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TWO YEAR B.Ed. DEGREE PROGRAMME
(NON -SEMESTER)

SECOND YEAR

PEDAGOGY OF BIOLOGICAL SCIENCE – PART 2

STUDY MATERIAL BASED ON PONDICHERRY UNIVERSITY SYLLABUS
(WITH EFFECT FROM 2015-2016)

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SECOND YEAR SYLLABUS

PEDAGOGY OF BIOLOGICAL SCIENCE – PART 2

Unit 1: Approaches of learning Biological science

5E learning model – Expository approach - Collaborative - Activity based learning approach– Concept attainment – Experiential learning– Inquiry approach.

Unit 2: Community and learning resources

Learning resources from immediate environment – using community resources – Community based learning resources in teaching of science. – Field visit to botanical garden, Science Park and zoo - scientific Lab and its equipment

Unit 3: Teaching resources

Machine operated aids: Overhead projector, digital projector, smart interactive board.

Non– Machine operated aids:

Graphical aids: flash cards, charts, flip chart, graphs, pictures, poster, and cut–outs and its effective uses.

Display Board: chalkboard, bulletin, flannel, magnetic, peg board and its effective uses.

3D aids: objects, specimens, models.

Unit 4: Biology Laboratory

Location, planning, organization and maintenance-practical preparation – laboratory registers – safety in the lab – common accidents and first aid – practical ethics

Unit 5: Biology practical work

Organizing and importance of practical work – problems in conducting practical – guidelines for teachers, evaluation of practical work – practical record work in biology

Unit 6: Research in science education

Types of Educational research – Status of research in science education in India – Educational research and innovation committee – utilization of science educational research

Unit 7: ICT Resources in learning bio–science

Dale's Cone of Experience (modified) – Teaching Bio–science with**:** audio broadcast, educational television, multimedia: audio, slideshow, animated video, simulation, games, and e–picture/poster. – Blended learning**:** eBooks, web, wikis, Moodle, social networking. – ICT tool used in classroom – advantages of using ICT in learning–teaching processes.

Unit 8: Professional development of biological teacher

Professional development programmes of science teacher –seminar, conferences, online sharing – members of professional organization. –Teacher as a community of learners – collaboration of school with colleges and universities and other institutions – role of reflective practice in professional development. –Teacher as a researcher – action research in biological science– Special qualities of a science teacher.

Unit 9: Exploring Learners

Identification of Diverse learners in classroom-addressing the diversity of learners in the classroom.– Motivating learners to bring their previous knowledge into classroom – involving learners in teaching learning process – encouraging learners to raise and ask questions- and its techniques.

Unit 10: Tools and techniques of assessment of learning biological science

Performance based assessment techniques – assessment of project work – assessment of participation in collaborative learning. –construction of test items (open ended and structure) and administration of tests – developing assessment frame work. – continuous and comprehensive evaluation – assessment of experimental work. –Grading system and type – measures of central tendency – measures of variability – correlation**.**

UNIT - I

APPROACHES OF LEARNING BIOLOGICAL SCIENCE

DEFINITION

The 5e learning cycle is an instructional design model that defines a learning sequence based on the on the experiential learning philosophy of John Dewey and the experiential learning cycle proposed by David Kolb. Attributed Roger Bybee of the Biological Science Curriculum Study (BSCS), the model presents a framework for constructivist learning theories and can be effectively used in teaching science.

ENGAGE

In the first phase of the learning cycle, the teacher works to gain an understanding of the students' prior knowledge and identify any knowledge gaps. It is also important to foster an interest in the upcoming concepts so students will be ready to learn. Teache rs might task students with asking opening questions or writing down what they already know about the topic. This is also when the concept is introduced to students for the first time.

EXPLORE

During the exploration phase, students actively explore the new concept through concrete learning experiences. They might be asked to go through the scientific method and communicate with their peers to make observations. This phase allows students to learn in a hands -on way.

EXPLAIN

This is a teacher-led phase that helps students synthesize new knowledge and ask questions if they need further clarification. For the Explain phase to be effective, teachers should ask students to share what they learned during the Explore phase before introducing technical information in a more direct manner, according to "The 5E Instructional Model: A Learning Cycle Approach for Inquiry-Based Science Teaching." This is also when teachers utilize video, computer software, or other aides to boost understanding.

ELABORATE

The elaboration phase of the 5E Model focuses on giving students space to apply what they've learned. This helps them to develop a deeper understanding. Teachers may ask students to create presentations or conduct additional investigations to reinforce new skills. This phas e allows students to cement their knowledge before evaluation.

EVALUATE

The 5E Model allows for both formal and informal assessment. During this phase, teachers can observe their students and see whether they have a complete grasp of the core concepts. It is also helpful to note whether students approach problems in a different way based on what they learned. Other helpful elements of the Evaluate phase include self - assessment, peer-assessment, writing assignments, and exams.

Application and Effectiveness

The 5E Model is most effective when students are encountering new concepts for the very first time because there is opportunity for a complete learning cycle. According to co-creator Rodger W. Bybee, the

5E Model is best used in a unit of two to three weeks in which each phase is the basis for one or more distinct lessons. "Using the 5Es model as the basis for a single lesson decreases the effectiveness of the individual phases due to shortening the time and opportunities for challenging and restructuring of concepts and abilities—for learning," Bybee explains. And if too much time is spent on each phase, the structure isn't as effective and students may forget what they've learned.

Expository approach

Expository teaching strategy is basically direct instruction. A teacher is in the front of the room lecturing and students are taking notes. Students are being told (expository learning), what they need to know. However, expository instruction goes beyond just presenting students with the facts. It involves presenting clear and concise information in a purposeful way that allows students to easily make connections from one concept to the next. The structure of an expository lesson helps students to stay focused on the topic at hand.

Expository teaching is a teaching strategy where the teacher presents students with the subject matter rules and provides examples that illustrate the rules. Examples include pictorial relationships, application of the rules, context through historical information, and prerequisite information. Examples are provided to give contextual elaboration and to help students see the subject matter from many different perspectives.

Expository Teaching Procedure

Expository teaching is a lecture, presentation or telling strategy used during instruction. The teacher is in control of presenting the subject matter and directs the students through the lesson. A rule is presented with an example and then practice is provided. The teacher focuses the students' attention on

the key points of the subject and may use graphics, diagrams, or other representations to elaborate on the subject.

COLLABORATIVE APPROACH

Collaborative learning is based on the view that knowledge is a social construct.

Principles of CL

Collaborative activities are most often based on four principles:

- ✓ The learner or student is the primary focus of instruction.
- ✓ Interaction and "doing" are of primary importance
- ✓ Working in groups is an important mode of learning.
- ✓ Structured approaches to developing solutions to real-world problems should be incorporated into learning.

Advantages of CL

The benefits of collaborative learning include:

- ➢ 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.

