Capacity Building Programme
On
Science
(Elementary Classes)

One Day Training Manual Central Board of Secondary Education 2020

Training Unit, CBSE Delhi

Content

About this Manual

CBSE has been continuously working to provide teachers opportunities to improve their teaching learning skills to keep pace with the continuously evolving academic and social

environment in the world. Capacity Building Program (CBP) for teachers of Upper Primary is another step forward in this direction.

This manual has been developed for the Resource Person (RP) of the CBSE for one day CBP for upper primary teachers and contains the program schedule, program objectives, explanatory material, procedures/methodologies and handouts. These facilitate the RPs to conduct CBP for teachers of Science who are teaching upper primary classes.

The main objectives of the manual are to:

- Facilitate the RP to conduct capacity building program for upper primary teachers.
- Equip teachers to understand the nuances and challenges of teaching of sciences in present scenario.
- Encouraging teachers to update their knowledge through self-learning/ teamwork
- develop ability to critically analyze various types of learning outcomes based on Revised Bloom's taxonomy.
- Develop competencies to design and use different modes of experiential learning

This manual should be read thoroughly by the RP before he/she conducts the program for teachers.

SCHEDULE

SESSIONS	TIMINGS	DURATION
Registration	8:30 am –9:00 am	30 minutes
Introductions	9:00 am - 9:15 am	15 minutes

SESSION 1: TEACHING LEARNING OF SCIENCE	9:15 am - 1:30 pm	4 hours
Activity 1: Setting the context of teaching of science	9:15 am - 10:15 am	1 hour
Tea Break (10:15 am – 10:30 am)	15 minutes	
Activity 2A: Bloom's taxonomy & educational objectives	10:30 am – 11:30 am	1 hour
Activity 2B: 21st century competencies & learning outcomes	11:30 am - 12:00 noon	30 minutes
Activity 3: Experiential learning	12:00 am – 1: 30 pm	1 hour 30 minutes
Lunch Break (1:30 pm – 2:00 pm)	30 minutes	
SESSION 2: LESSON PLANNING & ASSESSMENT	2:00 pm – 3:30 pm	1 hour 30 minutes
Activity 4: Lesson Planning	2:00 pm - 2:45 pm	45 minutes
Activity 5: Assessment	2:45 pm - 3:30 pm	45 minutes
SESSION 3: FINALISATION & PRESENTATION OF LESSON PLANS	3:30 pm – 4:00 pm	30 minutes
Certificate distribution & Closure	4:00 pm - 4:15 pm	15 minutes

NOTE FOR THE RESOURCE PERSON

Principles of working in team:

- Divide work equally
- Work on each other's strengths (e.g., one may be better at board writing, while the other may be better at talking to the group).
- Set aside a short time for review and planning each day
- Agree not to disagree in public.
- Complement and respect each other by listening carefully and by not interrupting and competing.

 Give each other constructive feedback after sessions (this is a development opportunity for you)
 Give feedback to each other on matters such as timing, voice, eye-contact, blackboard work etc.
 When teachers are working in pairs or small groups, decide amongst yourself as to who is to monitor which half of the group.
 Develop the habit of working briskly and keeping to the time allocated for each activity. Remember that you can run parallel sessions for some activities. (2x30 may be appropriate and easier to handle than 1x60).

Some general guidelines to ensure successful interaction/ participation

 Arrive early for the first session and make sure you are there to give the participants a warm welcome.
 Arrange the seating to your liking
 Start the workshop on time in the morning and stick to the agreed breaks. Know your plan for each session.
 Agree on a signal (a raised hand) to stop discussions without stress and strain. Prepare posters and or bulletin board with important messages to save time (e.g. aims of a particular session).
 Make sure that you have prepared and checked the handouts, videos and audios beforehand.
 Encourage active participation.
 Listen actively and with an open mind to participants' views and insist that course participants (CPs)listen to each other during discussions.
 Acknowledge and affirm participants' contributions.

 Understand and address their doubts.
 Ensure that each individual has an equal chance to contribute.
 Repeat instructions before starting a session or an activity.
 Maintain eye contact with participants during plenary sessions.
 Avoid long discussions.
 Admit that you may not know everything.
 Do not try to force your views.
 Avoid being sarcastic
 Treat teacher participants as contemporaries and not as students.
 Avoid criticism about the education system, policy and infrastructure as this is a public forum.
 Always have a grip over the discussion.
 Criticism must not be taken personally.

 Be flexible in your responses and do not be driven only by the material. After setting up the group work, do not interrupt except to announce the time.

Advice on dealing with difficult questions and participants

 With your fellow RP, note down the observations, objections or questions, which you think might be raised, and discuss strategies for dealing with them in advance. Remember that this is only a first step in a long process of change for the participants. You should expect awkward questions and resistance. You can help as a RP by allowing participants clear their doubts, by being patient and supportive, and by making provision for maximum opportunities to experience the alternative methodology and to consider their implications.
 Avoid getting involved in disputes with individual participants.
 Encourage participants to give each other patient hearing and discourage participants to shout each other down.
 If there is a disruptive participant, make sure you give a role which keeps him/her involved, especially in group work (where he/she could function as a secretary): then give positive feedback whenever you have an opportunity.
 Remember you are running the workshop; you should resist quietly but firmly, any attempt to usurp your role.
 Have a quiet word with any awkward participant who doesn't calm down within a day. Find out what is bothering him/her and discuss it.

Session 1

Teaching & Learning

of Science

Activity 1

Setting the context of teaching of Science

Time required: 60 minutes

Learning outcomes:

To enable participants to:

- reflect upon the nature of Science
- review the objectives of teaching Science at upper primary level
- examine the principles of learning Science
- evaluate the challenges in the teaching of Science
- summarize the conceptual framework of Science in the light of NCF 2005 and Position Papers NCERT

Mode: Individual and Group Activity

Material required:

- Handout HO1A – Science in the light of National Curriculum Framework 2005 (NCF) and Position Papers NCERT
- Handout HO1B – Highlights of NCF for upper primary science
- Handout HO1C – Key questions in the teaching of Science
- Handout HO1D – How do students learn Science?

Process:

1. Initiate the activity by distributing HO1A (individual). Highlight the following: *a. Objectives of teaching Science as specified in the NCF 2005*
   b. Epistemological shift in the teaching of Science as mentioned in NCF2005
2. Distribute HO1B and ask the course participants (CP) to complete the worksheet individually.
3. Discuss the correct responses.
4. Next, distribute HO1C and ask CPs the following key questions:
   a. What is Science?
   b. Why do we teach Science?
   c. How do students learn Science? What are the successful ways that students learn Science?
   d. What are the major challenges that you face while teaching Science? 5. Ask CP to reflect upon these questions for a few minutes and summarize their views in HO1C. Give them 7 to 10 minutes for this.
6. Next, ask the CPs to work in their groups. They should discuss their individual responses and come to some consensus.
7. Ask each group to respond to the questions. Keep writing the key points on the Board/ Flipchart.

8. Summarize the responses and the missing points.
9. Next, distributed HO1D and ask CPs to complete the worksheet.
10. Discuss the responses.
11. Conclude the activity by highlighting the main points of the activity.

Note to the RP *Emphasize on the following points:*

- *content, processes and attitudes are important in teaching Science*
- *objectives of Science for all (core curriculum till Class viii)*
- *textbook is a teaching tool to be used to transact the curriculum*

Handout HO1A

Science in the light of NCF 2005 and Position Papers NCERT (Individual Activity)

Science is a dynamic, expanding body of knowledge, covering ever-new domains of experience. In a progressive forward-looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition *(NCF 2005, pg. 46)*.

Good science education is true to the child, true to life and true to science. This simple and natural observation leads to six basic criteria of validity of a science curriculum are as follows:

a. Cognitive validity requires that the content, process, language and

pedagogical practices of the curriculum are age appropriate, and within the cognitive reach of the child.

b. Content validity requires that the curriculum must convey significant and correct scientific content. Simplification of content, which is necessary to adapt the curriculum to the cognitive level of the learner, must not be so trivialized as to convey something basically flawed and/or meaningless.

c. Process validity requires that the curriculum engage the learner in acquiring the methods and processes that lead to generation and validation of scientific knowledge and nurture the natural curiosity and creativity of the child in science. Process validity is an important criterion since it helps the student in 'learning to learn' science.

d. Historical validity requires that science curriculum be informed by a historical perspective, enabling the learner to appreciate how the concepts of science evolve with time. It also helps the learner to view science as a social enterprise and to understand how social factors influence the development of science.

e. Environmental validity requires that science be placed in the wider context of the learner's environment, local and global, enabling him/her to appreciate the issues at the interface of science, technology and society and preparing him / her with the requisite knowledge and skills to enter the world of work.

f. Ethical validity requires that the curriculum promote the values of honesty, objectivity co-operation, freedom from fear and prejudice, and develop in the learner a concern for life and preservation of environment *(NCF 2005, pg.48)*.

The general aims of science education follow directly from these criteria of validity.

AIMS OF SCIENCE EDUCATION

Science education should enable the learner to:

- know the facts and principles of science and its applications, consistent with the stage of cognitive development,
- acquire the skills and understand the methods and processes that lead to generation and validation of scientific knowledge,
- develop a historical and developmental perspective of science and to enable her to view science as a social enterprise,
- relate to the environment (natural environment, artifacts and people), local as well as global, and appreciate the issues at the interface of science, technology and society,
- acquire the requisite theoretical knowledge and practical technological skills to enter the world of work,
- nurture the natural curiosity, aesthetic sense and creativity in science and technology, imbibe the values of honesty, integrity, cooperation, concern for life and preservation of Environment, and
- cultivate 'scientific temper'-objectivity, critical thinking and freedom from fear and prejudice (*NCF 2005 Position Paper, page11*)

OBJECTIVES OF TEACHING SCIENCES AT UPPER PRIMARY LEVEL

At the upper primary stage, children get their first exposure to 'science' as a discipline.

- Science at this stage provides a gradual transition from environmental studies of the primary stage to the elements of science and technology at upper primary stage.
- Concepts of science to be taught at this stage should be chosen so as to make sense of everyday experiences.
- Activities and experiments should form the essential component part of the teaching learning process.
- Science concepts at the upper primary stage should not be governed by disciplinary approach. Science at this stage should be taught as an integrated subject and it is not to be regarded as a diluted version of secondary stage.
- The child should be engaged in learning the principles of science through familiar experiences, working with hands to design simple technological units and models. Focus should also be given to learn more about the environment and health, including reproductive and sexual health.
- Scientific concepts are to be derived mainly from observations, activities, experiments and surveys.
- Group activities, discussions with peers, teachers and community members, surveys, collection and organization of data and their display through exhibitions, etc., in schools and the neighborhood should be important components of pedagogy.
- Technological components such as design and fabrication of simple models, practical knowledge about common mechanical and electrical devices and local specific technologies are to be included in science curriculum.
- Apart from simple experiments and hands on experiences, an important pedagogic practice at this stage is to engage the students (in groups) in meaningful investigations particularly of the problems they perceive to be significant and important. This may be done through discussions in the class with the teacher, peer interactions, gathering information from newspapers, talking to knowledgeable persons in the neighborhood, collecting data from easily available sources (books, journals, magazines, television, internet, etc.) and carrying out simple investigations of which the students have a major role to play.

- There should be continuous as well as periodic assessment (unit tests, term-end tests). The system of 'direct' grades should be adopted. There should be no detention. Every child who attends eight years of school should be eligible to enter Class IX.

SOME OTHER RECOMMENDATIONS

Some other recommendations from NCF 2005 and National focus Group Position Papers – Teaching of Science Position Paper are given below:

- Shift from mere imparting of information to involvement in debate and discussion would keep both learners and teachers alive to social realities.
- Use science curriculum as an instrument of social change to reduce the socio-economic divide and to help fight prejudice related to gender, caste,

religion and region.

- Emphasis exploration, inventiveness and creativity through activities, experiments, technological modules, contextualized as far as possible.
- Encourage implementation of co-curricular and extra curricula components through a massive expansion of existing non-formal channels such as project exhibitions, children's science congress, etc.
- The textbooks are to be considered as tools to help develop perspectives on various contemporary issues. It is expected of learners to understand and apply concepts rather than simply memorize the information of each topic. In addition, use ICT as a powerful tool for bridging the social divide in education and as an opportunity equalizer.
- Content of the curriculum should promote respect for diverse lifestyles, even if there is a focus on contextualization.
- Create systems of peer group interaction among teachers. Promote various modes of academic exchanges between teachers within school and between schools.
- Emphasize gender sensitization of teachers both at the pre-service stage and during in- service training to promote gender fair science education. Science is a dynamic, expanding body of knowledge covering ever new domains of experience. The teaching of the Sciences must adopt methods that promote creativity, aesthetics, and critical perspectives among the learners.

