pulled various expressions — thereby providing a true four-dimensional experience — and state which emotion was being expressed the researchers are able to see which specific Action Units observers associate with particular emotions. It was through this method they found that the signals for fear/surprise and anger/disgust were confused at the early stage of transmission and only became clearer later when other Action Units were activated.

“Our research questions the notion that human emotion communication comprises six basic psychologically irreducible categories. Instead we suggest there are four basic expressions of emotion. We show that ‘basic’ facial expression signals are perceptually segmented across time and follow an evolving hierarchy of signals over time – from the biologically-rooted basic signals to more complex socially-specific signals,” Dr Jack said.

“Over time and as humans migrated across the globe, socio-ecological diversity probably further specialised once-common facial expressions, altering the number, variety and form of signals across cultures.” The team is planning to develop their study by looking at facial expressions of different cultures, including East Asian populations whom they have already ascertained interpret some of the six classical emotions differently — placing more emphasis on eye signals than mouth movements compared to Westerners.

Astronomer Found a New Fast and Furious Black Hole in nearby Galaxy M83

M83 is an iconic galaxy present to our southern sky. It is regularly being mapped with the Hubble Space and Magellan telescopes (detect visible light), the Chandra X-ray Observatory (detects light in X-ray frequencies), the Australia Telescope Compact Array and the Very Large Array (detects radio waves). Currently, a team of Australian and American astronomers was studying this galaxy M83 and has found a new super-powered small black hole named MQ1, the first object of its kind to be studied in this much detail.

The team observed the MQ1 system with multiple telescopes and discovered that it is a standard-sized small black hole, rather than a slightly bigger version that was theorised to account for all its power. Roberto Soria from Curtin University in Australia, who led the team investigating MQ1, said it was important to understand how stars were formed, how they evolved, and how they died within a spiral shaped galaxy like M83.

“MQ1 is classed as a microquasar — a black hole surrounded by a bubble of hot gas, which is heated by two jets just outside the black hole, powerfully shooting out energy in opposite directions, acting like cosmic sandblasters pushing out on the surrounding gas,” Soria said. “The significance of the huge jet power measured for MQ1 goes beyond this particular galaxy. It helps astronomers understand and quantify the strong effect that black hole jets have on the surrounding gas, which gets heated and swept away. “This must have been a significant factor in the early stages of galaxy evolution, 12 billion years ago, because we have evidence that powerful black holes like MQ1, which are rare today, were much more common at the time.”

“By studying microquasars such as MQ1, we get a glimpse of how the early universe evolved, how fast quasars grew, and how much energy black holes provided to their environment.” As a comparison, the most powerful microquasar in our galaxy, known as SS 433, is about 10 times less powerful than MQ1. Although the black hole in MQ1 is only about 62 miles (100 kilometres) wide, the MQ1 structure, as identified by the Hubble Space Telescope, is much bigger than our solar system — the jets around it extend about 20 light-years from either side of the black hole.

Black holes vary in size and are classed as either stellar mass — less than about 70 times the mass of our sun — or super massive —millions of times the mass of our sun, like the giant black hole that is located in the middle of the Milky Way.

MQ1 is a stellar-mass black hole and was likely formed when a star died, collapsing to leave behind a compact mass. The discovery of MQ1 and its characteristics is just one of the results of the comprehensive study of galaxy M83; a collection of millions of stars located 15 million light-years away from earth.

The reason behind use of bigger accelerator in particle physics.

While the world's largest circular particle accelerator — the Large Hadron Collider (LHC) — will continue operation for the next few years, scientists have already started the conversation to build a much bigger, post-LHC circular accelerator. A five-year feasibility study of the Future Circular Collider (FCC) was launched in a meeting of scientists earlier this month near Geneva, under the leadership of the European particle physics laboratory CERN, which hosts the LHC. The proposed accelerator would be housed underground in an 80–100 km tunnel — roughly four times longer than the existing LHC's 27 km tunnel. But what's the point of building a bigger version of what we already have? And with confirmation of the discovery of the Higgs boson last year, what's left to explore?

Designing the FCC: The modern powerful and high-energy experimental facilities are highly complex and technologically challenging to build and therefore comprehensive studies are required before selecting a final design. Proposals for the current LHC began in the

early 1980s but the machine wasn't actually completed and switched on until 2009. So while the LHC will continue to run experiments until around 2030 (or slightly beyond), now is the perfect time to start talking about its successor.