Examples of collaborative learning

- ❖ Stump your partner
- ❖ Think-pair-share/ Write-pair-share
- ❖ Catch-up
- ❖ Case study
- ❖ Team-based learning

Group problem solving

ACTIVITY BASED LEARNING

Characteristics

- ✓ Under the system, the curriculum is divided into small units, each a group of Self Learning Materials (SLM) comprising attractively designed study cards **for English, Tamil, maths, science** and Social Science.
- ✓ When a child finishes a group of cards, he completes one "milestone". **Activities** in each milestone include games, rhymes, drawing, and songs to teach a letter or a word, form a sentence, do maths and science, or understand a concept.
- ✓ The child takes up an Exam Card only after completing all the milestones in a subject. On a common chart, the milestones are arranged in the form of a ladder and the child knows exactly which milestone he completed in the last lesson.
- ✓ This is a child-friendly way to evaluate and reinforce learning. If a child is absent one day, he/she continues from where he/she left unlike in the old system where the children had to learn on their own what they missed out on.

Advantages of Activity Based Instruction:

- ✓ The most important feature of activity based instruction is learning by doing. So this method of instruction can fulfil the natural urge of a growing child on one hand also can help them learn their lesson.
- ✓ The method also promotes better understanding of a lesson among students as they learn the lesson by practicing the task themselves.
- ✓ It inspires the students to apply their creative ideas, knowledge and minds in solving problems as well as promoting competitive spirit among them.
- ✓ It also helps learner psychologically as they can express their emotions through active participation in something useful.
- ✓ The method also helps in developing their personalities, social traits and inter-personal management skills.

Disadvantages of Activity Based Instruction:

- ✓ The activity based instruction method requires long-term planning with minute details of the whole process because before engaging the learners, the teacher has to make sure that all students have sufficient knowledge and skills regarding the task they are going to perform. So this method can not be used on a regular and daily basis as it involves a lengthy procedure.
- ✓ The objectives of the method can only be fulfilled if the planning of the lesson is flawless. If there is slightest flaw in the planning, this method would do more harm than good.
- ✓ Learners have varied levels of merit and understanding. So less meritorious students might not prepare for a task as other which might lead to failure of objectives of the whole process.
- ✓ Many renowned educationists also are of the opinion that the activity based method is more suitable for branches of experimental sciences and less useful for subjects of social sciences.

CONCEPT ATTAINMENT MODEL

Major Theorist : Jerome Bruner.

The term concept attainment is historically linked with the information processing model, this is completely based on the Jerome S. Bruner and his associates and that it is why the model is named as Bruner's concept attainment model.

Basic ideas from the work of Bruner (1960)

Our environment is full of tremendously diverse things and it would have been impossible to adjust in it if we had not been endowed with the capacity to discriminate, categories things in groups and form concepts.

A concept has three elements:

- ✓ Examples,
- ✓ Attributes, and
- ✓ Attribute values.

Each examples can be described in terms of its basic characteristics called attributes, and each attribute has an attribute value. For illustration, if the concept is 'apple' each fruit is an example. Here, pears and oranges are negative and apples are positive example. The colour may be an attribute and yellow or red may be the attribute values.

- ✓ In categorization or concept formation, although the concept of categories may differ from one culture to another; yet all sets of concepts are the product of the same through process.
- ✓ The categorization activity actually has two components
- ✓ The act of category formation (concept formation) and

- ✓ The act of concept attainment. The concept formation is the first step towards concept attainment.
- ✓ In concept attainment, the concept is determined in advance and the task is to determine the elements of the concept
- ✓ Concept formation and attainment differ significantly in terms of thinking process and consequently require different teaching strategies.
- ✓ In identifying the strategies used to attain concepts, a distinction should be made between the two learning conditions of selection and reception.

The reception models of concept attainment are as follows:

The concept attainment model facilitates the type of learning referred to as conceptual learning. In practice, the model works as an inductive model designed to teach concept through the use of examples. Therefore, in addition it helps the students in the attainment of a particular concept.

Syntax:

The sequence of the phase and activities covering the concept attainment model may be outlined as in table:

SYNTAX OF THE CONCEPT ATTAINMENT

Phase one – presentation of data and identification of the concept (activities)	➢ Presenting examples with 'yes' or 'no' labels in a pre-arranged order by the teacher. ➢ Comparing attributes in positive and negative examples. ➢ Generating and testing hypotheses ➢ Naming the concept

	➢ Stating the rule or definition of the concept according to its essential attributes.
Phase two-testing attainment of the concept(activities)	➢ Correctly identifying additional unlabelled examples of the concept as "yes" or "no". ➢ Generating own examples
Phase three-analysis of thinking strategies (activities)	➢ Describing thoughts ➢ Discussion of hypothesis and attributes ➢ Discussing type and number of hypotheses ➢ Evaluating the strategies

Principle of reaction:

The important principle of reaction is the teacher is to remain supportive of the student's hypotheses, has to maintain record by keeping track of the hypotheses (concepts), has to remain supportive for turning the students' attention towards analysis of their concepts and strategies, has to encourage analysis of the merits of various strategies.

Social system:

In most part of the teaching, the teacher has to exercise control over the social system. He has to present examples in such a way that the attributes are clear and are, indeed, both positive and negative examples of the concept.

Application context:

The concept attainment model proves an excellent way(based on inductive reasoning and systematic thinking) to teach concept through the use of examples.

Types of concept attainment

1. Reception model
2. Selection model

DIFFERENCES BETWEEN RECEPTION AND SELECTION MODEL OF CONCEPT ATTAINMENT:

Reception Model	Selection Model
Highly structured	Unstructured
Controlled by teacher	Autonomy, more freedom and controlled by students.
Initially two examples are provided	All the examples are displayed to the students from beginning of the activity.
All the examples are labeled	All the examples are unlabelled
Sequence of the examples presented is decided by the teacher.	Sequence of the examples are decided by the teacher.
Examples provided by the teacher.	Students using their own example.
Less students responsibility.	More students responsibility.

EXPERIENTIAL LEARNING

1. Experiential learning and reflection

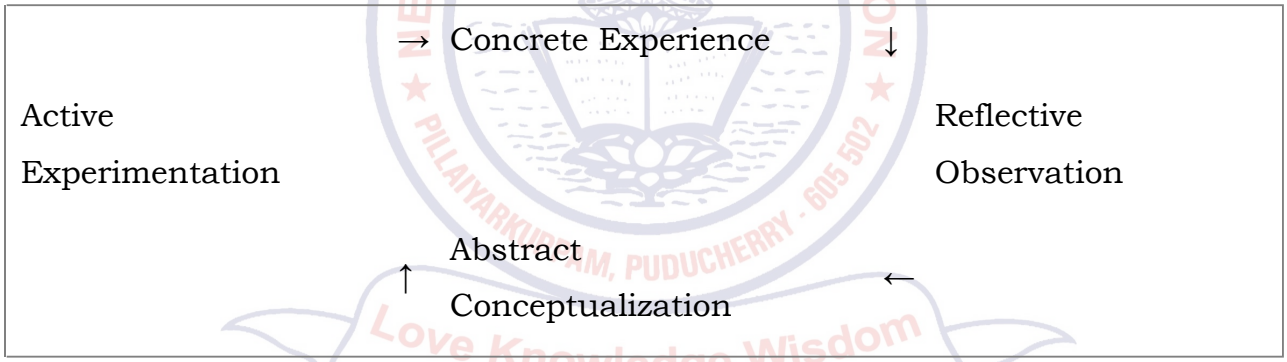
Experiential learning is the process of learning through experience, and is more specifically defined as "learning through reflection on doing". Experiential learning is distinct from rote or didactic learning, in which the learner plays a comparatively passive role. It is related to but not synonymous with other forms of active learning such as action learning, adventure learning, free choice learning, cooperative learning, and service learning.