Source:

- NCF2005
- National focus Group Position Papers – Teaching of Science 2005 by NCERT

Handout HO1B

Highlights of NCF for upper primary science

Instructions: Participants to read and mark True/False

Q1. In the context of NCF- 2005 'true to child' means that the science we teach should be understandable to the child, and be able to engage the child in meaningful and joyful learning……

Q2. Good science education being 'true to life' means science education should be related to the environment of the students and prepare them for the world. It should promote concerns about preservation of the environment among the students…….

Q3. "Good science education is true to science". It means science education should convey its content at a suitable level and engage the child in learning the procedures of obtaining and validating scientific knowledge……

Q4. These validates set the limit for the teachers and forbid them from planning a variety of experiences which seek participation of students in learning process……

Q5. Principle of various optical instruments using relevant formulae and wave theory of light should be taught in class VII……

Q6. The statement 'matter is destroyed during burning' is contrary to content validity……..

Q7. Verbal description of the arrangement of flowers (inflorescence) in a plant fulfil the requirement of process validity**…….**

Q8. Teaching Heliocentric Theory of Solar System with reference to the earlier Geocentric model meet the requirement of historical validity**……**

Q9. Teaching concepts of sound without any sensitization to noise pollution does not satisfy environmental validity…….

Q10. Being insensitive to water and electricity wastages in schools and homes, indulging in cutting of trees and cruelty to animals satisfies ethical validity……

There are more possibilities than hurdles and more elasticity than rigidity in the inculcation of validity features in the science curriculum. True /True ☺

For RP

ANSWER KEY

1. TRUE
2. TRUE
3. TRUE

4. FALSE
5. FALSE
6. FALSE
7. TRUE
8. TRUE
9. TRUE
10.FALSE

Handout HO1C

Key questions in the teaching of science

Instructions: Please reflect and complete the following questionnaire:

1) What is science?

2) Why do we teach science?

3) How do students learn science? What are the successful ways that students learn science?

4) What are the major challenges that you face while teaching science?

Handout HO1D

How do students learn science?

1) Do students really enjoy science? Why do you think so?

2) Write down any two situations from the real life that you can use to trigger scientific temperament and briefly outline the different steps of scientific method you used in at least one situation.

3) If you are to be a guide of class 6 student, who has high scientific temperament, mention two steps you can take to promote the same.

4) Water can be taught in all classes from class 1 to class 12. How will you make it a special topic of science, linking it to the next class 7?

5) 'Students can do much better, if their connection with the virtual world is limited'. What are your views on it? Give two points in support of your view.

6) As a science teacher, in what way can you offer options to students for better learning of science?

Activity 2 A

Understanding Bloom's Taxonomy of Learning Outcomes

Time required: 60 minutes

Learning outcome:

• To enable participants to frame Learning outcomes based on revised Bloom's Taxonomy.

Mode: Individual Activity

Material required:

• Handout HO_{2A} – Understanding Bloom's Taxonomy of learning outcomes • Handout HO_{2B} – Identifying Bloom Domain/Cognitive level of Learning outcomes • Handout HO_{2C} – Framing of learning outcomes

Process:

1. Initiate the activity by asking the following questions:

What are Learning outcomes?
What is the difference between a learning objective and learning outcomes?
Why should learning outcomes be framed?
What are the key components of a learning outcome?

2. Add the missing points, if any.

3. Introduce Bloom's Taxonomy of learning outcomes. Distribute handout HO_{2A} to reinforce their understanding on Bloom's Taxonomy.

4. Distribute handout HO_{2B} to each participant and ask them to complete it in 10 mins.

5. Invite 2-3 volunteer participants to share their responses with the larger group. Encourage them to add the rationale for classifying the learning outcomes as belonging to a particular level.

6. Next, give handout HO_{2C} to the participants and ask them to frame learning outcomes. Invite one participant from each group to share one learning outcome. Ask other participants to opine whether the stated learning outcomes are SMART.

Note to the RP

Emphasize that

• All written work should start from the framing of the learning outcomes • The learning outcomes framed should pertain to all three domains of Bloom's taxonomy • The learning outcomes in cognitive domain should pertain to all levels of the Bloom's cognitive domain.

Handout HO_{2A}

Understanding Bloom's Taxonomy of Educational Objectives & Outcomes

An objective is-

- An *intent* communicated by a statement describing a proposed change in a learner
- A statement of what the learning outcome will be

A Learning outcome *describes an intended outcome*. The outcome states a change in behavior or performance that is seen in the learner when he/she is demonstrating his/her achievement of the objective. Learning outcomes should be measurable.

Learning outcomes describe what students can demonstrate in terms of knowledge, skills, and values upon completion of a course. Clear articulation of learning outcomes serves as the foundation to evaluating the effectiveness of the teaching and learning process.

STRUCTURE OF A LEARNING OUTCOME:

The statement of a learning outcome can

- Begins with "Students will be able to...,"
- Followed by an appropriate verb relating to the desired action or performance
- Ending with the object of the statement describing the content to be learnt.

COMPONENTS OF A LEARNING OUTCOME:

Learning objectives can include 3 components: performance, conditions, and criteria.

Performance: All SMART learning objectives contain a performance component. The performance statement describes what the learner will know or be able to do in specific, measurable terms. The statement should contain an action verb.

Conditions: A learning objective may include conditions. Conditions describe the circumstances under which the participant will perform. Conditions can include tools, situations, settings, or restrictions that will direct the activity.

Criteria: Criteria describe the required level of quality of performance. Criteria can be described in terms of accuracy (minimum/maximum), productivity level, time, and degree of excellence.

CHARACTERISTICS OF A GOOD LEARNING OUTCOME:

A learning outcome should be **S.M.A.R.T.**, that is:

S – Specific – says exactly what the learner will be able to do i.e. focus on student behavior
M – Measurable – can be observed by the end of the training session
A – Attainable for the participants within scheduled time and specified conditions
R – Relevant to the needs of the participant and the organization
T – Time-framed - achievable by the end of the training session

Please note: Conditions and criteria are not necessary for an objective to be SMART but can assist in the measurement and level of specificity of the objective.

CREATING STATEMENTS OF LEARNING OUTCOMES:

Let us understand, through examples, how to create learning outcomes which incorporate all the ideas discussed above.

Example statement of learning outcome:
Student will be able to explain why a matchstick does not catch fire on its own at room temperature.

Structure check:
Here,
Action verb => explain
Object => why a matchstick does not catch fire on its own at room temperature

Component check:
Let us check further if the statement incorporates all the required components.

Performance: 'Explain' describes the performance, i.e. what the student will be able to do.

Conditions: The statement does not clarify under what conditions the student will be able to explain.
A better statement may be
After a demonstration on ignition temperature, the student will be able to explain why a matchstick does not catch fire on its own at room temperature.
Or
After the lesson, the student will be able to explain why a matchstick does not catch fire on its own at room temperature.

Criteria: The statement does not give the level to which the explanation is expected.
An improved learning outcome may be
After the lesson, the student will be able to explain why a matchstick does not catch fire on its own at room temperature, giving two key points.
A teacher may choose to skip this criterion of 'two key points' while writing the learning outcome in the lesson plan but if she is writing a test item, she must include 'giving two key points' to specify the level of expected performance.

Characteristics check:
Statement: ***After the lesson, the student will be able to explain why a matchstick does not catch fire on its own at room temperature.***

Let us check if this is a S.M.A.R.T. learning outcome statement.

Specific: Does it focus on student behavior? Does it say exactly what the learner will be able to do?

Yes. 'Explain' says exactly what learner will be able to do.

Consider another statement: *teacher will demonstrate an activity on ignition temperature to the*

students.
Does it focus on student behavior?
No. This is not an example of learning outcome. It focuses on teacher's behavior.

Measurable: Does it describe a student behavior that can be observed and measured?
Yes. Explanation can be observed and measured.

Consider another statement: ***In the lesson, student will learn about ignition temperature.*** Even though 'learn' is focused on student behavior but is not observable and measurable. Learning is not observable, its evidence in form of 'Definition' can be observed and measured! Hence, a better statement will be: After the lesson, student will be able to define ignition temperature.

Attainable: Can the student do it within scheduled time and specified conditions? Yes, immediately after the lesson the student can explain the reason of a matchstick not catching fire at room temperature.

Consider another statement: ***Student will be able to experimentally verify if a given material is inflammable at room temperature.***
This outcome is not attainable by a student of upper primary level, nor is it safe for the student to carry out any experimentation with inflammable materials.
A teacher must keep in mind the safety of the students and ensure precautions are observed during any experimental work.

Relevant: Is the learning outcome relevant to the needs, age, capability of the participant and the organization?
Yes. Explaining why a matchstick does not catch fire on its own at room temperature is very much relevant for a class VI-VIII student.
But the same learning outcome will not be relevant for a class II student.

Timeframe: Is it achievable by the end of the lesson?
Yes.

Consider another statement: ***Record the height of a growing apple tree sapling for a fortnight and detect the periods of accelerated growth.***
Even though the learning outcome is specific, measurable, attainable and relevant to a class VIII student but it may not be attainable in just one fortnight. The growth in a fortnight may not be significant or there may not be any significant patterns of growth spurts in this short time span.

The taxonomy of educational outcomes is a framework for classifying statements of learning outcomes. It is a classification system that is arranged in a hierarchy.

In 1956, Dr. Benjamin Bloom and his associates classified instructional objectives into three major domains: **cognitive, affective and psychomotor or conative**.

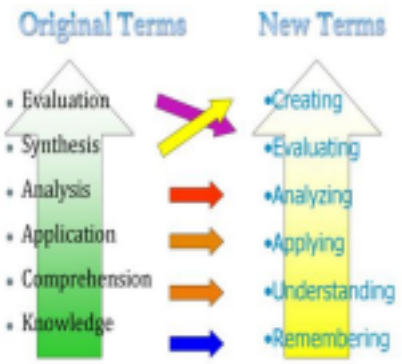
The **cognitive domain** includes those objectives that deal with recall or recognition of learned material and the development of intellectual abilities and skills. The largest proportion of educational or instructional or teaching learning objectives falls into cognitive domain. The **affective domain** includes objectives that emphasize interests, attitudes and values and the development of appreciation and adequate adjustment.
The **psychomotor domain** is concerned with physical, motor or manipulation skills. Handwriting, map, diagram, drawing, setting up experiments etc. are examples of psychomotor domain.

The cognitive domain as described by Bloom et.al. (1956) is featured around levels of complexity. The levels are ordered from simple to complex. The cognitive domain consists of the following six major levels:

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

Bloom's Revised Taxonomy of Instructional Outcomes
Lorin Anderson, a former student of Bloom, revisited the cognitive domain in the learning taxonomy in the mid-nineties and made some changes, with perhaps the two most prominent ones being,
1) changing the names in the six categories from noun to verb forms, and
2) Slightly rearranging them (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, Wittrock, 2000; Pohl, 2000).

This new taxonomy reflects a more active form of thinking and is perhaps more student-centered:



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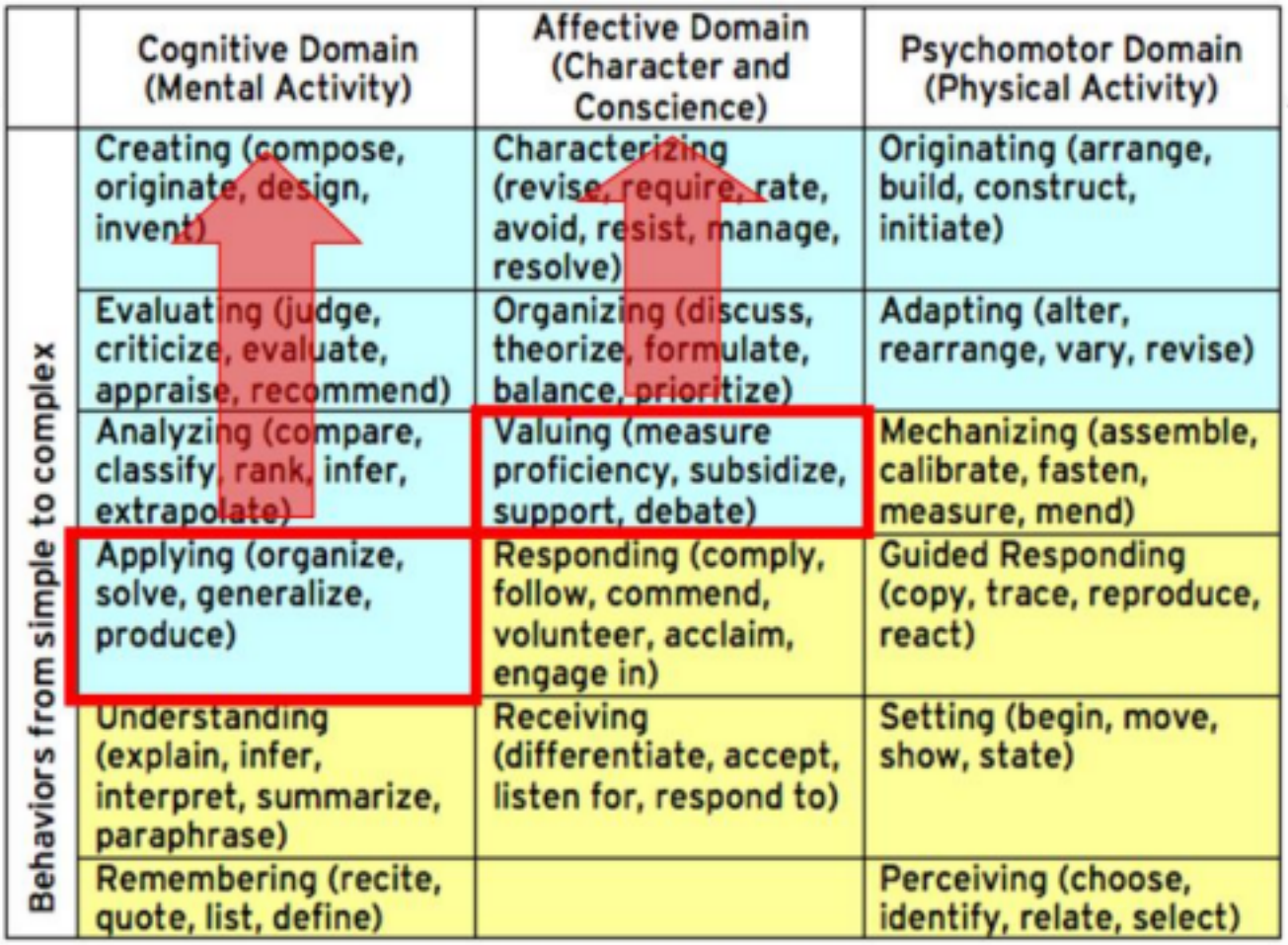
The advantage of Bloom's taxonomy is that it organizes learning into action verbs for the three domains and can help us in creating good statements of learning outcomes.