The FCC design study will have input from scientists across the globe from national laboratories, institutes and universities. There are a few contenders to host the gigantic machine. The obvious front-runner is the CERN who is banking on the success of the LHC and their existing research and development accelerator infrastructures — but there is strong interest from Japan and China too. If the machine is built in Geneva then the brand new tunnel will straddle the Switzerland–France border, go under Lake Geneva and kiss the Alps in the east and the Jura mountains in the west.

Deciding what to throw in the collider pot:

The FCC would be required to operate nearly an order of magnitude higher energy than the LHC but this could be achieved with the assembly of different types of superconducting steering magnets to accelerate particles through the tunnel. The total length of a collider's arc is measured by the number of the magnets and their strength. In a realistic scenario, if the FCC's magnetic system were to provide a magnetic field of 16 Tesla (maximum 20 Tesla) — around twice the value of the LHC magnetic field — then we'd require the accelerator complex to have a circumference of 100 km. This assembly would accelerate the particles very close to the speed of light.

When the LHC switches on again next year we might get a peek at the secrets behind super-symmetry, dark matter or other exotic phenomena (all collectively known as the New Physics). Those results would build a strong physics case for the FCC. There is

tons of theoretical physics work that can only be confirmed or ruled out experimentally at higher energies (in other words, with faster acceleration and higher speeds).

There is open debate on the types of particles to smash together in the FCC:

1. Proton-proton (hadron collider) — needing roughly an order of magnitude higher energy than the LHC.
2. Electron-positron (lepton collider) as a potential intermediate step towards realisation of the hadron facility. For this option, combining with the International Linear Collider — a proposed electron-positron 31 km long linear collider — would also be considered.
3. Electron-proton.

The LHC currently hosts seven experiments but it is probably too early to say how many experiments the FCC would host. In addition, there is no official funding number for this project yet. We might have to wait a little while for those figures, but the five-year study will provide cost and energy optimisation. Colliders help us to understand the nature deeper and at a very minute level — and, with talks beginning now, they have the added benefit of galvanising industries to develop and provide cutting edge technologies. If the post-LHC circular collider becomes a reality then it will easily snatch the title of The Lord of the Particle Ring from the LHC.

Study Sheds More Light on Origin of Birds

“We were really surprised to discover that the key size shifts happened at the same time, at the origin of *Paraves*,” said Mr Mark Puttick from

the University of Bristol, UK, the lead author of a paper published in the journal *Evolution*. “This was at least 20 million years before the first bird, the famous *Archaeopteryx*, and it shows that flight in birds arose through several evolutionary steps.”

Being small and light is important for a flyer, and it now seems a whole group of dozens of little dinosaurs were lightweight and had wings of one sort or another. Most were gliders, spreading their feathered wings, but not flapping them. “Out of all these flappers and gliders, only the birds seem to have been capable of powered flight,” said study senior author Professor Mike Benton, also from the University of Bristol. “But you wouldn’t have picked out *Archaeopteryx* as the founder of a remarkable new group.”

Mr Puttick and his colleagues applied new numerical methods that calculate the rate of evolution of different characteristics across a whole evolutionary tree, and identify where bursts of fast evolution occurred. “Up to now you could only have guessed roughly where the major evolutionary transitions occurred, but the new methods pinpoint the size changes. The small size of birds and their long wings originated long before birds themselves did,” said co-author Dr Gavin Thomas from the University of Sheffield.

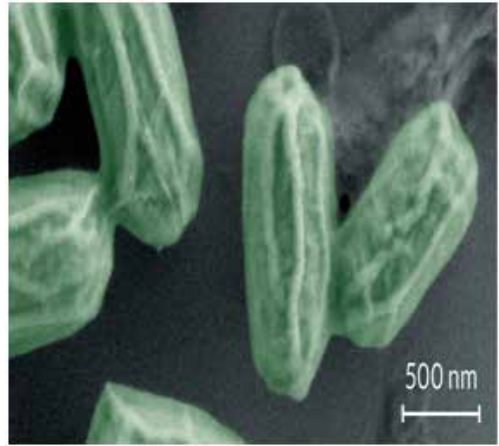
Birds owe their success to their flight, wings and feathers. Until the 1990s, when the first feathered dinosaurs were found in China, birds were thought to have originated rapidly, marking a major transition from dinosaurs. Now, palaeontologists known that *Archaeopteryx* was only one of a large number of small, flying dinosaurs. “The origin of birds used to be seen as a rapid transition, but now we know that the key characteristics we associate with them arose much earlier,” Mr Puttick said.