Experiential learning

KOLB EXPERIENTIAL LEARNING MODEL

Experiential learning focuses on the learning process for the individual.

Figure 1 – David Kolb's Experiential Learning Model (ELM)



Elements of experiential learning

Kolb states that in order to gain genuine knowledge from an experience, the learner must have four abilities:

- ✓ The learner must be willing to be actively involved in the experience;
- ✓ The learner must be able to reflect on the experience;
- ✓ The learner must possess and use analytical skills to conceptualize the experience; and
- ✓ The learner must possess decision making and problem solving skills in order to use the new ideas gained from the experience.

Importance of Experiential learning

- ✓ Experiential learning teaches students the competencies they need for real-world success.
- ✓ Experiential learning motivates students.
- ✓ Experiential learning creates self-directed learners.

INQUIRY APPROACH

Inquiry-based learning (also enquiry-based learning starts by posing questions, problems or scenarios—rather than simply presenting established facts or portraying a smooth path to knowledge. The process is often assisted by a facilitator.

Steps :

- ✓ Creating questions of their own
- ✓ Obtaining supporting evidence to answer the question(s)
- ✓ Explaining the evidence collected
- ✓ Connecting the explanation to the knowledge obtained from the investigative process
- ✓ Creating an argument and justification for the explanation

Advantages

- ✓ Reinforces Curriculum Content
- ✓ "Warms Up" the Brain for Learning
- ✓ Promotes a Deeper Understanding of Content
- ✓ Helps Make Learning Rewarding
- ✓ Builds Initiative and Self-Direction
- ✓ Works in Almost Any Classroom
- ✓ Offers Differentiated Instruction

UNIT - 2

COMMUNITY AND LEARNING RESOURCES

LEARNING RESOURCES FROM IMMEDIATE ENVIRONMENT

Immediate environment

It describes the environment which is closest and easily available environment to the human being for example family, domestic animals, local plants and locally available non-living things.

Importance of using immediate environment as resources

- Easy to understand the concepts.
- One can develop self employment.
- Develop independent learning.
- Implement the education in our day today life.
- Teaching will be more interesting & fun.
- No need to prepare teaching learning materials, so economy is not a problem for learning.
- Reflective learning will occur.
- It may bridging the gap between educational institution and society.

USING COMMUNITY RESOURCES

DEFINITION

Community Resources are assets in a community that help meet certain needs for those around them. These assets can be people, places or structures, and community services. These resources can be essential in developing skills post-discharge by helping the student diversify their range of outlets of support, expression and natural self-development.

LIST OF COMMUNITY RESOURCES

- Botanical gardens
- Zoos
- Sanctuaries
- National parks
- Science parks
- Planetarium
- Nature like mountain, river, forest,etc.
- Herbal garden
- Fruit garden
- Block Development Offices
- Government offices
- Biosphere reserves
- Museums

ADVANTAGES OF USING COMMUNITY RESOURCES

- Taking students on field trips or using other community resources in their classes is not a new idea for teachers. Often, however, these experiences are thought to be frills or rewards that compete with instructional time in the classroom.
- Curriculum reform in science and mathematics calls for a new look at using community resources.
- The national standards in science and mathematics suggest that good programs require access to the world beyond the classroom so that students will see the relevance and usefulness of science and mathematics both in and out of school.
- Changing the educational experiences of children by moving beyond the classroom walls can diversify the array of learning opportunities and connect school lessons with daily life and real problems.
- Away from the structure of the classroom, many characteristics of constructivism, a key idea in the current reforms, clearly emerge.
- Teachers always face the task of pulling together the diverse

understandings their students bring to the classroom. The use of community resources provides a shared memory for the class.

- Teachers can effectively develop interdisciplinary units with their students outside of the classroom.
- Community resources that can enhance mathematics and science learning include science centers to visit (museums, nature centers, interactive science centers, aquaria, gardens and zoos), places to explore that are unique to the local school (a nearby creek, pond, city street or business), people in the community, or materials that can be borrowed or purchased.

COMMUNITY BASED LEARNING RESOURCES IN TEACHING OF SCIENCE.

FIELD VISIT TO BOTANICAL GARDEN, SCIENCE PARK AND ZOO - SCIENTIFIC LAB AND ITS EQUIPMENT

Field Visit

A **field trip** or **excursion** is a journey by a group of people to a place away from their normal environment. When done for students, it is also known as **school trip**

The purpose of the trip is usually *observation* for education, non-experimental research or to provide students with experiences outside their everyday activities, such as going camping with teachers and their classmates. The aim of this research is to observe the subject in its natural state and possibly collect samples. It is seen that more-advantaged children may have already experienced cultural institutions outside of school, and field trips provide a common ground with more-advantaged and less-advantaged children to have some of the same cultural experiences in the arts.

Field trips are most often done in 3 steps: preparation, activities and follow-up activity. Preparation applies to both the student and the teacher. Teachers often take the time to learn about the destination and the subject before the trip. Activities that happen on the field trips often include: lectures, tours, worksheets, videos and demonstrations. Follow-up activities are generally discussions that occur in the classroom once the field trip is completed.

ORGANIZING A FIELD VISIT TO ZOO/ BOTANICAL GARDEN / SCIENCE PARK / SCIENTIFIC LAB

Steps To Planning a Field Trip

BEFORE THE TRIP

1. **Decide Where You are Going**

Choose a location that meets all of the criteria you have outlined throughout your selection process. The site should meet all learning objectives, provide appropriate activities for the age and learning abilities of your students, be able to accommodate the number of students in your class, and be reasonably priced.

- Once you have officially selected a destination, you should get the name, phone number, and email address for a contact person at the site. This will make it easier to book the trip, once you have received the necessary approval.

2. **Ask Your Administrator**

Ensure that you're able to plan a field trip or if what you want to do is possible. Explain the educational value and the relationship to the curriculum of the grade level(s) that will attend.

- You will also want to clarify a date with the principal in order to ensure that the class trip does not conflict with any other mandatory school activities.
- Ask about emergency protocols while you're on the trip. Review the school's guidelines so you can be prepared.