Complete Taxonomy of Instructional outcomes at a glance



	Cognitive Domain (Mental Activity)	Affective Domain (Character and Conscience)	Psychomotor Domain (Physical Activity)
Behaviors from simple to complex	Creating (compose, originate, design, invent)	Characterizing (revise, require, rate, avoid, resist, manage, resolve)	Originating (arrange, build, construct, initiate)
	Evaluating (judge, criticize, evaluate, appraise, recommend)	Organizing (discuss, theorize, formulate, balance, prioritize)	Adapting (alter, rearrange, vary, revise)
	Analyzing (compare, classify, rank, infer, extrapolate)	Valuing (measure proficiency, subsidize, support, debate)	Mechanizing (assemble, calibrate, fasten, measure, mend)
	Applying (organize, solve, generalize, produce)	Responding (comply, follow, commend, volunteer, acclaim, engage in)	Guided Responding (copy, trace, reproduce, react)
	Understanding (explain, infer, interpret, summarize, paraphrase)	Receiving (differentiate, accept, listen for, respond to)	Setting (begin, move, show, state)
	Remembering (recite, quote, list, define)		Perceiving (choose, identify, relate, select)

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Bloom's Taxonomy of Action Verbs: Cognitive Domain

Level	Remembering	Understa nd ing	Applying	Analyzing	Evaluating	Creating

Definition	Remember previously learned information.	Demonstrate an under standing of the facts.	Apply knowledge toa ctual situations.	Break down objects or ideas into simpler parts and find evidence to support generalizatio ns.	Make and defend judgments based on internal evidence or external criteria.	Compile component ideas into a new whole or propose alternative solutions.
Verbs	• arrange • define • describe • duplicate • identify • label • list • match • memorize • name • order • outline • recognize • relate • recall • repeat • reproduce • select • state	• classify • convert • defend • describe • discuss • distinguish • estimate • explain • express • extend •generalized •give example(s) • identify • indicate • infer • locate • paraphrase • predict • recognize • rewrite • review • select • summarize • translate	• apply • change • choose • compute •demonstrate • discover • dramatize • employ • illustrate • interpret • manipulate • modify • operate • practice • predict • prepare • produce • relate • schedule • show • sketch • solve • use • write	• analyze • appraise • breakdown • calculate • categorize • compare • contrast • criticize • diagram •differentiae •discriminate • distinguish • examine • experiment • identify • illustrate • infer • model • outline • point out • question • relate • select • separate • subdivide • test	• appraise • argue • assess • attach • choose • compare • conclude • contrast • defend • describe •discriminat e • estimate • evaluate • explain • judge • justify • interpret • relate • predict • rate • select • summarize • support • value	• arrange • assemble • categorize • collect • combine • comply • compose • construct • create • design • develop • devise • explain •formulate • generate • plan • prepare • rearrange • reconstruct • relate • reorganize • revise • rewrite • set up • summariz

						e • synthesize

Bloom's Taxonomy of Affective Domain

Level	**Receiving**	**Responding**	**Valuing**	**Organizing**	**Internalizing value**
Definition	Selectively attend to stimuli. Awareness, willingness to hear, selected attention	Respond to stimuli. Show interest in objects, phenomena or activity by seeking it out or pursuing it with pleasure. (Motivation)	Attach value or worth to something. Internalization of an appreciation for the objectives, phenomena or activity	Conceptualize a value and resolve conflict between it and other values.	Integrate the values into a value system that controls the behavior.

Examples	Listens to others with respect. Listen for and remember the name of newly introduced people.	Participates in class discussion. Gives a presentation. Questions new ideas, concepts, models etc. in order to fully understand them. Knows the safety rules and practices them.	Demonstrates belief in the democratic process. Is sensitive towards individual and cultural differences. Shows the ability to solve problems. Proposes a plan for improvement in class cleanliness and follows through with commitment.	Recognizes the need for balance between freedom and responsible behavior. Accepts responsibility for one's behavior. Explains the role of systematic planning in solving problems. Prioritizes time effectively to meet the needs of the school, family and self.	Shows self reliance when working independently. Cooperates in group activities. Uses an objective approach in problem solving. Revises judgements and changes behavior considering new evidence. Values people for what they are, not how they look.

Simpson's Taxonomy of Psychomotor Domain

Level	**Perceive**	**Set**	**Guided response**	**Mechanize**	**Overt response (Expert)**	**Adaptation**	**Origination**

Definition	Ability to use sensory cues to guide motor activity	Readiness to act. It includes mental, physical and emotional sets. These three sets are dispositions that predetermine a person's response in different situations (Mindset)	The early stages in learning a complex skill that includes imitation, trial and error. Adequacy of performance is achieved by practicing.	Intermediate stage in learning a complex skill. Learnt responses have become habitual and the movements can be performed with some confidence and proficiency.	Skillful performance of motor acts that involve complex movement patterns. Proficiency is indicated by a quick, accurate and highly coordinated performance, requiring minimum energy. Performing without hesitation and automatically	Skills are well developed, and the individual can also modify actions to fit special requirements.	Ability to create new movement patterns tofit a situation or specific problem. Outcomes depict creativity based on highly developed skills.
Examples	Separates metallic from non metallic out of the given vessels	Describes the procedure for finding the time period of a simple pendulum.	Determines the density of the given Stone by following instructions	Sets up an experiment to check if a liquid can conduct, using deflection in the magnetic needle on passing current through	Identifies which of the given liquids is a conductor by deploying deflection of magnetic needle in a previously used circuit.	Devices a method to identify the positive and negative terminals of a battery on which the markings are not visible.	Designs and creates artwork which use glowing LEDs.

				the liquid.			

Handout HO2B

Identifying Domain & Cognitive level of educational outcomes

Time: 10 minutes

Some instructional outcomes are given in the table below. Identify the domain of each (Cognitive/affective/psychomotor). Also identify the competency/level for each of the learning outcome belonging to cognitive domain. (Remembering/understanding/applying/analyzing/evaluating/creating).

S. No.	**Learning outcome**	**Domain** (Cognitive/affective/psycho motor)	**Competency/level of cognitive domain**
1.	Identify carnivores and herbivores from the given list of animals		
2.	Assess whether a bulb in the given circuit will glow or not		
3.	Measure the time period of a simple pendulum using a stopwatch		
4.	Design a set up in which a ball takes 1 minute to reach the ground from a given height.		
5.	Name different parts of a human digestive system		
6.	Explain the instant release of energy from glucose		
7.	Limit the intake of carbonated drinks after learning about their acidic nature		
8.	Plan a strategy to deal with the situation created in the neighborhood by a cyclone		

9.	Compare aerobic and anaerobic respiration		
10.	Explain the role of hormones in initiating reproductive function.		
11.	Calculate the value of one division on a given thermometer		

12.	Prepare an acid-base indicator from the extract of colored flowers		
13.	Relate wind speed with air pressure after seeing a demonstration		
14.	Stop using single use plastics after learning of their non biodegradable nature		
15.	Select the best domestic fuel out of a given list.		

For RP

Answer Key Handout HO_{2B}:

1. Remembering
2. Evaluating
3. Psychomotor
4. Creating/synthesizing
5. Remembering
6. Understanding
7. Affective
8. Creating
9. Analyzing
10. Understanding
11. Applying
12. Psychomotor
13. Analyzing
14. Affective
15. Evaluating

Handout HO2C

Framing of Learning Outcomes

Time: 20 minutes

Choose one broad concept from the Science Curriculum (VI/VII/VIII). From the chosen concept, frame one learning outcome for each of the six cognitive levels of the Bloom's Taxonomy in the table below. Also frame one learning outcome each for Psychomotor and Affective domains.

Class:

Topic:

After the lesson, students will be able to

Cognitive Domain	
Remembering	
Understanding	
Applying	
Analyzing	

Evaluating	
Creating	
Psychomotor Domain	
Affective Domain	

For RP

One example for Handout HO2C:

After the lesson, the student will be able to

Cognitive Domain	
Remembering	State what is an inflammable substance?
Understanding	Explain why kerosene oil requires a cool place for storage but wood does not.
Applying	Name two areas of school building which could be potential sources of fire.
Analyzing	Point out potential fire hazards from the given picture of a drawing room
Evaluating	Compare the effectiveness of water with that of CO_2 as a fire extinguisher for a fire break out in a large storehouse.
Creating	Design a flower vase which can double as a fire extinguisher
Psychomotor Domain	Evacuate the school building within one minute of fire alarm in fire drill.
Affective Domain	Demonstrate how a fire extinguisher is operated.

Activity 2B

Learning outcomes based on 21st century competencies

Time: 30 minutes

Learning outcome: Participants will be able to

- Communicate effectively the importance of incorporating 21st century competencies in teaching learning methodology
- Incorporate the 21st century competencies in their lesson planning

Mode: Group activity

Material: Handout HO2D

Process:

1. Initiate the activity by explaining the meaning of a competency.
2. Next, ask the participants their idea of 21st century competencies and their significance. 3. Distribute handout HO2D. Assign each group one competency which they will discuss among the members of the group for about 5 minutes.
4. Invite the convener of each group to present their learning to the whole group. 5. Next, ask each group to identify if the learning outcomes in HO2C nurture any 21st century competency. Ask them how the topic chosen by them in HO2C could be used to nurture 21st century competencies not identified in HO2C.

Handout HO2D

21st Century competencies

Competency: A *general* statement that describes the desired knowledge, skills, and behaviors of a student at the end of a course or activity.

Competencies commonly define the applied skills and knowledge that enable students to successfully perform in educational, professional and other life contexts.

Outcome: A very *specific* statement that describes exactly what a student will be able to do in some measurable way. There may be more than one measurable outcome defined for a given competency.

Examples of "21st Century competencies" include:

1. Creativity and Innovation
2. Critical thinking and problem solving
3. Capacity for lifelong learning
4. Collaboration
5. Communication
6. Citizenship and Character
7. Computational thinking

HOW TO INCORPORATE THESE COMPETENCIES IN TEACHING LEARNING PROCESS

1. CREATIVE EDUCATION is when students can use imagination and critical thinking to create new and meaningful forms of ideas where they can take risks, be independent and flexible. Instead of being taught to reiterate what was learned, students learn to develop their ability to find various solutions to a problem.

Coming up with various out-of-the box solutions is known as **divergent thinking**

Why Creative education?

Creation of more divergent thinkers in business, science, politics and every sphere to be able to solve complex problems plaguing the world.

How to nurture Creativity in classroom

- Don't limit assignments to one format. For example, instead of limiting the student to the writing assignment, they can create a podcast, video, role playing, poem, composing songs, etc.
- Don't set time aside for creativity. Design the lesson plan such that creativity is an integral part of regular teaching learning process.
- Use technology to broaden your idea of assignments. For example, you can use Google Maps to differentiate between distance and displacement, integrate it with geography and make the class more interactive.
- Introduce unconventional learning materials into class. Besides using the books in the classrooms, you can use educational podcasts and videos, such as Radio lab and Ted

Talks, which can create entertainment with education

- Reward creative ideas, thoughts and products
- Encourage risk-taking, allowing mistakes, and imagining from various perspectives

2. CRITICAL THINKING & PROBLEM SOLVING

Critical thinking means being able to present evidence for our ideas**,** analyzing the way we think instead of simply learning facts without ever questioning them.