Rehydration Burst of Bacillus Spores Offer a New Source of Renewable Energy

Bacillus spores quickly shrivel in dry times and swell with a blast of humidity. The transitions, which take about half-a-second, pack a powerful punch that biophysicist Ozgur Sahin at Columbia University realised, could translate to usable energy. By smearing spores onto a flat piece of rubber about the length of a human hand, Sahin and his colleagues developed a spore-powered generator. In arid conditions, parched spores pull the rubber into a curve, while wafts of wet air plump up spores and spring it flat again.

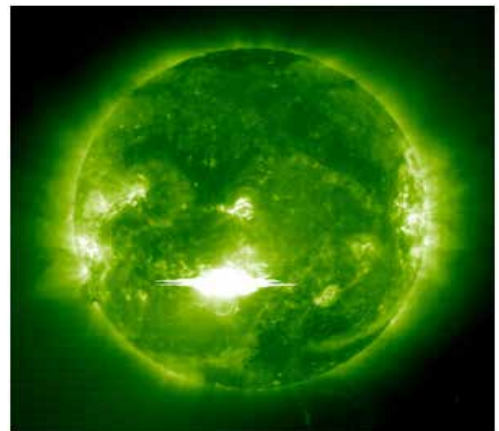
The team linked the rubber to an electromagnetic generator, so that every flex produced an electric current. By weight, spore power rivalled the juice in a car battery, Sahin and colleagues report January 26 in *Nature Nanotechnology*. Since the spores tote such a high energy potential—more than 1,000 times that of mammalian muscle—Sahin and colleagues say energy-harvesting devices based



on the dormant dynamos could be linked into municipal grids to contribute a power boost to homes and cities.

Antimatter Particles Found in Solar Flares

Associated with solar magnetic storms, solar flares are giant explosions on the sun that send energy, light and particles into space. Their number increases approximately every 11 years. Positrons are antimatter counterparts of the electron. Positrons and electrons have the same physical behaviour, except that electrons have a



negative charge while positrons, as their name implies, have a positive charge. This charge difference causes positrons to emit the opposite sense of circularly polarised radio emission, which Prof Gregory Fleishman from the New Jersey Institute of Technology and his colleagues from the Russia's Institute of Solar-Terrestrial Physics used to distinguish them.

Using data from NASA's Solar and Heliospheric Observatory and radio images at two frequencies from Nobeyama Radioheliograph Japan, the American-Russian team found that the radio emission from the solar flare was polarised in the normal sense at the lower frequency where the effect of positrons is expected to be small, but reversed to the opposite sense at the same location, although at the higher frequency where positrons can dominate.

The findings were presented at the 44th meeting of the American Astronomical Society's Solar Physics Division in Bozeman, Montana.

The study has far-reaching implications for gaining valuable knowledge through remote detection of relativistic antiparticles at the sun and, potentially, other astrophysical objects by means of radio-telescope observations.

The ability to detect these antiparticles in an astrophysical source promises to enhance our understanding of the basic structure of matter and high-energy processes such as solar flares, which regularly have a widespread and disruptive terrestrial impact, but also offer a natural laboratory to address the most fundamental mysteries of the Universe.

Kepler Space Telescope Data uncovers 715 New Planets

The galaxy just got more crowded. Astronomers using data from the Kepler space telescope

have confirmed the existence of 715 new planets orbiting 305 stars, increasing the total number of known planets to about 1,700. This is the largest number of planet confirmations ever announced at once.

"We've struck the mother lode," said Jack Lissauer, a planetary scientist at NASA's Ames Research Center in Moffett Field, Calif., during a February 26, 2014 press conference. "It's an exoplanet bonanza." The new planets are mostly small — 95 per cent are no bigger than Neptune — and circle their stars along with sister-planets in compact, circular orbits all in the same plane. The new findings increase the number of confirmed earth-sized planets by 400 per cent.

The cache of confirmations more than doubles the number of planets established by the now-crippled Kepler since its 2009 launch. Kepler searched for planets by looking for tiny dips in starlight that occur when a planet periodically passes in front of, or transits, its star. However, transiting planets aren't the only reason stars appear to flicker. Most commonly, the light dips can be caused by a chance alignment with an "eclipsing binary" — a pair of stars that orbit each other and one occasionally blocks the light from the other.

For the new findings, mission scientists argued that several detections around a single star are not likely to be false positives. "It's very, very exciting to see this result," says Rory Barnes, an astronomer at the University of Washington in Seattle. The reasoning behind the team's argument is sound and based on solid mathematics, which they've been perfecting for several years, he adds.