3. **Arrange for Transportation**

Schools usually have different systems for organizing buses and transportation for field trips. You will either use an outside contractor or the regular school board buses. If you are using buses through the school board you will need to make sure that the field trip does not interfere with the bus driver's regular scheduled route.

- Regardless of the type of bus you use, you will need to clearly

communicate to the driver the proper addresses and times for pickup and drop off. You should also provide the number of people traveling, including chaperones and teachers.

- You should also introduce yourself as the class leader on the day of the trip and thank the bus driver for their work. Exchange numbers to stay in contact in case there are any changes on the day of the trip.

4. Decide On a Food Plan

Decide on where you will eat, and when. Here are some different options:

- **On site restaurant/cafeteria**: Sometimes the facility will have a restaurant or cafeteria on-site. This makes for easier supervision, but you are not sure of the food quality. The facility may even offer a special for groups coming in, so check with them to see if they do. This would be an easy option, because it could be done up ahead, and would save on waiting time.
- **Off-site restaurant**: The advantage of this is that it is usually popular with students. The disadvantage is that it isn't healthy, and may make it harder to supervise. It can also eat up an inordinate amount of time if you have a big group.

5. Plan Your Schedule

Plan your schedule for the day. Break it up into activities, and decide how long each one would take. Take into consideration the attention span and interests of the students. Try to plan a variety of activities that different types of students will enjoy. Plan very carefully, not allowing for time that is not planned for. This is when kids get into trouble: when they don't know what they are supposed to be doing. Your students are in a new environment; they will be excited, and you don't have your safe four walls to keep them in.

6. Arrange Your Supervision

You must decide how many adults you need in order to handle the children. This will vary depending on the behaviour of your students, as well as their age and maturity. Check with your administrator for permission to take the teacher's aide, and perhaps an extra teacher's aide on the trip.

You may need to ask for parent volunteers, as well. You may do this by calling up specific parents, by a letter, or by asking students to ask their parents, or in your regular communication you have with your parents (I.e.. communication book, newsletter, website, etc.) Go over your students and put into groups of no more than 15 (preferably less) and assign each adult a group. Make up a list of group members for each staff member, which you will use for roll call during the trip

Now that you have your itinerary planned out, and all the resources in place, you are ready to write your permission form letter.

7. Create a Permission Form

Obtain permission from your school board. Speak with a representative from your school board in order to gain access to standardized letters for parental permission as well as the standard trip planning package. If your school board has a trip planning package you will need to fill out all of the forms included in the planning package in order to get permission from the superintendent.

- This will vary between school boards. Talk with the principal or a senior colleague to determine the exact requirements associated with taking a class on a field trip.

Gain parental permission for each student. Each parent will also need to fill out a permission form in order for their child to attend the class trip. Permission forms should be sent out well in advance of the trip date in order to give families time to read over the forms, pay any costs associated, and arrange their schedules accordingly. Things to include on a permission form are:[6]

- Date and location of field trip as well as all transportation arrangements.
- Educational purpose of the field trip.
- Cost associated with the trip and date the money needs to be submitted.
- Information about meal arrangements.
- Trip schedule or list of activities for the day.
- Place for parental signature and contact information.

8. Decide Who's Allowed To Go

Decide who will be going on the trip. By this, I mean that you might require acceptable behaviour for a week before the trip. This is a good incentive for children, and it does stop a student from going who will be a behaviour problem and ruin for everyone else. Decide on will be done with the students that can't go on the trip (stay home? Go to another class? Library?) Check to make sure that another adult is responsible for him or her while you are gone for the day.

Have a backup plan. Decide what you will do if a student is absolutely defiant and refuses to listen and causes a scene. Hopefully, this doesn't happen, but decide ahead of time, just in case. You might an agreement that that child will go to the bus for a time to cool down. Decide whatever is appropriate, and let all the children know that there will be consequences for misbehaviour. Just like they do with parents at a grocery store, kids will sometimes see a public place as an opportunity to get away with as much as they can.

9. Tie in Your Field Trip to Your Curriculum

Decide what kind of assignment and learning you would like to tie in with this lesson plan. For some ideas for assignments to do before the trip, see this article. This may include pre-learning where you do some background reading on the place you are going, or on a related topic. You may also do some assignments while you are there. Also, see what the facility has for learning activities while there. Tell students that they have to do these because they are

part of their mark. Also, you can have follow-up activities and assignments. I have a lot of ideas for curriculum tie-ins, which I will save for another article.

DAY OF THE TRIP

- The day of the trip, try to arrive at the school a little earlier than usual to give yourself peace of mind.
- Check to make sure all students have their permission forms signed back in, and the money is collected.
- Have all students wait in their rooms until is time to go. Have an activity for them. If this relates to the trip, that's great. It might be a group game or a puzzle. The point is that they have something to do, because this time is one of anticipation for them, and you need a plan!
- When the transportation is ready, have students go the buses or cars, in groups. Don't have everyone go at once, unless you have a very small group.
- Assign each staff member a group, and give them their list. They will do roll call throughout the day. They do this either silently by just doing a visual check, or if it's a big group, call out their names.
- Give instructions at two times to make sure they are heard. Check for understanding by getting one of the students to repeat it. Treat this like the learning experience it is.
- Bring along some puzzle books and magazines to give out to students if you're going to be driving for more than half an hour.

AFTER THE TRIP

- When you return, conduct a closure activity on the field trip by asking students to explain why, where, how, and what was accomplished during their outing.
- Send thank you notes from the class and the teacher to the chaperons, bus driver(s), staff where visited, and the bus company. Even if the buses are

owned by your school district, you should still thank and commend the drivers for their contributions to the success of your event. In the primary grades, the students might dictate a letter to the teacher who writes it displayed for students to see, edit, and approve. Individual students may copy the letter and one may be selected to be sent or, in some cases, they may all be sent.

- Assess if the goals of the trip have been achieved.
- Assess the conduct of the class in terms of the standards set up before the trip. Discuss whether they listened attentively, stayed in a group, observed habits of courtesy... This assessment should always include favorable reaction as well as ways in which they might improve on subsequent trips. A list might be made of these suggestions for improvement and saved for review just before the next trip is undertaken.
- Utilize opportunities to draw upon data and experiences from the field trip in other subjects taught in the classroom.

IMPORTANCE OF FIELD TRIP

- **Real World Learning**

As teachers, a field trip is one of the best tools that we can use to provide every student with real-world experiences. Whether that's a trip to the local grocery store, waterfront park, a library, a museum, a theater, a community garden or a restaurant, each experience that a student participates in contributes to their understanding of the world.

When students leave the classroom, they see the connections between what is happening at school and in the 'real-world'. They begin to see that what they learn within the walls of the classroom can help them solve the problems they see in the world around them and can have a direct impact on who they become as people.