Problem solving refers to the ability to use knowledge, facts, and data to effectively solve problems. This doesn't mean you need to have an immediate answer, it means you have to be able to think on your feet, assess problems and find solutions. The ability to develop a well thought out solution within a reasonable time frame, however, is a skill greatly required at every step in life.

Why critical thinking:

1. Students are being prepared for jobs that don't exist yet.
2. Improves Students' flexibility and learning skills
3. Essence of democracy
4. Makes education less passive and more interactive
5. Helps students better express their ideas

6. Help in making next generation more adaptable to changes

What is problem-based learning (PBL)?

Problem-based learning is approach that uses creative & critical thinking to help learners solve real-world problems that may or may not have a 'definite' solution. The focus is on developing conceptual understanding and skills such as creative & critical thinking skills, research skills etc rather than finding a 'right' answer. It is a dynamic and student-centric approach, as learning is driven by the motivation to solve problems rather than direct instruction from the teacher.

What is the role of the teacher in problem-based learning?

The teacher's role in PBL is very different from that in the traditional classroom. The teacher does not explicitly instruct but rather plays the role of a guide and coach. When PBL is initially introduced, students may not have the skills needed, so the teacher may model the creative thinking skills required to solve the problem, by posing questions along

with the students or by offering an alternative perspective. However, the teacher must take care to ensure that he or she is not over-involved in the students' explorations or leading that in a unilateral direction of thought.

As the students gain more experience of solving problems, the teacher is expected to gradually withdraw the amount of coaching and empower the students to learn independently. When students have reached this stage, the teacher's role is limited to posing the problems, and monitoring the groups to ensure the learning outcomes are met.

How is problem-based learning different from traditional learning?

Problem Based Learning	**Traditional Learning**
Student-led	Teacher-led
Scope for application extends beyond the classroom	Scope for application is limited to the classroom
Students are given a problem to solve	Students are told what they need to know
Typically occurs in groups	Typically occurs in a whole group or individually
Problems used for the development of concepts, skills and knowledge	Problems used as examples to explain content

3. CAPACITY FOR LIFELONG LEARNING:

Lifelong learning is defined as "all learning activity undertaken throughout life, with the aim of improving knowledge, skills and competences within a personal, civic, social and/or employment-related perspective".

It is often considered as the learning that occurs after the formal educational years of childhood and into adulthood. It is sought out naturally through life experiences as the learner seeks to gain knowledge for professional or personal reasons.

'Knowledge results from the combination of grasping experience and transforming it'

(Kolb 1984: 41).

The concept of lifelong learning has become of vital importance with the emergence of new technologies that change how we receive and gather information, collaborate with others, and communicate.

How to nurture capacity for life-long learning in school?

The idea is to make sure that once our children leave school, they no longer need us. They can learn on their own and never stop being learners.

Few ways of doing it:

1. Encourage learning ownership:

When students own their learning, it sticks with them. Show them the rewards of taking such a responsibility: higher self-esteem, pride in achievement, independence they want, ability to help others.

2. Turn mistakes into opportunities:

Treat their mistakes as steppingstones, as opportunities not crimes!

3. Stash a few go-to learning tools

Give them blogs to read, encourage debates and discussions. Give them a thirst for learning and growing.

4. Let them take the teaching reins

Allow them to be mentors, assisting others and guiding their peers

5. Find time to play

Play allows learning to be fun and enjoyable. The learning stops being a chore. Onstage play allows a student to learn about oneself as well as others. Communication, comprehension, social skills are nurtured as actors bring alive stories to teach others.

6. Set learning goals

There must be a valid reason and worthwhile reason for learning. Goal setting itself is a lifelong learning skill that strengthens the *desire* to learn.

4. **COLLABORATION**:

Collaborative learning is the most ideal approach to learning given that it enables students to benefit from guidance from peers and teachers. Vygotsky's work highlighted the importance of interactions and communication with others during the learning process, which is the main advantage offered by collaborative learning.

What is collaborative learning?

Collaborative learning is a process in which multiple individuals come together to learn by tapping into each other's prior knowledge, skills and resources through active discussion. In collaborative learning, all members of a group are accountable to each other in completing the common task. Debates, collaborative writing assignments, role plays, and study teams all fall into this category.

How is collaborative learning different from cooperative/group learning?

Collaborative *learning Cooperative/group* Learning Oriented towards group's learning goals	Oriented towards accomplishing individual learning goals within group goals
Learning is dependent on individuals' conceptual understandings which may or may not be discussed, but tends to be shared	Learning relies on shared conceptual understandings, which emerges from discussion
Individual members of the group have different roles and responsibilities; minimal interaction	Roles & responsibilities are shared across the group; interactions are the primary mode of learning

Why collaborative learning?

- Development of higher-level thinking, oral communication, self-management, and leadership skills.
- Promotion of student-faculty interaction.
- Increase in student retention, self-esteem, and responsibility.
- Exposure to and an increase in understanding of diverse perspectives. •

Preparation for real life social and employment situations.

5. COMMUNICATION:

Communication competence refers to the ability to articulate ideas and thoughts in variety of forms and contexts. More specifically, the ability to listen effectively so as to understand the main points being made by others and to utilize different modes of communication as appropriate for specific purposes (e.g. persuading, arguing or providing appropriate information)

Basic speaking & learning competencies:

For developing effective speaking & listening competence, students should be able to do the following by the time they graduate from the school:

- State ideas clearly.
- Communicate ethically.

• Recognize when it is appropriate to communicate.
• Identify their communication goals.
• Select the most appropriate and effective medium for communicating. • Demonstrate credibility.
• Identify and manage misunderstandings.
• Manage conflict.
• Be open-minded about another's point of view.
• Listen attentively.
• Formulate appropriate questions

Why communication skills in science learning?

Communication skills are a requisite for scientific literacy for

• Obtaining, evaluating and communicating information
• communicating within a wide range of local, national and global communities • communicating scientific ideas with others during the process of scientific inquiry in a positive way to facilitate further communication and discussion of the related scientific issues.
• Communicating their ideas on science and socio-scientific issues with others via both verbal and written dialogue

• articulating their ideas, thoughts and feelings by using a variety of verbal and visual representations (e.g. words, images, gestures etc.)
• delivering key messages taken from complex ideas in an efficient and effective manner. • Ability to listen carefully so as to understand the main ideas involved in an argument, detecting bias, recognizing over generalization, and detecting claims during ongoing conversations.
• Developing a shared understanding tempered with empathy and based on commitment to treating others with respect.

6. CITIZENSHIP & CHARACTER

Citizenship and character competency refer to the ability to guide individual actions as a person for the common good of the community, so that an individual uses personal values for the service of the community.
While values and character are by their very nature personal, citizenship is a very public concept.

Why Citizen & Character Education (CCE)?

CCE is of immense importance, especially in our increasingly global context. We are confronted with so many choices every day, and the choices we make as individuals have repercussions on the community we live in.

A student can be made aware of his role, his responsibilities and his rights at different levels of his existence e.g. as an individual, as a member of his class, as a student of the school, as a resident of a locality, as a citizen of a state/country and as a global citizen. This allows him to make choices based on his awareness and the values that he holds. CCE helps them make choices that are defensible, informed and not only serve their own interests but also to think about the larger community

How to teach character and citizenship in school?

- One way to help our students make good choices – and choose good values – is to expose them to rich learning experiences and help them to reflect on the choices they make.

- Citizen and Character Education is more than just transmitting a body of knowledge, it has to be applied; and application comes with deep understanding. It must be a lived experience – how you live as a person, how you live in the school, how you live out your values in the public domain.

- It is important to involve our learners in co-constructing meanings in the CCE curriculum. Classroom instruction and climate can be enhanced to improve students' confidence to participate more actively.

In doing so, we are also teaching them citizenship – that their views count and they are valued as part of the community

- While some may view citizenship in national terms, focusing on local issues and patriotism, living in a global society is about recognizing that global issues like social injustice, climate change and war can equally affect us and require us to take action to resolve them.

- Discussions on scientific topics that lead to an appreciation that citizenship is multi layered – always grounded in the local context, but also national and global. With globalization, even our identities have become multiple and complex, derived from ethnicities, religions, political affiliations, as well as transnational influences like social media.

Citizenship education should therefore help young students understand and address pressing social issues that are not only local, but also affecting nations and communities everywhere."

- It is important for teachers to think about the nature of critical thinking they want students to engage in, not just to be better workers, but also to challenge assumptions, think critically about policies and government decisions, and form their own conclusions.

Take the issue of global climate change for example. For students to see how they can

help address the problem requires an understanding of not just the economics, politics and history of climate change, but also the different narratives of what "progress" is.

• Experiences like educational travel, Internet collaboration to solve problems e.g Asteroid search program of NASA

7. COMPUTATIONAL THINKING (CT)

Computational thinking refers to the thought process involved in formulating a problem and its solution in step-by-step sequences of simple operations that can be understood by a computer or a human or both.

Computational Thinking = critical thinking skills + power of computing

What is the difference between computational thinking & programming?

programming tells a computer what to do and how to do it. Computational thinking enables you to work out exactly what to tell the computer to do.

Why computational thinking?

• Before computers can be used to solve a problem, the problem itself and the ways in which it could be resolved must be understood. Computational thinking techniques help with these tasks.

Computational thinking enables you to work out exactly what to tell the computer to do. • Computational thinking allows students to move from being consumers of technology to being builders of tools that benefit society

Four steps of computational thinking

• **Decomposition**: breaking down a complex problem or system into smaller, more manageable parts

• **Pattern recognition**: looking for similarities among and within problems • **Abstraction**: focusing on the important information only, ignoring irrelevant detail • **Algorithm writing**: developing a step-by-step solution to the problem, or the rules to follow to solve the problem

Each cornerstone is as important as the others. They are like legs on a table - if one leg is missing, the table will probably collapse.

How to incorporate CT in science classroom?

We can teach computational thinking without any technology at all.

Teaching Decomposition

Teaching decomposition to young learners means that students are invited into problem-solving scenarios. Teachers share the complex, multi-step problem and facilitate conversations that help students to break it down. While students at these ages are not always developmentally ready for multi-step directions or problems, they *are* ready to be exposed to models of adult thinking. In

doing this, students begin to develop a framework of strategic, computational thinking.

Example: ***Baking a cake***

It is only normally when we are asked to do a new or more complex task that we start to think about it in detail – to decompose the task.

For example, decomposing the task of baking a cake would highlight the need for us to know the solutions to a series of smaller problems:

- what kind of cake we want to bake?
- what ingredients we need and how much of each
- how many people we want to bake the cake for
- how long we need to bake the cake for
- when we need to add each ingredient
- what equipment we need

Teaching Pattern Recognition

Pattern recognition, as a cornerstone of computational thinking, begins with the basic ABAB pattern creation that is taught in the primary grades and extends to more complex layers of thinking. Pattern recognition invites students to analyze similar objects or experiences and identify commonalities. By finding what the objects or experiences have in common, young students can begin to develop an understanding of trends and are therefore able to make predictions.

Example: ***Patterns in process of baking a cake***

Once we know how to bake one particular type of cake, we can see that baking another type of cake is not that different - because patterns exist.

For example:

- each cake will need a precise quantity of specific ingredients
- ingredients will get added at a specific time
- each cake will bake for a specific period of time

Once we have the patterns identified, we can work on common solutions between the problems.

Teaching Abstraction

Abstraction is focusing on the information that is relevant and important. It involves separating core information from extraneous details.

Abstraction helps us to create a model. A model is a general idea of the problem we are trying to solve.

In primary classrooms, teachers naturally teach kids the concept of abstraction with literature as

they identify the main idea and key details. To take this one step further, teachers can encourage students to hunt for information, clues, or treasures by giving them a goal as they approach a book or even an experience. As students listen to a speaker during a school presentation about dental hygiene, a kindergarten class might be hunting for details about brushing your teeth. By teaching students abstraction, they are able to sort through all of the information available to identify the specific information they need. This is an invaluable skill as students read larger texts and are presented with more and more complex information.

Example: **Baking a cake**

When baking a cake, there are some general characteristics between cakes. For example:

- each cake will need a precise quantity of specific ingredients
- ingredients will get added at a specific time
- each cake will bake for a specific period of time

When abstracting, we remove specific details and keep the general relevant patterns.

General patterns	Specific details
We need to know that a cake has ingredients	We don't need to know what those ingredients are
We need to know that each ingredient has a specified quantity	We don't need to know what that quantity is
We need to know that each cake needs a specified time to bake	We don't need to know how long the time is

Then we think of a model cake. A model cake wouldn't be a specific cake, like a sponge cake or a fruit cake. Instead, the model would represent all cakes. From this model we can learn how to bake any cake, using the patterns that apply to all cakes.