The next step for the Kepler team is to pore over the rest of their data. The 715 new planets emerged from only the first two years of observations. But Kepler kept observing

for an additional two years before a reaction wheel, which is needed to accurately point the telescope, died in May 2013. With another two years of data to sift through, mission scientists are confident that this technique will turn up hundreds more exoplanets.

Meanwhile, astronomers now have an additional 300 solar systems to mull over. The compactness of these systems along with the prevalence of small planets is surprising. Theorists will stay busy figuring out why planets stop growing after reaching the size of earth or neptune and how all these worlds end up huddling close to their suns. But Kepler is more sensitive to planets with compact orbits, so it's too early to say whether this type of arrangement is the norm. Previously discovered exoplanets tended to be larger than the new finds, making clear that the galaxy is littered with an enormous diversity of planetary systems.

New Effective Painkiller from Venom of Tarantula

The novel method, named toxineering, has the potential to search millions of different spider toxins for safe pain-killing drugs and therapies. Dr Michael Nitabach from Yale

School of Medicine and his colleagues screened toxins from a variety of tarantula species to find one that blocked TRPA1, an ion channel on the surface of pain-sensing neurons that is implicated in inflammation and neuropathic pain.



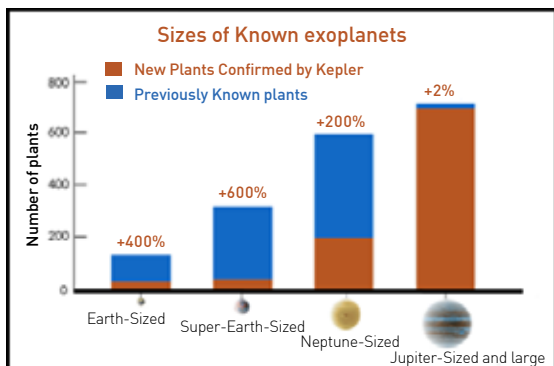
By generating a small library of mutated versions of the tarantula toxin, they identified Protoxin-I — a 35-residue peptide from the venom of the Peruvian green-velvet tarantula — that blocks TRPA1 but has no effect on activity of other channels on the surface of neurons.

“The beauty of the system is we can also screen engineered toxins not found in nature, and identify higher-potency and more specific molecular variants that lack deleterious effects on essential nerve functions,” said Dr Nitabach, who is the lead author of a paper published in the journal *Current Biology*. “The likelihood is that within the vast diversity of spider toxins we will find others that are active against other channels important for pain,” he said. The team plans to ramp up efforts to test tens of thousands of new toxins for similar biological activity against pain-sensing neurons.

Source : Science Daily

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WEB WATCH

In this section, we present websites and a brief introduction about them. Inclusion of a site does not imply that School Science endorses the content of the site. Sites have been suggested on the basis of their possible utility to school systems.



- <http://www.brainpop.com>

This website contains cartoon videos with characters Tom and Moby, giving answers to a number of problems from numerous subjects namely science, mathematics, social studies, health, arts and music. Having bagged a number of awards, this website is useful for students of secondary classes.

- <http://www.discoveryeducation.com/students/>

Discovery Education offers free student resources that bring learning to life both inside and outside the classroom. The website consists of a number of interactive games, videos, contests, virtual labs, homework help and activities designed to help you delve deeper into a topic —and have fun too!

- <http://www.nasa.gov/audience/forkids/kidsclub/flash/index.html#.UxbJPeOSyjm>

This website is maintained by NASA and designed for kids of all ages. The website has a number of puzzle games and also has space-related games for actual understanding of space facts. The space games are designed for students of K to 12 Grades.

- <http://www.sciencekids.co.nz/>

The website has been designed to provide educational resources that help make science fun and engaging for kids, taking important concepts and putting them into a form that kids can not only understand but also enjoy. Fun activities, facts, projects and experiments can be the first step in fostering a desire amongst kids

to learn more about science and technology, subjects that have practical applications in both career and everyday life.

- <http://www.chem4kids.com/index.html>

This website is designed to make clear to the students the basic concepts of chemistry. This website also contains hyperlink to other subjects, like astronomy, biology, earth science and physics containing factual knowledge of the subjects.

- <http://www.cut-the-knot.org/>

This website is dedicated to mathematics queries, interactive mathematics, miscellany and puzzles. It contains interesting puzzles, problems, theorems, proofs, etc. This website also hosts links to other good websites.

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