- **Access**

Students are able to access tools and environments that are not available at school. Our communities are rich learning laboratories. Field trips make it possible to take students to see an underwater ecosystem at an aquarium, participate in citizen science in a river, use high powered microscopes, see and touch historical artifacts in person and present on a public stage among hundreds of other things. Each experience solidifies learning and supports important academic concepts.

- **Socio-emotional Growth**

Students who go on field trips become more empathetic and tolerant. A study conducted by the University of Arkansas found that students that participate in a field trip to an art museum show increased empathy, tolerance and critical thinking skills. Studying art gives students a chance to think about a topic or theme from a different perspective.

- **Academic Impact**

Field based learning increases test scores. A recent study by Emilyn Ruble Whitesell showed that middle school students who participate in science field trips through the Urban Advantage program score better on the state science test. Field trips and hands on learning make concepts more memorable. Just think back to what you learned in school, the field trips you took, and what you learned on them are still some of the clearest concepts.

BOTANICAL GARDEN

DEFINITION

"A botanical garden is a controlled and staffed institution for the maintenance of a living collection of plants under scientific management for purposes of education and research, together with such libraries, herbaria, laboratories, and museums as are essential to its particular undertakings".

Each botanical garden naturally develops its own special fields of interests depending on its personnel, location, extent, available funds, and the terms of its charter. It may include greenhouses, test grounds, an herbarium, an arboretum, and other departments. It maintains a scientific as well as a plant-growing staff, and publication is one of its major modes of expression.

Contemporary botanic garden

A **contemporary botanic garden** is a strictly protected natural urban green area, where a managing organization creates landscaped gardens and holds documented collections of living plants and/or preserved plant accessions containing functional units of heredity of actual or potential value for purposes such as scientific research, education, public display, conservation, sustainable use, tourism and recreational activities, production of marketable plant-based products and services for improvement of human well-being.

REASONS TO VISIT A BOTANICAL GARDEN

1. **Access to Unique Plant Collections and Varieties:** At the heart of every botanical garden is its unique collection of plants, and the opportunity for visitors to get a close-up look at interesting plant species they may not otherwise be able to see. Some botanical gardens exist for the sole purpose of acquiring and maintaining large collections of regional native species (e.g. prairie plants, alpine plants, or desert plants). Others specialize in tropical plants, medicinal plants, rare and endangered species, or plants of historical significance.

2. **The Discovery of New Ideas and Information:** Botanical gardens work hard to instill an appreciation for the role plants play in supporting the Earth's ecosystem and the quality of human life. One way they do this is by offering a wide array of educational programs to their visitors. From basic gardening to botanical sketching, you'll find classes and plant-based education programs geared for every

interest and every age.

Workshops and lecture series cover topics ranging from bulb planting and plant breeding, to photography and how to make a rain barrel.

Many of the classes also have a family focus. At the Chicago Botanic Garden families can take weekend classes that investigate insects, make art out of plants, or learn how our favorite kinds of ice cream are flavored by plants. The Missouri Botanical Garden even offers an 8 week fitness class called "strollerobics." For botanical gardens that house libraries, visitors also gain access to thousands of plant-related books, periodicals, videos, DVDs, slides, and nursery catalogs.

3. **Inexpensive (or Free) Admission to Special Events:**Throughout the year, botanical gardens host numerous festivals and special events that are open to the public. These may include flower shows, art exhibits, concerts, plant sales, holiday-themed parties, book signings, or presentations from nationally or internationally known speakers. Many of these events are free to the general public, or at least free with the price of a membership.
4. **The Opportunity to Support Plant Conservation:**According to Botanical Gardens Conservation International, it is estimated that there are 270,000 plant species in the world, and one in eight are threatened with extinction. Current threats to plant diversity include habitat loss and degradation, the introduction of alien species, over-exploitation, pollution and disease, and global climate change. By visiting a botanical garden, not only are you are helping support the important conservation work being done to preserve and protect the world's plant species, but you're helping to address poverty and human well-being.

5. **A Temporary Escape from the Blahs:** Probably the best reasons to visit a botanical garden is to simply slow down and reconnect with the natural world. Got the winter gardening blues? Strolling through an indoor arboretum filled with blooming tropical plants can be a great elixir.

ROLE AND FUNCTIONS OF BOTANICAL GARDEN

- ✓ availability of plants for scientific research
- ✓ display of plant diversity in form and use
- ✓ display of plants of particular regions (including local)
- ✓ plants sometimes grown within their particular families
- ✓ plants grown for their seed or rarity
- ✓ major timber (American English: *lumber*) trees
- ✓ plants of economic significance
- ✓ glasshouse plants of different climates
- ✓ all plants accurately labelled
- ✓ records kept of plants and their performance
- ✓ catalogues of holdings published periodically
- ✓ research facilities utilising the living collections
- ✓ studies in plant taxonomy
- ✓ examples of different vegetation types
- ✓ student education
- ✓ a herbarium
- ✓ selection and introduction of ornamental and other plants to commerce
- ✓ studies of plant chemistry (phytochemistry)
- ✓ report on the effects of plants on livestock
- ✓ at least one collector maintained doing field work

SCIENCE PARK

DEFINITION

An area devoted to scientific research or the development of science-based or technological industries.

Major Objectives and Activities of Science Park:

- To inculcate inquisitiveness, sense of inquiry,scientific attitude and thinking by encouraging curiosity and questioning processes and creativity among visitors.
- To offer interactive and activity based learning environment.
- To evolve a two way channel of learning by adopting pedagogic concepts for indoor and outdoor exhibits and demonstrations and other training activities.
- To collect and disseminate information relating to mutual interaction of science, technology and society
- To promote and support innovative and experimental activities
- To assist, collaborate and organize training programmes/activities in the field of science popularization and communication.
- To help in the growth of Science and Technology awareness.
- To develop scientific temper amongst masses,especially the student folks.
- To make visitors learn seemingly complex scientific principles in an inquisitiveness generating and participative manner, that leads to questioning and self discovery.
- To make learning of science for visitors a joy.
- To make visitors aware about process of development of tools and technologies in a logical order and make them understand the role of S & T in evolution of

man in past, present and future.

- To develop in young generation, particularly in entrepreneurship and engineering oriented minds
  zeal towards experimentation, innovation and invention in a self expressive manner.

ZOO

DEFINITION

A **zoo** (also called an **animal park** or **menagerie**) is a facility in which all animals are housed within enclosures, displayed to the public, and in which they may also breed.

ADVANTAGES OF VISITING ZOO

While you visit zoo, you can get the following benefits. Those are:

- **Enhanced Language Development**

  As children walk around the zoo, they are exposed to words and concepts. It also encourages dialogue between parents, children and even siblings. While walking around with your child, it is important to label every animal and ask questions. This will help increase their vocabulary and comprehension skills.

- **Promotes Family Bonding**

  Visiting a zoo is the perfect way to spend a day together as a family. Grandparents, parents, cousins and siblings can all find something to enjoy at the zoo. One of my fondest recent memories is visiting the Turtle Back Zoo with my mom, grandmother and two boys. It was an exciting and magical day for everyone!