TEACHING ALGORITHMS

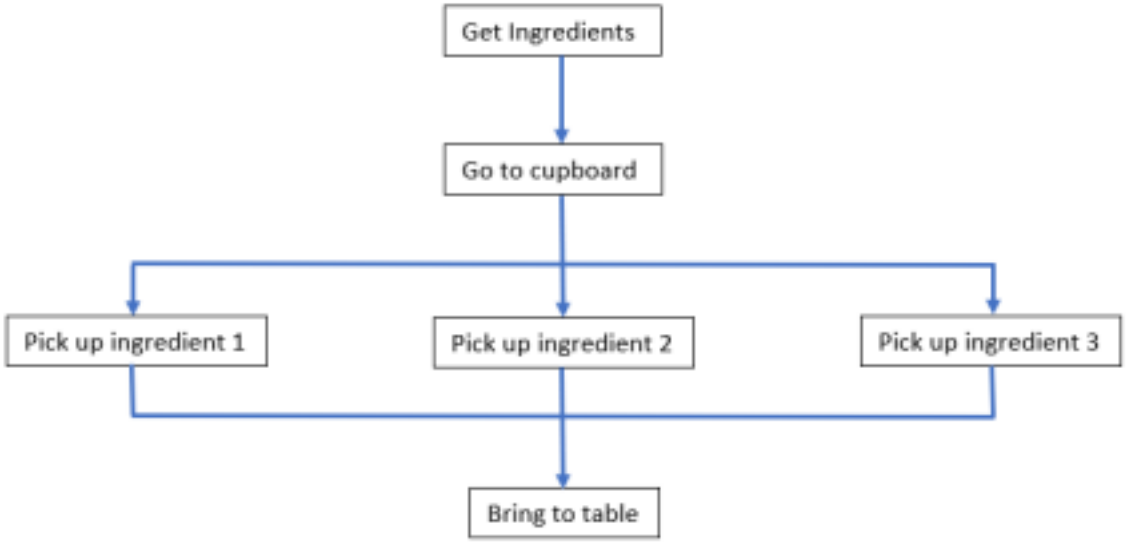
Algorithmic thinking involves developing solutions to a problem. Specifically, it creates sequential rules to follow in order to solve a problem. In the early grades, kids learn to tie shoelaces, get dressed and already know how to follow a step by step process to solve a problem.

To get students thinking in algorithms, invite them to design the path from their classroom to the gym by detailing a series of steps. Then, let them try it out! Additionally, invite students to think about their morning routine. What steps do they take to get ready for school each morning? How would the order impact the outcome? Asking students to consider how inputs change the outcome encourages them to be reflective in their thinking and to make changes to their plan to

achieve the desired result.

In an algorithm, each step is identified and the order in which they should be carried out is planned. To begin with an algorithm can be written as a flowchart.

Example: **Putting together the material to bake a cake**



Source: Adapted from https://www.bbc.co.uk/bitesize/topics/z7tp34j

Activity -3 A
How Scientific Is It?

Time: 5 minutes

Learning outcome:
Participants will be able to

- Differentiate between more scientific and less scientific process
- Deduce the real sense of what science is?

Mode- Group activity

Instructions to RP

- Assign one set to each group.
- *Place the letters on the spectrum below from least scientific to more scientific (using different color sheets/crayons etc.) and move from Less scientific ---------- ---▯ more scientific*

Handout HO3A

Instructions:

- *Read each of the knowledge claim statements below.*
- *Discuss and agree on an order to the claims, by letter, from that which you deem least to that which you deem most scientific.*
- *Place the letters on the spectrum below from least scientific to more scientific (using different color sheets/crayons etc.) and move from Less scientific ---------- ---▯ more scientific*
- *Justification: Be ready to explain to others the justification you used for this order.*

Group 1: SET-I

a. All living things are composed of one or more cells. We know this because every living thing examined to date has been found to be composed of one or more cells. b. If you break a mirror, you will have seven years of bad luck.

c. The Earth is flat. Anybody can see that!

d. Taking Vitamin C prevents the common cold. Linus Pauling, the Nobel laureate who discovered the structure of Vitamin C, says it does.

e. Humans have a soul. I believe this because it says so in our religious scriptures. The soul is what separates us from animals.

f. The rate of acceleration of all falling objects on Earth is constant. Two spheres of identical diameter and volume are dropped from the top of a building; one is made of steel, the other made of a plastic polymer. They both will accelerate at the same rate (9.8 m/sec^2) and hit the ground at the same time.

Group II-SET-II

a. Rainbow is made up of seven different colors.

b. Ravi was unable to score good in the exam due to his bad luck.

c. Our body has a mechanism of keeping the body temperature to a normal by way of sweating and perspiration during summers.

d. Desert animals have special features to combat excessive heat.

e. A person can alter her life by changing her thoughts.

f. Art in any form can give people emotions that can lift their spirit & make them more driven than ever.

Group 3- SET-III

a. Galaxy is a gravitationally bound system of stars, stellar remnants, interstellar gas, dust and dark matter.

b. Plants are perceived as green because Chlorophyll absorbs mainly the blue and red wavelength and reflects the green.

c. Ashoka's reign significantly influenced the course of Indian history with a powerful military system and effective political and social reforms.

d. Vitamin D helps in building strong bones and metabolizes Calcium from the diet. e. A person who violates moral norms and codes of conduct is considered as immoral f. Newton's law of

Gravitation states that every particle attracts every other particle with a force that is directly proportional to the product of their masses and inversely proportional to the square of distance between their centers.

Group 4 -SET-IV

a. The law of Conservation of Energy states that total energy of an isolated system remains constant, although it can be transformed from one form to another.

b. The shell of the turtle acts as a protective cover enclosing all the vital organs. c. Mars is also termed as 'Red Planet' due to the Iron Oxide present on its surface that gives it a reddish appearance.

d. Religion constitutes a cultural system consisting of certain set of designated behaviors, morals, worldviews, sanctified places, ethics that connects humanity to spiritual elements. e. Researchers have estimated that more than 8.3 Billion tonnes of plastic has been produced since the early 1950s.

f. One always learns from own mistakes.

Group 5-SET-V

a. The IUCN estimates that almost 50 percent of the world's primate species are at risk of extinction.

b. Right to Education is an act of the Parliament of India that confers free and compulsory education for all children between the age of 6 – 14 years.

c. A magnet attracts metallic objects made up of Iron, Nickel & Cobalt.

d. Maintaining a balance of mind, body and soul is very important to live happy and fulfilled life.

e. Every organism is constituted of cells, which is a basic unit of life.

f. The pollution level in the city is rising due to altered human behavior.

Resource: Adapted from Scharrman et al. 2005. Explicit reflective nature of science instruction: Evolution, Intelligent Design, and umbrellaology. Journal of Science Teacher Education 16:27–41.

Activity 3B

EXPERIENTIAL LEARNING

Time: 1 hour 30 minutes

Material required:

- Handout HO_{3B} – Understanding different features of Experiential learning
- Handout HO_{3C} – Hands on activity
- Handout HO_{3D} – Identifying criteria & Creating observation table

Learning outcomes:

Participants will:
1. identify and summarize the important features and significance of experiential learning
2. carry out one hands on/experiential activity
3. identify the learning skills based on Bloom's taxonomy and 21st century competencies imparted through the activity.
4. develop a lesson plan incorporating experiential learning

Group activity

Process:
The RP will ask the participants to
1. take up one article from handout HO3B and discuss within the smaller group and then the convener selected from the group will share it with the larger group.
2. carry out any one of the experiential learning activities given in handout HO3C. 3. plan the lesson as per the format given in handout HO3D and HO3E incorporating the following • learning outcomes incorporating competencies based on domains of Bloom's taxonomy as well as 21st century competencies.

- carry out the activity as per the instructions given
- create criteria for tabulating observations on the experiential learning activity. • interdisciplinary approach - Specify the concepts which cut across different subjects • prepare Assessment worksheet reflecting assessment of competencies as well as content mentioned in the learning outcomes
- make a rubric for assessing setting up of the experiment successfully

Handout HO3B

Group I

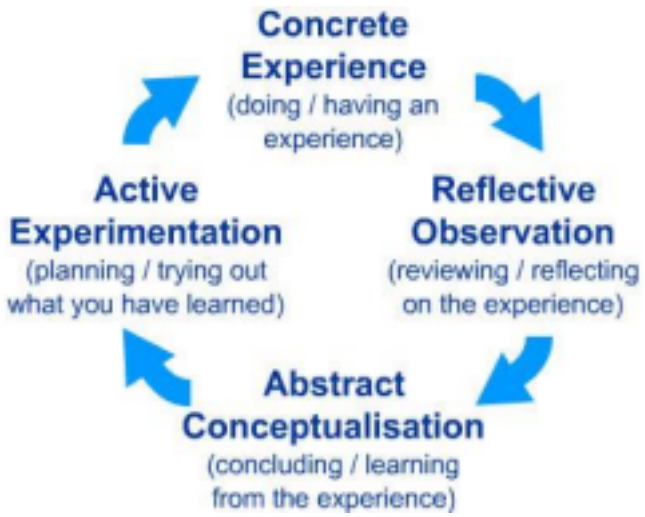
CBSE Theme for 2019-2020- Innovative Pedagogy including Experiential Learning and Active learning

In accordance with the NCF2005, we follow the constructive approach. According to the

approach ,the child is placed at the center of learning and the approach believes that children learn best through experiencing and reflecting on the topic/concepts being taught .

'We will learn no matter what! Learning is as natural as rest or play. With or without books, inspiring trainers or classrooms, we will manage to learn. Educators can, however, make a difference in what people learn and how well they learn it. If we know why we are learning and if the reason fits our needs as we perceive them, we will learn quickly and deeply.'
Malcolm Knowles

"Experiential [learning] is a philosophy and methodology in which educators purposefully engage with students in direct experience and focused reflection in order to increase knowledge, develop skills, and clarify values" (Association for Experiential Education, para. 2). As the name suggests, experiential learning involves learning from experience. The general concept of learning through experience is ancient. Around 350 BCE, Aristotle wrote in the *Nicomachean Ethics "for the things we have to learn before we can do them, we learn by doing them".* But as an articulated educational approach, experiential learning is of much more recent vintage. Beginning in the 1970s, David A. Kolb helped to develop the modern theory of experiential learning, drawing heavily on the work of John Dewey, Kurt Lewin, and Jean Piaget.



Kolb's Experiential Learning Model

Handout HO3B

Group II

The experiential theory proposed by Kolb takes a more holistic approach and emphasizes how experiences, including cognition, environmental factors, and emotions, influence the learning process

Hands-on learning can be a form of experiential learning but does not necessarily involve

students reflecting on their product.

1. CONCRETE EXPERIENCE:
Concrete experience describes the hands-on experiences that we learn from. It's here that we try new things, face problems and step out of our comfort zone. These experiences could be anything in our personal or professional lives. It's through experience that we get to learn from our successes or failures.

2. REFLECTIVE OBSERVATION

Next, we need to reflect to learn from our experiences. The 'reflective observation' phase of the experiential learning cycle is all about reflection on the experiences which include both action and feelings. It's during this stage that we ponder on the experiences. We get to reflect on what went right and what could be improved? It's also a chance to observe how it could have been done differently and to learn from each other.

3. ABSTRACT CONCEPTUALIZATION
Once we have identified and understand the defining characteristics of an experience, we can decide on what we can do differently next time. This is a time for planning and brainstorming steps for success.

4. ACTIVE EXPERIMENTATION
The active experimentation phase of the learning cycle is where we get to experiment with our ideas. It's time to put our plan of action

An example of experiential learning –

Learning how to ride a bike, a process which can illustrate the four-step experiential learning model (ELM) as set forth by Kolbin Following this example, in the "concrete experience" stage, the learner physically experiences the bike in the "here-and-now". This experience forms "the basis for observation and reflection" and the learner has the opportunity to consider what is working or failing (reflective observation), and to think about ways to improve on the next attempt made at riding (abstract conceptualization). Every new attempt to ride is informed by a cyclical pattern of previous experience, thought and reflection (active experimentation).

Handout HO3B

Group III

Benefits of Experiential Learning

- Builds on past knowledge and experiences
- Links theory to practice
- Increases Participants' engagement
- Assists in memory retention,

- Leads to development of skills for lifelong learning,
- Encourages collaboration and exchange of ideas and perspectives

Extract from - Experiential Learning –Gandhiji's Nai Talim Book launched by SCERT & MGNCRE

Work is a curricular activity and it is not extracurricular or co-curricular.

The idea of work and education has been experimented with through various initiatives all over the world. And while the benefits of the pedagogic role of work in education cannot be denied, these experiments have never been adopted as the way in which mainstream education can be taken ahead. The same is true for India. Both policy and curricular documents in India acknowledge the indelible role of work in education but do not see it as the center of all curricular activity. Work is a curricular activity and it is not extracurricular or co-curricular. School is a science Center not a knowledge shop. Here knowledge is created through learning of scientific principles through practice of productive work. It is a place of experimentation, demonstration, dissemination and development of technology. It is a place for development of skill, knowledge and attitude and not just transfer of these attributes.

Schooling experience needs to make this as a source of experiential learning. It also makes learning superior. It makes learning complete.

IMPLEMENTATION

Although Interactive lecturing should be part of an educator's teaching repertoire, faculty should also actively involve their students "in the learning process through discussion, group work, hands-on participation, and applying information outside the classroom". This process defines experiential learning where students are involved in learning content in which they have a personal interest, need, or want.

A key element of experiential learning, therefore, is the student, and that learning takes place (the knowledge gained) as a result of being personally involved in this pedagogical approach.

During each step of the experience, students will engage with the content, the instructor, each other as well as self–reflect and apply what they have learned in another situation.

Experiencing/Exploring "Doing" Students will perform or do a hands-on minds-on experience with little or no help from the instructor. Examples might include: Making products or models,

role-playing, giving a presentation, problem-solving, playing a game. A key facet of experiential learning is what the student learns from the experience rather than the quantity or quality of the experience.

Handout HO3B

Group IV

Role of a Teacher in Experiential Learning, the instructor guides rather than directs the learning process where students are naturally interested in learning. The instructor assumes the role of facilitator and is guided by a number of steps crucial to experiential learning

1. Be willing to accept a less teacher-centric role in the classroom.

2. Approach the learning experience in a positive, non-dominating way.

3. Identify an experience in which students will find interest and be personally

committed. 4. Explain the purpose of the experiential learning situation to the students.

5. Share your feelings and thoughts with your students and let them know that you are learning from the experience too.
6. Tie the course learning objectives to course activities and direct experiences so students know what they are supposed to do
. 7. Provide relevant and meaningful resources to help students succeed.

8. Allow students to experiment and discover solutions on their own.

9. Find a sense of balance between the academic and nurturing aspects of teaching. 10. Clarify students and instructor roles.

Integrating Experiential Learning (EL) in Teaching: The primary role for instructors is to identify a situation which challenges students through problem-solving, cooperation, collaboration, self- discovery and self-reflection. At the same time, decide what the students should learn or gain from the learning experience. Below are some primary points to consider when integrating experiential learning in your own teaching.

Prepare. After the planning has been completed, prepare materials, rubrics, and assessment tools and ensure that everything is ready before the experience begins.

Facilitate. As with most instructional strategies, the instructor should commence the experience. Once begun, you should refrain from providing students with all of the content and information and complete answers to their questions. Instead, guide students through the process of finding and determining solutions for themselves.

Evaluate. Success of an experiential learning activity can be determined during discussions, reflections and a debriefing session. Debriefing, as a culminating experience, can help to reinforce and extend the learning process. In addition, make use of the assessment strategies previously planned.

Happy Experiencing!

Handout HO3B

Group V

The How's of Experiential learning

NOTABLE

Experiential Learning includes all these:

Joyful Learning!

Art integrated learning!

Activity Based Learning!

Fun, games and studies!

Sport Integrated Learning!

Inquiry based learning!

Collaborative learning!

Assessment as learning!

Learning by doing!

The Experiential Learning Process Experiential learning involves a number of steps that offer student a hands-on, collaborative and reflective learning as self–reflect and apply what they have learned in another situation.

Experiencing/Exploring "Doing" Students will perform or do a hands-on minds-on experience with little or no help from the instructor. Examples might include: Making products or models, role-playing, giving a presentation, problem-solving, playing a game. A key facet of experiential learning is what the student learns from the experience rather than the quantity or quality of the experience.

Sharing/Reflecting "What Happened?" Students will share the results, reactions and observations with their peers. Students will also get other peers to talk about their own experience, share their reactions and observations and discuss feelings generated by the experience. The sharing equates to reflecting on what they discovered and relating it to past experiences which can be used for future use.

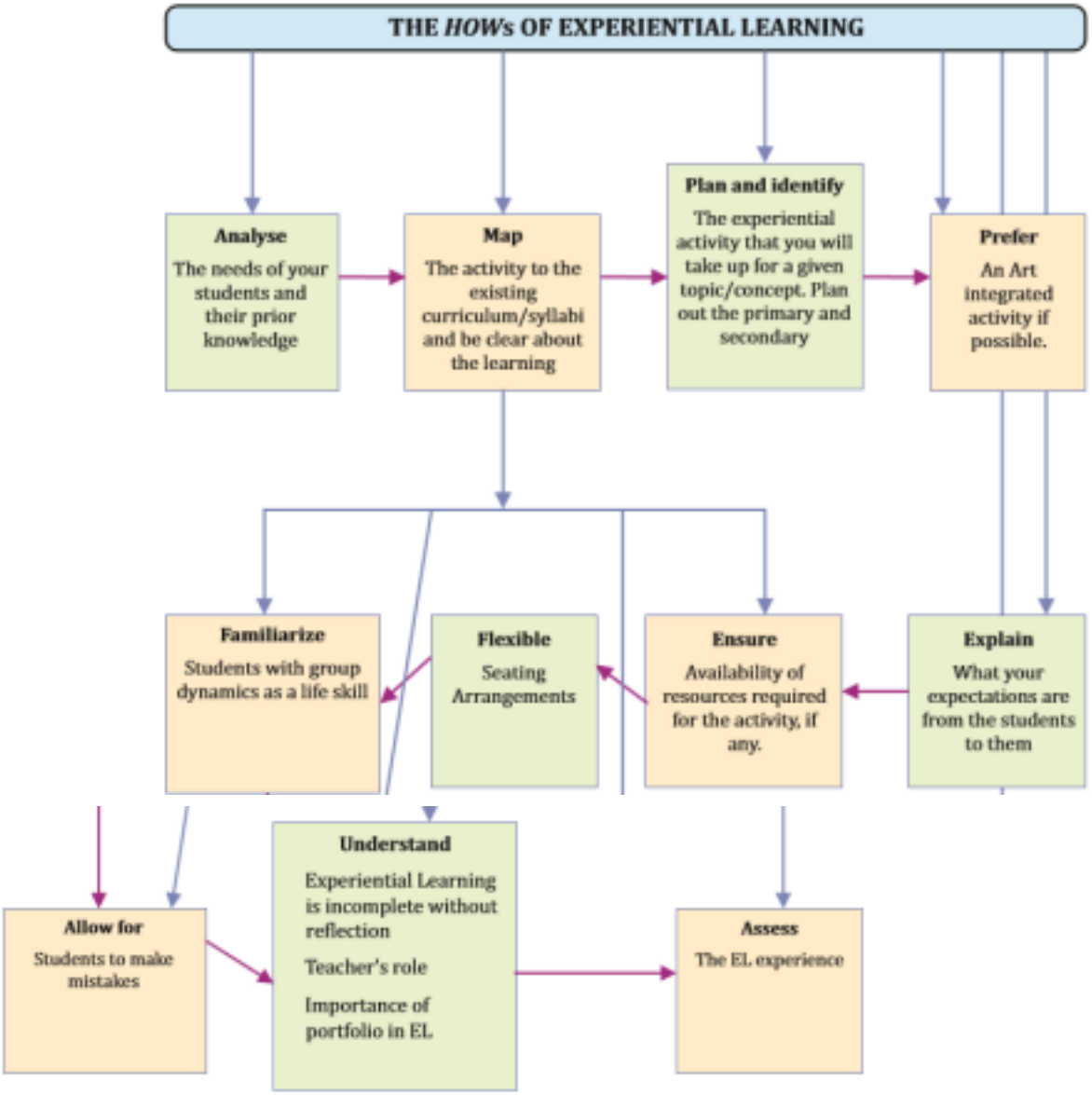
Processing/Analyzing "What's Important?" Students will discuss, analyze and reflect upon the experience. Describing and analyzing their experiences allow students to relate them to future learning experiences. Students will also discuss how the experience was carried out, how themes, problems and issues emerged as a result of the experience. Students will discuss how specific problems or issues were addressed and to identify recurring themes.

Generalizing "So What?" Students will connect the experience with real world examples, find trends or common truths in the experience, and identify "real life" principles that emerged.

Application "Now What?" Students will apply what they learned in the experience (and what

they learned from past experiences and practice) to a similar or different situation. Also, students will discuss how the newly learned process can be applied to other situations. Students will discuss how issues raised can be useful in future situations and how more effective behaviors can develop from what they learned. The instructor should help each student feel a sense of ownership for what was learned.

In experiential learning, the instructor guides rather than directs the learning process where students are naturally interested in learning



Handout HO3C

Hands on activity group 1

Introduction: Experience is the best teacher-the dictum remains valid anytime, all the time. Let the participants be divided into seven groups and each group be provided with straws, bamboo fibers, match sticks, a base board and a few weights. Each group is told to make a bridge using the given material and see which bridge has the maximum weight bearing capacity.

Design another model of a bridge having the same weight bearing capacity.

RPs to ask the participants not to create the same structure as given in pic

Purposes of Activity 3C

1. Experiencing the fun of a group activity.
2. Learning by failing, detecting the failings in the failings, then attaining the goal. 3. Experiencing the same situation in different ways.
4. The joy of being successful after failing.

Handout HO3C

Handout group activity 2

Experimental learning comes with its own joy. This is what is the joy of leaning by diving. Potters, sculptors, cooks, tailors and many other people in the constructive occupation, first experience learning, then make their learning into 'earning'.

Continuing with group activities, each group is given to select any chapter from the elementary

school's science textbook and design a "learning by doing".

To demonstrate the process that has potential to work. Give the following demonstration. Build a catapult using ice cream sticks and rubber band

RPs to ask the participants not to create the same structure given in pic

Purposes of Activity 3D

1. Demonstrations are the best visual experiences.
2. The theories when given visual demonstrations turn into delightful experiences thus making learning more effective.
3. Experiential learning makes class responses better.
4. Increases the curiosity quotients of the students.
5. Takes away the mundane style of chalk and talk methods.

Handout HO3C

Handout group activity 3

Experimental learning comes with its own joy. This is what is the joy of leaning by diving. Potters, sculptors, cooks, tailors and many other people in the constructive occupation, first experience learning, then make their learning into 'earning'.

Continuing with group activities, each group is given to select any chapter from the elementary school's science textbook and design a "learning by doing".
To demonstrate the process that has potential to work. Give the following demonstration. Build a create a tower using 10 paper sheets. Height and width will be checked

RPs to ask the participants not to create the same structure given in pic

Purposes of Activity 3D

1. Demonstrations are the best visual experiences.
2. The theories when given visual demonstrations turn into delightful experiences thus making learning more effective.
3. Experiential learning makes class responses better.
4. Increases the curiosity quotients of the students.
5. Takes away the mundane style of chalk and talk methods.

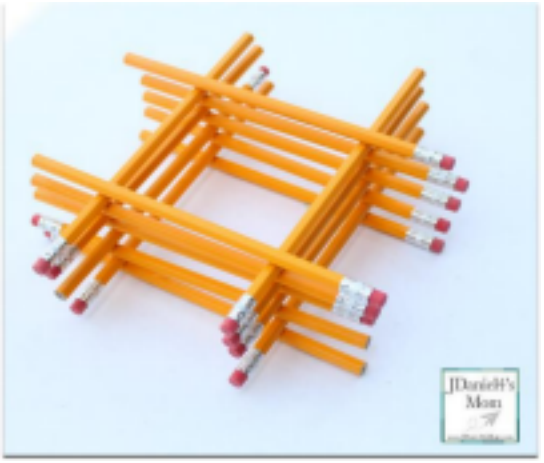
Handout HO3C

Handout group activity 4

Experimental learning comes with its own joy. This is what is the joy of leaning by diving. Potters, sculptors, cooks, tailors and many other people in the constructive occupation, first experience learning, then make their learning into 'earning'.

Continuing with group activities, each group is given to select any chapter from the elementary school's science textbook and design a "learning by doing".

To demonstrate the process that has potential to work. Give the following demonstration. Create tower out of pencils . use of 40 pencil is mandatory



RPs to ask the participants not to create the same structure given in pic

Purposes of Activity 3D

1. Demonstrations are the best visual experiences.
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4. Increases the curiosity quotients of the students.
5. Takes away the mundane style of chalk and talk methods.

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Handout HO3C

Handout group activity

Experimental learning comes with its own joy. This is what is the joy of leaning by diving. Potters, sculptors, cooks, tailors and many other people in the constructive occupation, first experience learning, then make their learning into 'earning'.

Continuing with group activities, each group is given to select any chapter from the elementary school's science textbook and design a "learning by doing".

To demonstrate the process that has potential to work. Give the following demonstration. Cut a huge circle with single paper

RPs to ask the participants not to create the same structure given in pic

Purposes of Activity 3D

1. Demonstrations are the best visual experiences.
2. The theories when given visual demonstrations turn into delightful experiences thus making learning more effective.
3. Experiential learning makes class responses better.
4. Increases the curiosity quotients of the students.
5. Takes away the mundane style of chalk and talk methods.

Handout HO3D

Identifying criteria & Creating observation table

1/2/3/4/5 (PL. tick the activity you are working on)

Create a table for recording observations for the activity as per criteria identified by you.