- **Attend Special Events and Activities**

  Many zoos offer exciting and educational activities and special events. For example, Turtle Back Zoo and Cape May County Zoo both offer night-time programs where visitors get a first hand look at how animals behave and interact at night. Other events may include conservation days and days

dedicated to specific animals. Seasonal events such as the holiday lights at Turtle Back Zoo and Zoo Boo at the Bergen County Zoo are also great events for families to enjoy.

- **Encourages Environmental Awareness**

Visiting a zoo helps children understand the importance of taking care of the environment as it has a significant impact on the lives and welfare of animals. Zoos also teach families about the importance of conservation and animal care. Children can especially learn about the impact humans have on animals at Popcorn Zoo as this zoo only takes in animals that are sick, elderly, abandoned, abused or injured. Visitors can learn the unique story about each animal as they walk around the zoo.

- **Offers Educational Programs**

Most zoos offer educational programming including camps that help children become more aware of animal behavior, care and conservation.

- **Great Exercise**

Most zoos cover a vast amount of land which allows for ample exercise. Space Farms Zoo, for instance, has wide open spaces including several hills which is perfect for getting the heart pumping. Many zoos also provide playground areas for children to work those gross motor skills while making new friends. My favorite zoo playground is the Prehistoric Playground at the Turtle Back Zoo.

- **Increase Academic Knowledge**

Even if you don't attend the educational programs, activities or special events, children will still absorb an insane amount of knowledge when visiting a zoo. They will use all of their senses to take in their surroundings and expand their understanding about animals and their environment. They will learn the way an animal smells, the sounds he makes, the way he feels and what he looks like. Zoos offer a true multi-sensory approach to learning!

- **Get Hands-On**

For many kids, and adults, the best way to learn is by doing and feeling. Many zoos offer petting and feeding areas which allow kids to truly immerse themselves in the animals lives. The Turtle Back Zoo also offers an amazing Touch Tank where visitors can touch live sharks and stingrays. It is an experience the kids will not forget!

- **Sparks Curiosity**

As soon as a child enters a zoo, their eyes widen and the wheels start turning. "Mommy can I see that animal?" "Mommy where does that animal come from?" "Mommy can I take that one home?" Kids are innately curious which allows them to learn and take in their environment. Zoos encourage curiosity thus encourage learning and brain development!

- **Allows for Exploration and Self-Discovery**

What I love most about the zoo, is that it allows children to explore their environment and make new discoveries. This all leads to cognitive, language, motor and academic growth. While exploring a zoo, children go on a wild adventure full of running around, asking questions and engaging in story telling

SCIENTIFIC LAB

Definition

Science is a practical subject, teaching of which cannot be done properly only in theory form. For proper education of science, it is necessary to conduct various kinds of experimental works, which are practical in nature.

These practical functions cannot be carry out in absence of scientific apparatus and equipments. The place where various kinds of scientific apparatus and equipments are arranged in systematic manner is called science laboratory.

Science laboratory is central to scientific instructions and it forms essential component of science education.

It is in this place that various kinds of practical works are carry out by the students. Without proper and well- equipped science laboratory, it is not possible to carry out the science teaching process effectively in any school or educational institution.

Students learn to handle various apparatus and to think independently in the laboratory, because of which it is considered to be one of an important place. When students carry out various kinds of experiments, then they draw conclusions from their studies, which raise their level of self confidence and develop scientific attitude among them.

These are considered to be main objectives of science teaching, for which it is considered by experts that without a well equipped and organised scientific laboratory, there cannot be any proper teaching of science. Students should be encouraged by the science teacher to make active parts in various experimental processes, as most of the achievements of modern science are due to the application of experimental methods.

SCIENTIFIC LAB EQUIPMENT AND SUPPLIES

Laboratory equipment refers to the various tools and equipment used by scientists working in a laboratory:

The classical equipment includes tools such as Bunsen burners and microscopes as well as specialty equipment such as operant conditioning chambers, spectrophotometers and calorimeters.

Chemical laboratories

- laboratory glassware such as the beaker or reagent bottle
- Analytical devices as HPLC or spectrophotometers

Molecular biology laboratories & Life science laboratories

- Autoclave
- Microscope

- Centrifuges
- Shakers & mixers
- Pipette
- Thermal cyclers (PCR)
- Photometer
- Refrigerators and Freezers
- Universal testing machine
- ULT Freezers
- Incubators
- Bioreactor
- Biological safety cabinets
- Sequencing instruments
- Fume hoods
- Environmental chamber
- Humidifier
- Weighing scale
- Reagents (supply)
- Pipettes tips (supply)
- Polymer (supply) consumables for small volumes (µL and mL scale), mainly sterile

Laboratory equipment is generally used to either perform an experiment or to take measurements and gather data. Larger or more sophisticated equipment is generally called a scientific instrument.

IMPORTANCE OF SCIENCE LABORATORY

- ✓ In laboratory, it is possible to keep various scientific instruments and chemicals in safe and secure conditions, as without them, it is not possible to carry out any kind of experiment in any way.

- ✓ If there is proper of well equipped and properly arranged laboratory in the school, then students will get encouraged by it to take active part in the experimental processes as in such kind of laboratory, a congenial kind of atmosphere exist, which promote the interest of students in practical works.

- ✓ With the help of well equipped and organised laboratory, science teacher will get help in developing the scientific attitudes among the students to considerable extent.

- ✓ All the students have to carry out experiments collectively in the laboratory as often there is shortage of such facilities in schools. With such functions, spirit of co-operation and team work gets developed among the students and they begin to appreciate the work done by others. Not only this, through this, they also begin to appreciate the views and ideas of others, which help them in becoming successful in future life.

- ✓ When students themselves get the opportunity to take part in experimental processes, then their area of experiences get widen and their level of intuitiveness also gets developed, as a result of which, they become people with wide mentality and open- mindedness.

UNIT - 3

TEACHING RESOURCES

MACHINE OPERATED AIDS: Overhead projector, digital projector, smart interactive board.

Overhead Projector

An **overhead projector (OHP)**, like a film or slide projector, uses light to project an enlarged image on a screen. In the overhead projector, the source of the image is a page-sized sheet of transparent plastic film (also known as 'foils') with the image to be projected either printed or hand-written/drawn. These are placed on the glass surface of the projector, which has a light source below it and a projecting mirror and lens assembly above it (hence, 'overhead'). They were widely used in education and business before the advent of computer-based projection.

Uses in education

Overhead projector displaying a slide for note taking in a high school biology class. Overhead projectors were widely used in education and business before the advent of computer-based projection.

The overhead projector facilitates an easy low-cost interactive environment for educators. Teaching materials can be pre-printed on plastic sheets, upon which the educator can directly write using a non-permanent, washable color marking pen. This saves time, since the transparency can be pre-printed and used repetitively, rather than having materials written manually before each class.