Activity 4

Lesson Planning

Time: 45 minutes

Material required:

- Handout HO4A – Understanding different features of Experiential learning
- Handout HO4B – Hands on activity
- Handout HO4C – Identifying criteria & Creating observation table

Learning outcomes:

Participants will:

1. Identify importance of competencies as part of Pedagogical plan.
2. Incorporate competencies in the lesson plan.
3. Develop learning outcomes reflecting competencies based on domains of Bloom's taxonomy and also 21st century competencies.
4. Incorporate experiential learning in the lesson plan

Group activity

Process:

The RP will

- discuss the flowchart of lesson plan.
- Ask the RPs to plan outline of a lesson as per the format given in handout HO4A & HO4B
- Give out hand out HO4C and ask the CPs to complete it in 10 minutes.

Handout HO4A

Lesson Plan Template (Summary)

Content (Topic & Sub-topic)	

Class and Section: Subject:

Estimated Number of Sessions/Periods: Duration:

Session/Period Number: Name of Teacher:

Subtopic	
General Outcomes(s)	
Specific Learning Outcome (s)	

Pre-requisites/Prior Knowledge	
Resource Kit/Materials	
Trans-disciplinary linkages	
Warming Up/Anticipatory Set/Trigger/Set Induction/Hook	
Facilitation (Core Instructional Elements) Strategies/Activities/Tools	
Guided Practice/experiential learning activities	
Accommodations	
Checking for Understanding (signaled answers, choral responses, quiz, rapid fire)	
Closure (Internalize learning)	
Independent Practice (assignments/projects)	
Assessment to measure Learning Outcomes (Informal/structured)	
Sunny/Muddy Areas ***(self reflection for teacher)***	

Signature of teacher signature of coordinator signature of principal

Handout HO4B

Sample Format of the Lesson Plan

Lesson- Growing plants

Content	General Learning Outcomes	Specific Learning Outcomes	Teacher activity	Student Activity	Teacher's Remarks &remedial
Pre Content	-Importance of reproduction in plants	-Draw conclusions about the relationship between reproduction and the survival of plants	-KWLW chart Worksheet-1 -Life cycle of a plant Through video or chart	-Will fill up the chart -Draw the life cycle of a plant and write a description of the process -Worksheet-1	
Content	Identify different modes of reproduction in plants	-Identify seeds and different parts of plant responsible for reproduction - list the parts of a flower. -Students will explain how flowers reproduce. -Students will be able to describe the role of insects in the reproduction of flowers.	-demonstration of an activity to observe seed germination. Bryophyllum plants are common house plants that can reproduce by growing new plants on long stems called runners. -Demonstration of dissection parts of Hibiscus flower	-Dissect parts of Hibiscus flower, Worksheets-2 &3	

K **WORKSHEET-1** **W** **L** **W** **What I *know***	Let child write the information about what he/she knows about the unit, in this space. **What I *want to know*** Let the student write the information	about what the he/she wants to know through this unit, in this space. **What I *learned*** After the completion of the unit , let the student write the	information that he/she has learned, in this space. **What I *wonder about*** *Let the student write about what he/she still wonders about after the unit, in this space.*

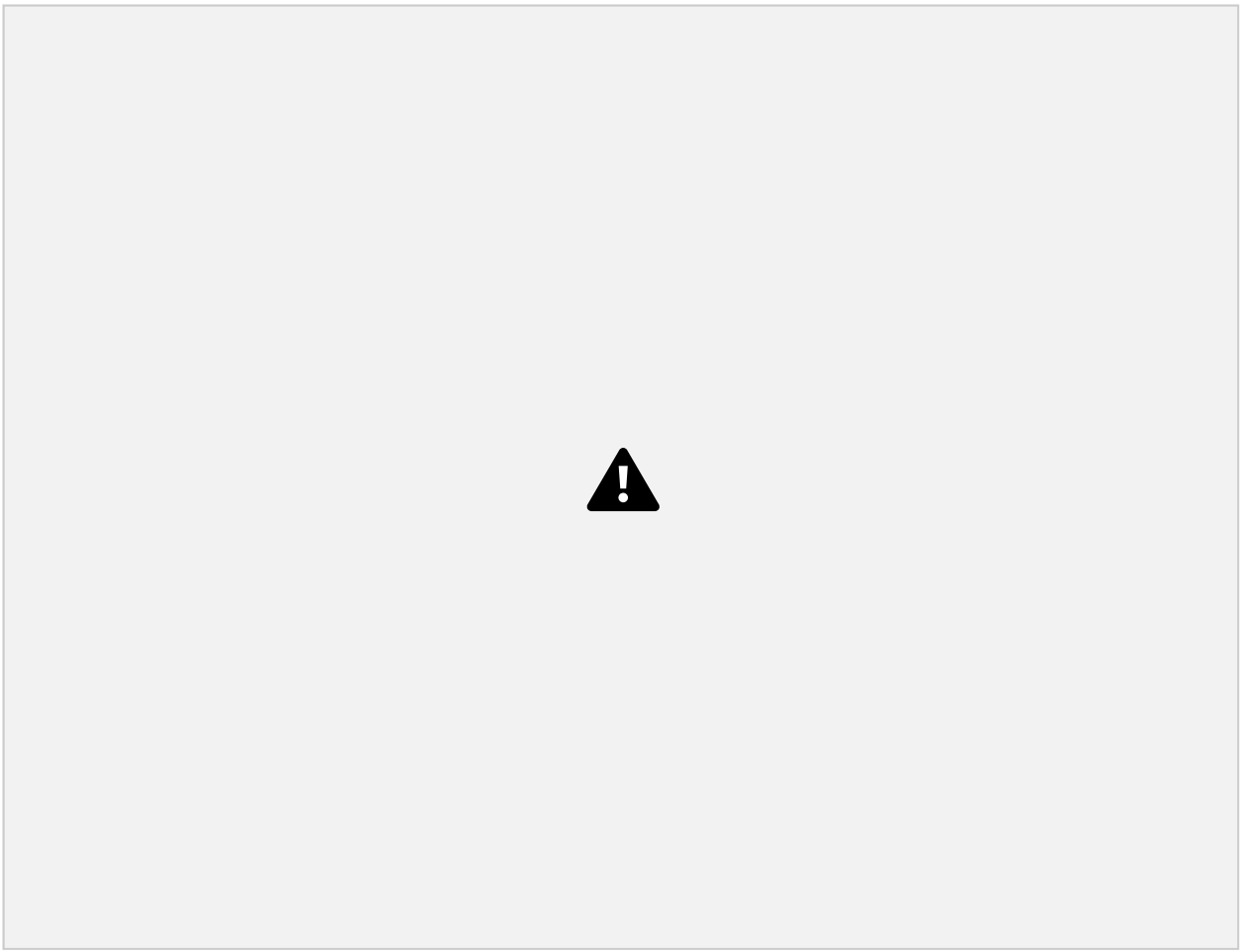
WORKSHEET-2

GROUPACTIVITY

Examine the parts of the flowers with your group and fill outthe worksheet given below.

Draw partsof the flower	Name the parts of flower	State the functions of each part in your own words.

WORKSHEET 3



http://www.scribd.com/doc/8023314/Science-Lesson-Plan-Topic-Flower#scribd

http://printableworksheets.in/?dq=Flowering%20Plants

Handout HO4C

Planning for teaching: Planning Learning outcomes & Pedagogy

1. With reference to experiential learning activity performed by you, prepare learning outcomes incorporating competencies based on domains of Bloom's taxonomy and the 21st century competencies.

-
-
-
-
-
-

2. Interdisciplinary approach - Specify some concepts that can be related to the activity and which cut across different subjects.

Activity – 5A

Assessment

Time: 25 minutes

Material required:
• Handout HO5A – Preparation of assessment worksheet

Learning outcomes:

Participants will be able to

- frame questions to assess different cognitive skills along with the content (based on Learning outcomes)
- prepare rubrics to assess the students' learning.
- promote transparency in assessment by asking students to do self-assessment based on rubric provided.

Mode- Individual activity

Process:

RP will ask Participants to

- Prepare a worksheet having questions incorporating each learning outcome ranging from 'remembering' to 'creating' on the content covered. This will help teacher to assess the content as well as competencies he/she has consciously incorporated in the learning outcomes. Handout HO5A

Handout HO5A

Time: 10 mins Activity No.-

Prepare Assessment worksheet reflecting assessment of competencies as well as content mentioned in the learning outcomes

Activity 5B

Making of Rubrics

(Guided Activity)

Time: 20 minutes

Outcomes:

Participants will be able

- To identify the key components of a rubric
- To prepare a rubric for assessment of hands on activity.

Material: Handout HO5B –Making Rubrics

Mode: Individual Activity

Procedure:

- *Introduce the word 'rubrics' and explain them the steps of constructing rubrics with the help of an example.*
- *Ask participants to refer to Hand out4 b–Making Rubrics.*
- *Ask participants to highlight key points while reading.*
- *Encourage one or two participants to present the key points to the larger group.*

Plenary:

Participants will present the key points in formation of rubrics.

Handout HO5B

Making Rubrics

According to Heidi Andrade's, "*Rubrics is a document that articulates the expectations for an assignment by listing the criteria, or what counts, and describing levels of quality from excellent to poor".*

Rubrics are specific guidelines with criteria to evaluate the quality of student work, usually on a point scale. They are used to grade students' performance on predefined criteria. It is a scoring guide for the teachers to evaluate their work or the acquired skills. *The main purpose of rubrics is to assess performances.*

Rubrics, when used as a part of Formative Assessment, help teachers to teach well and help students to evaluate themselves and reflect.

Scoring rubrics include:

- one or more dimensions on which performance is rated **(Criteria)**
- definitions and examples that illustrate the attribute(s) being measured **(Descriptors)** •
- a rating scale for each dimension **(Levels)**

Effective rubrics have appropriate criteria and well-written descriptions of performance.

Format of a Scoring Rubric

Criteria	**Grade or Mark**	**Grade or Mark**	**Grade or Mark**	**Grade or Mark**
	Descriptor	Descriptors	Descriptors	Descriptors

While making a rubric, the teachers should keep in mind the learning outcomes of the task to be assessed. Then decide the criteria to be used for assessing the task done by the students. Lastly he/she should write the descriptors of the performance for different defined levels.

When rubrics are created and used correctly, they are strong tools that support and enhance classroom instruction and student learning.

Students should be given rubrics at the beginning of an assignment because rubrics not only are valuable to teachers for consistent grading but are helpful to students as well. *"Instructional rubrics make teachers' expectations very clear. Traditionally, we educators have kept our criteria and standards to ourselves. The answers to the test were secret, and teachers tended not to articulate what counted when they gave grades."* (Goodrich Andrade, 2000) The rubric of an assignment helps students to know what is expected of them. Rubrics allow students to self regulate themselves by empowering students to monitor their learning and evaluate their ownwork. Rubrics also provide students feedback about their strengths and weaknesses. (Goodrich Andrade,

2000).