The overhead is typically placed at a comfortable writing height for the educator and allows the educator to face the class, facilitating better communication between the students and teacher. The enlarging features of

the projector allow the educator to write in a comfortable small script in a natural writing position rather than writing in an overly large script on a blackboard and having to constantly hold their arm out in midair to write on the blackboard.

When the transparency sheet is full of written or drawn material, it can simply be replaced with a new, fresh sheet with more pre-printed material, again saving class time vs a blackboard that would need to be erased and teaching materials rewritten by the educator. Following the class period, the transparencies are easily restored to their original unused state by washing off with soap and water.

Digital projector

1) A digital projector, also called a digital projection display system, is a specialized computer display that projects an enlarged image on a movie screen. Such devices are commonly used in presentations.

There are two main types of digital projection display systems. The older, less expensive type employs three transparent liquid-crystal-display (LCD) panels, one for each of the primary colors (red, green, and blue). The light transmittivity of each pixel varies depending on the image data received from the computer. The light from a lamp is directed through the LCD panels, collimated using a lens, and projected onto a screen. The overall construction of the device is similar to that of a slide projector, where the "slide" consists of the three LCD panels placed close together near the focal point of the projection lens. Advantages of LCD technology include efficiency, ease of brightness and contrast adjustment, and high image resolution .

A newer, more expensive scheme is known as Digital Light Processing (DLP), a proprietary technology developed by Texas Instruments. In a DLP display, tiny mirrors are used instead of transparent panels. Each mirror represents one pixel. The light, rather than passing through the panel, is reflected from it. The mirrors move back and forth, varying the amount of light that reaches the projection lens from each pixel. Color is obtained by passing the light from the lamp through a rotating wheel with red, green, and blue filters. This subjects the mirrors to light at each of the primary colors in a rapid rotating sequence. The result is a color-modulated image that the human eye sees as natural color. Advantages of DLP technology include light weight, high contrast, and lack of pixelation.

2) The term digital projector is sometimes used for a program that facilitates the viewing of three-dimensional (3D), interactive, full-motion audio-visual files on a personal computer. Versions are available for both IBM-compatible and Macintosh computers, and can be downloaded from the Internet. They can be used as plug-ins for popular browsers for viewing animated Web-page content. For optimum performance on the Internet, a broadband connection should be used because of the high-speed, interactive nature of the content, and because the transmitted files are often large.

Smart interactive Board

The Definition

An interactive smart board, also known as an electronic whiteboard, is a classroom tool that allows images from a computer screen to be displayed onto a classroom board using a digital projector. The teacher or a student can “interact” with the images directly on the screen using a tool or even a finger.

With the computer connected to the internet or a local network, teachers can access information around the world. They can do a quick search and find a lesson they used previously. Suddenly, a wealth of resources is at the teacher's fingertips.

For teachers and students, the interactive white board is a powerful benefit to the classroom. It opens up the students to collaboration and closer interaction to the lessons. Multimedia content can be shared and used in lectures, keeping students engaged.

Interactive Boards in the Classroom

According to a recent article from Yale University, interactive lessons presented on a smart board or white board increased student engagement. The technology encourages active learning in students. Students asked more questions and took more notes, enabling more effective group activities like brainstorming and problem-solving.

More and more teachers are using smart board technology in the classroom. Here are five ways teachers are engaging with students using this technology:

1**. Presenting Additional Content on the Whiteboard**

The whiteboard shouldn't replace teaching or lecture time in the classroom. Instead, it should enhance the lesson and provide opportunities for students to better engage with the information. The teacher has to prepare additional materials that can be used with the smart technology before class starts – such as short videos, infographics, or problems the students can work on using the whiteboard.

2. Highlight Important Information from the Lesson

Smart technology can be used to highlight essential information as you work through a lesson. Before the lesson begins, you can outline the sections to be covered in class. As each section begins, you can break down the key topics, definitions, and critical data for students on the whiteboard. This can also include graphics and videos in addition to text. This will help students not only with note taking, but also to review future topics you will be covering.

3. Engage Students in Group Problem Solving

Center the class around problem solving. Present the class with a problem, then pass over the interactive whiteboard to the students to let them solve it. With the smartboard technology as the center of the lesson, students can better collaborate in the classroom. The digital technology unlocks the internet as they work, allowing students to connect the lesson to technology they use every day.

4. Answer Student Questions

Engage the students using the interactive whiteboard and questions from the class. Look up additional information or data using the smart technology. Write the question on the whiteboard and then work through the answer with the students. Let them see how you answer the question or pull in additional or data. When you are finished, you can save the results of the question and send it to the student in an email for later reference.

Smart board Technology in the Classroom

For schools struggling to connect students to classroom lessons, or keep students engaged, smart technology like interactive whiteboards is an ideal solution. An interactive whiteboard in the classroom provides students with the

technology they know and understand. It enhances collaboration and invites interaction with the lesson. Afterwards, students can see how the technology they use connects to the lessons they learn in school.

Non- Machine operated aids

It is a combination of graphic and pictorial material designed for the orderly and logical visualizing of relationships between key facts and ideas ex: comparisons, relative amounts developments, processes, classification or organization. It includes the following:

Graphical aids:

CHARTS

These visual symbols used for summarizing, comparing, contrasting or performing other services in explaining subject matter. A chart is a combination of pictorial, graphic, numerical or vertical material, which presents a clear summary.

Purposes:

- To visualize an item, it is otherwise difficult to explain only in words.
- To highlight important points.
- To provide outline for materials covered in presentation.
- To show continuity in process.
- For creating problems and stimulating thinking.
- For showing development of structure.

Types of charts:

- **Narrative chart:** Arrangement of facts and ideas for expressing the events in the process or development of a significant issue to its point of resolution or we can show an improvement over a period of years.
- **The cause and effective chart:** Arrangement of facts and ideas for expressing the relationship between rights and responsibilities or between a complex of conditions and change or conflict.
- **The chain chart:** arrangement of facts and ideas for expressing transitions or cycles.
- **The evolution chart:** facts and ideas for expressing changes in specific items from beginning data and its projections in to future.
- **Strip tease chart:**

    a. it enables speaker to present the information step by step

    b. It increases the interest and imagination of the audience.

    c. The information on the chart is covered with thin paper strips to which it has been applied either by wax, tape or sticky substance or pins.

    d. As the speaker wishes to visually reinforce a point with words or symbols, he removes the appropriate strip or paper.

    e. It produces interest.

    f. It increases learning and aids recall.