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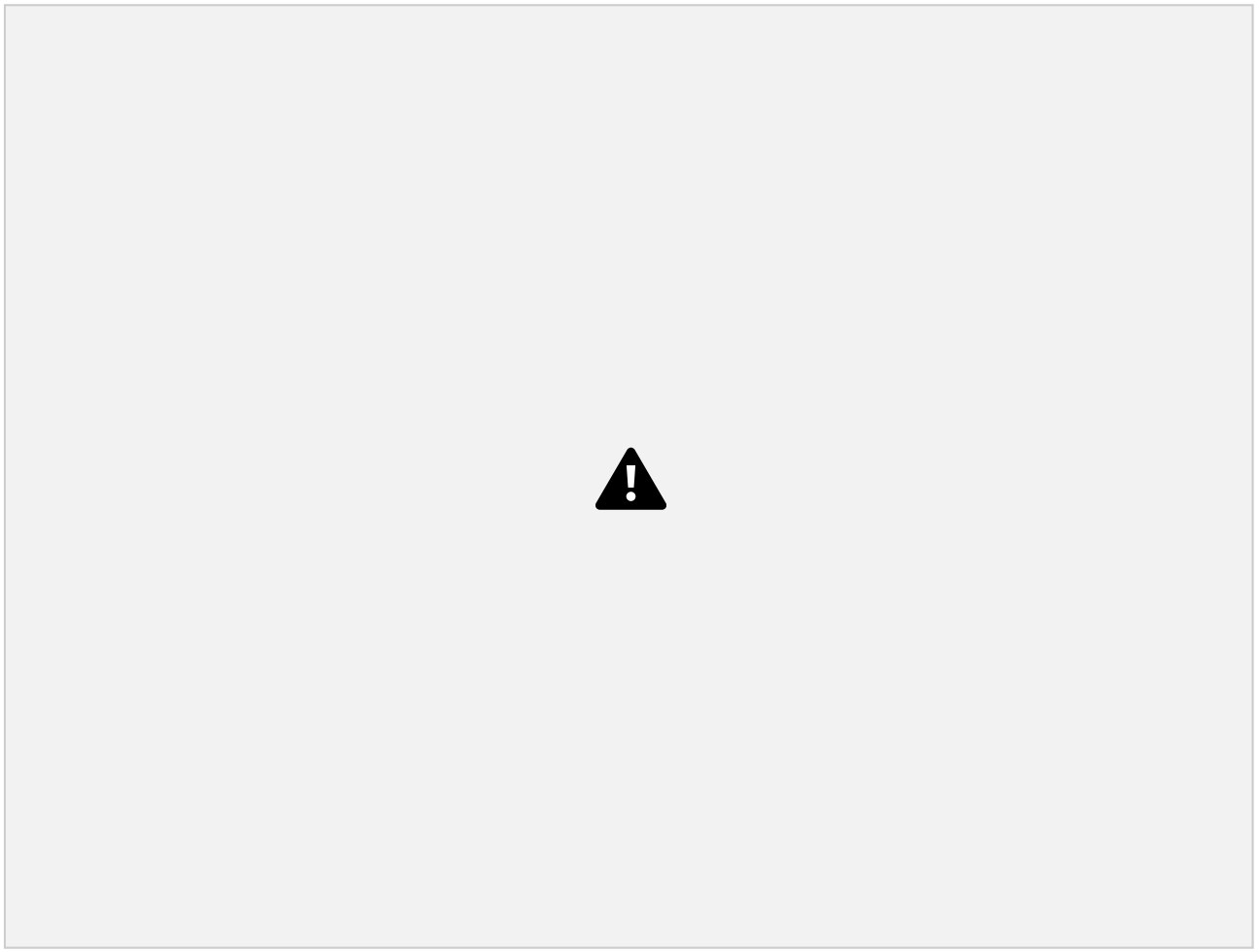
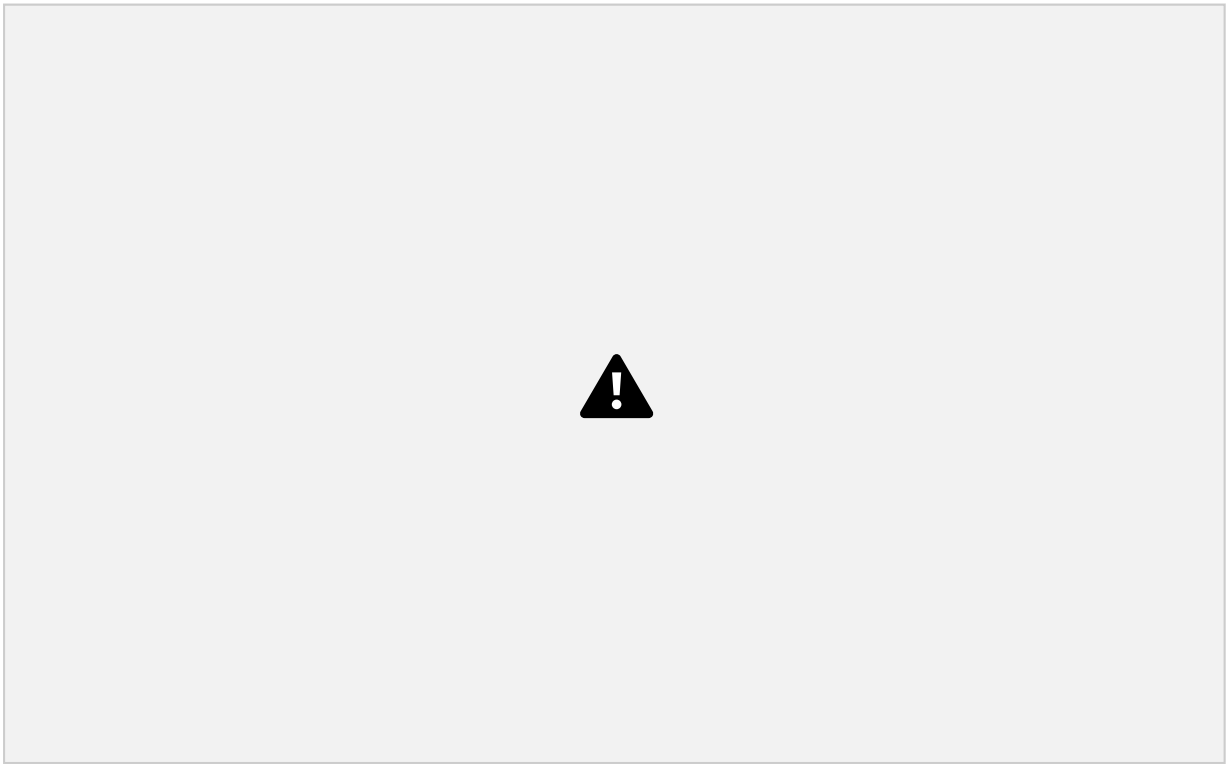
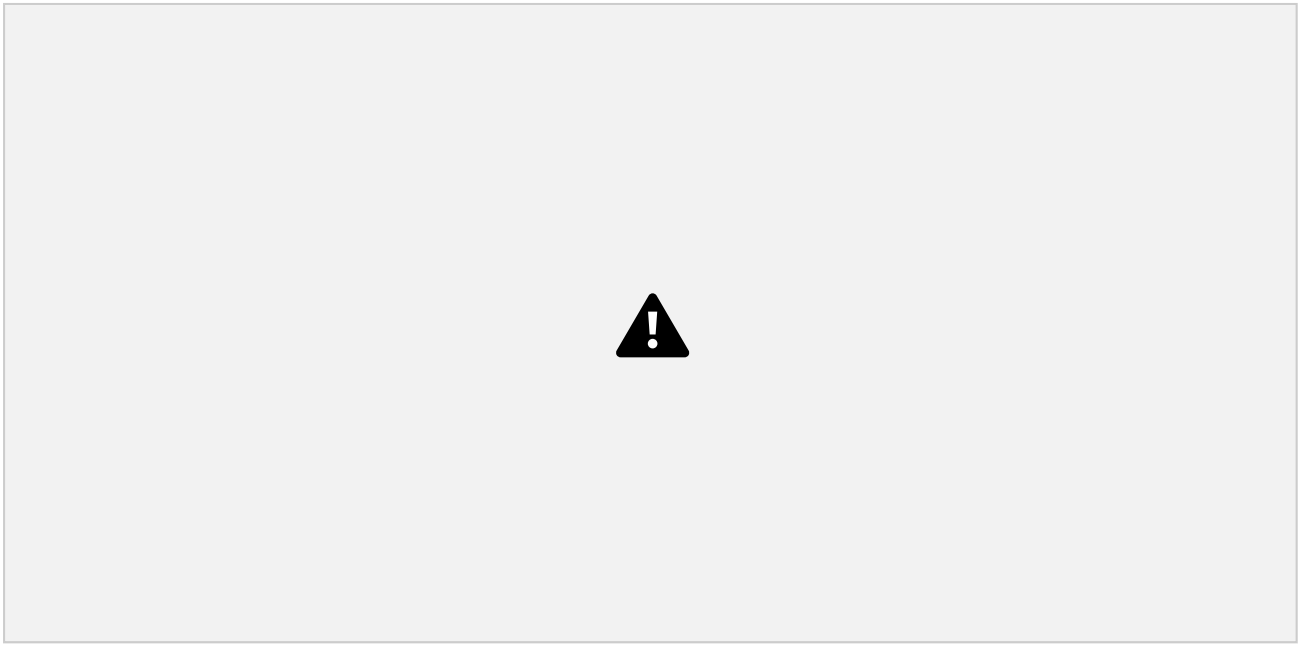
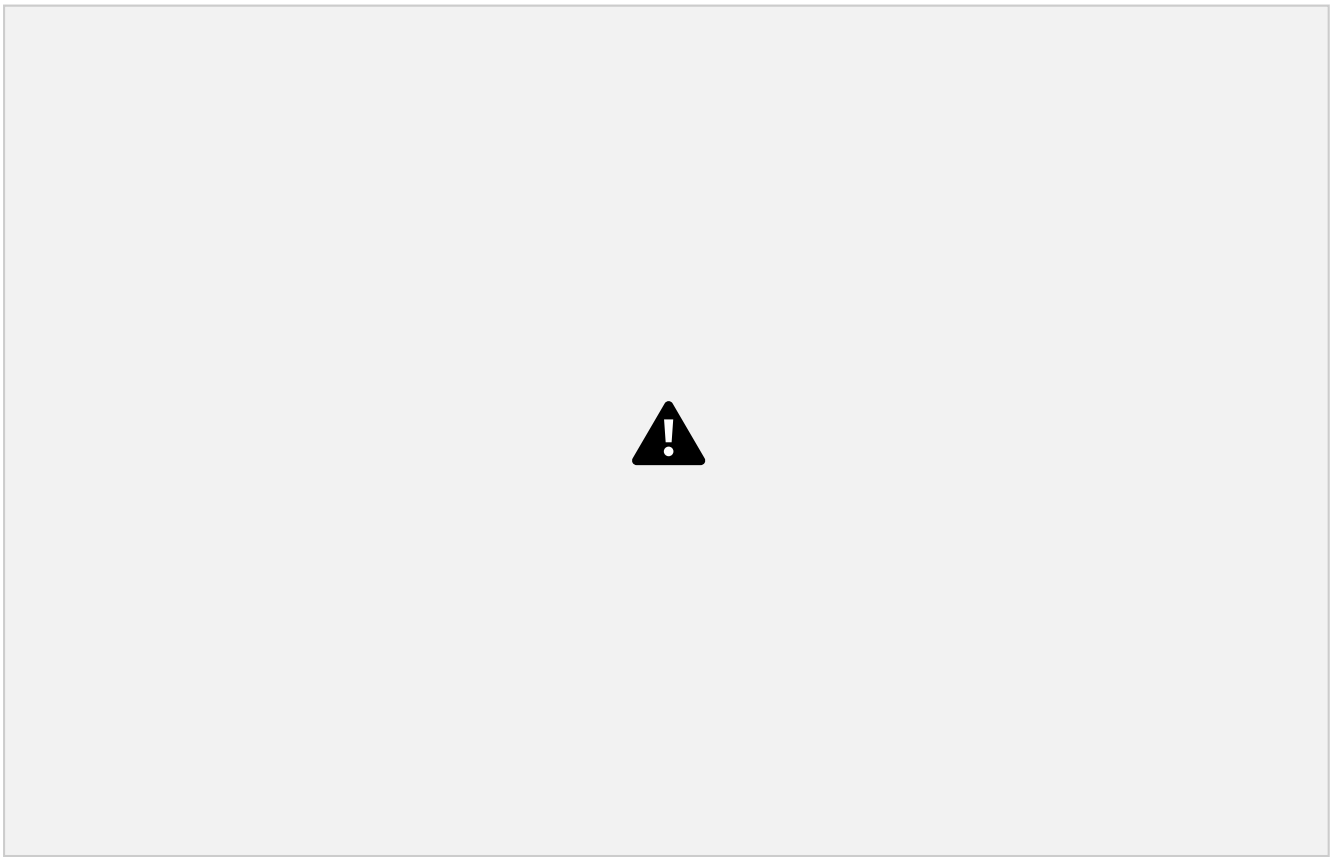
Final Presentation

An integration of all the four sessions.



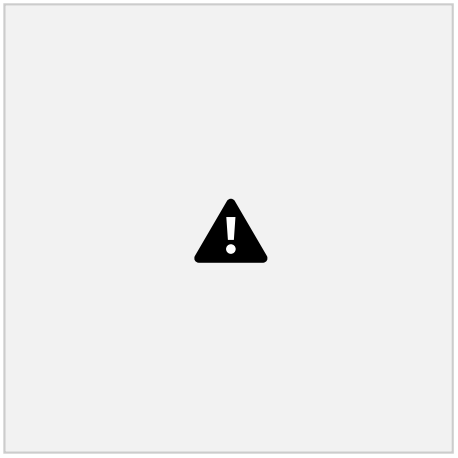






So the summation of all that have been presented goes like this.

Curriculum expectations and the learning out comes
Should be in synergy making a neat lum-sum
Bloom's taxonomy is forever young
It just cannot remain unsung
The six cognitive domains must be given attention
It is all very easy no anxiety and no tension
Unless one experience what one learns
There is no benefit that the learning earns
Plan your work, then work your plan
Only then the famous dictum 'You will, you can'
Lesson plans are like a building's blueprint
A very open assertion not just a hint
Assessments in science must be very fine in mission
Error-free in content, context, concept and communication
And there must be oodles and oodles of activities
If those are not there, then it is a pity,
So my dear participants, it is time to put on your walking shoes.
The learners and the teachers are all ready to wash away their blues.



Materials Required

1. Printouts of all the handouts.

2. Paper

3. Pens

4. Straws

5. Bamboo fibres

6. Match sticks

7. Base boards

8. Weights (in grams)

9. Plastic bottles

10.A sharp object to drill

11.Beakers

12.Sucking straws

13.Spools of thread

14.Cellotape

15.Papers

16.Sketch pens

17.Ice cream sticks & rubber band

18.Pencils

19.Scissors