- Pull chart: it consists of written messages which are hidden by strips of thick paper. The message can be shown to the viewer, one after another by6 pulling out the concealing strips.
- Flow chart: diagrams used to show organizational elements or administrative or functional relationships. In this chart lines, rectangles, circles, are connected by lines showing the directional flow.
- Tabulation chart: it shows the schedule of an activity or of an individual ex: time-table of a class. These are very valuable aid in the teaching situation where breakdown of a fact or a statement is to be listed. Also it is a useful aid for showing points of comparison, distinction, and contrasts between two or more things. While making the table charts the following points must be kept in the mind.
    a. The chart should be 50 X 75 cm or more in size.
    b. The chart should be captioned in bold letters.
    c. The vertical columns should be filled in short phrases rather than complete sentences.

FLIP CHART: *a set of charts related to specific topic have been tagged together and hang on a supporting stand. The individual charts will carry a series of related materials or messages in sequence. The silent points of specific topic will be presented.*

FLASH CARDS

Definition:

"Flash cards are a set of pictured paper cards of varying sizes that are flashed one by one in a logical sequence."

Purposes:

1. To teach the students.
2. To give health education.
3. Useful for small group.
4. Used in group discussions.

Principles:

- The messages can be brief, simple line drawing or photographs, cartoons and the content will be written in few lines at the back of the each card.
- 10" X 12" or 22" X 28" is commonly used size.
- 10-12 cards for one talk can be used. It should not be less than 3 and more than 20.
- Prepare a picture for each idea which will give visual impact to the idea.
- The height of writing on the flash card is to be approximately 5cm for better visualization.

Using the flashcards:

For class room instruction, the flash card s is to be properly used. The following steps are used while displaying flash cards.

1. Give brief introduction about the lesson to students.

2. Give instructions to students about their actions while you flash the cards.

3. Flash the card in front of the class by holding it high with both your hands so that all the students can see it.

4. Let the student respond as per instructions already given.

5. Review the lesson by selectively using flash cards.

Advantages:

- Flash cards can be used to introduce and present topics.
- It can be used to apply information already gained by students to new situations
- It can be used to review a topic.
- Can be used for drill and practice in elementary classes
- To develop the cognitive abilities of recognition and recall of students.
- It can work as a useful supplementary aid and can be effectively used with other material.

Disadvantages:

- ❖ Can not be used for a large group
- ❖ Prone to get spoiled soon
- ❖ Preparation is time consuming.

POSTERS

Definition:

"Posters are the graphic aids with short quick and typical messages with attention capturing paintings."

Purposes:

- ✓ To provide general motivation.
- ✓ To create an esthetic or atmospheric effect.
- ✓ To communicate a more general idea. To thrust the message for leading to action.
- ✓ For the class room and community.

Preparation and rules:

- ✓ To do a special job.
- ✓ To promote one point.
- ✓ To support local demonstration.
- ✓ Planned for specified people
- ✓ Tell the message at single glance.

- ✓ Use bold letters.
- ✓ Use pleasing colors…
- ✓ It should place, where people pass or gather.

Features of a good poster:

- ❖ Brevity: message should be concise
- ❖ Simplicity: message should be easily understandable
- ❖ Idea: should base on single idea and it should be relevant.
- ❖ Color: suitable color and combination should be used to make the poster attractive and eye catching.
- ❖ Display: while displaying one should be sure to find a place where there is ad4equate light and where the larger population will see it.

Advantages:

- ❖ It attracts attention.
- ❖ It conveys the message very quickly.
- ❖ It does not require a detailed study.
- ❖ Good poster leads to action with good motivation
- ❖ It can stand alone and is self explanatory.

Disadvantages:

- ❖ Poster does not always give enough information
- ❖ When a poster is seen for longer time it may not attractive. So it should be dynamic

GRAPHS

Definition:

Graphs are the visual teaching aids for presenting statistical data and contrasting the trends or changes of certain attributes.

Method of preparation:

- ❖ Before making the bar chart makes a rough sketch of it in a note book.
- ❖ For drawing the bar graph use the chart paper of 50x 72 cm size.
- ❖ Use two different color shades for the two contrasting groups.
- ❖ The bars should be equi-spaced.
- ❖ Write the key to the bar graph in a box on the right hand side corner of the chart paper.
- ❖ Numbers specifying the magnitude of the bars should be on the top on the bars.

TYPES:

Pie graph:

These are called as circle diagram. The data are presented thorough the sections of portions of a circle.

- ✓ In determining the circumference of a circle we have to take in to consideration a quantity known as pie.
- ✓ The surface area of a circle is to cover 360 degree.

- ✓ The total frequencies or value us equated to 360 degree and then the angles corresponding to component parts are calculated.
- ✓ After determining their angle, the required sectors in the circle are drawn.

Bar graph:

The graphic presentation extends the scale horizontally along the length of bars. Each bar must be of the same width, height of the bar over a period represents the corresponding time of the variable. Graphs are available in 2 forms that is vertical and horizontal

Line graph:

To show the trends and relationships ex: single line shows the relation and the variation in the quantity. Quantitative data are plotted or when the data is continuous. The concepts are represented with the help of lines drawn either horizontally or vertically. The plotted points are connected to one another, instead of the base thus producing the curve.

Pictorial graph:

It is an out standing method of graphic representation. Pictures are used for the expression of ideal; they are more attractive and easily understood. Vivid pictures will be used to create rapid association with the graphic message; each visual symbol may be used to indicate quantity.

Pictures

Generally speaking, pictures, paintings, and other visuals constitute the most effective, most plentiful, and least expensive teaching medium. It is also the medium that is least utilized. There are good school-useful pictures in

abundance, almost anywhere you look. Yet, we as teachers are underutilizing this eminently useful resource.

The old saying that a picture is worth a thousand words may or may not be true. What is true, however, is that one appropriate picture can be a catalyst giving rise to the production of thousands of words and a multitude of creative and analytical thoughts.

Used appropriately and sequentially, pictures can not only illustrate a topic but also can provide the experience base children require in order to profit from reading and writing and from numerous other learning experiences, including those associated with art programming.

1. PICTURE AS A TEACHING AID

Easy to use and carry. And do not require electricity Inexpensive to produce or purchase/ can be reused Adaptable to many purposes Motivate students and depicts story Tremendous amount of information Can be found on books, magazines, newspapers, catalogs and calendars More realistic interpretation of symbols

CUT-OUTS

Cutout animation is a form of stop-motion animation using flat characters, props and backgrounds cut from materials such as paper, card, stiff fabric or even photographs. The props would be cut out and used as puppets for stop motion.

Uses

Farm Friends **cut-outs** are perfect for **use** in a variety of classroom displays and themes, including science, plants, animals, and life on the farm. They also make perfect decorations for a child's party.

DISPLAY BOARDS

Chalk board

A blackboard (also known as a **chalkboard**) is a reusable writing surface on which text or drawings are made with sticks of calcium sulfate or calcium carbonate, known, when used for this purpose, as **chalk**. Blackboards were originally made of smooth, thin sheets of black or dark grey slate stone.

Uses

Accessibility: In many developing countries, **chalkboards** far outnumber whiteboards because they are easier to access. ... They are very popular in education segments because the running cost of **chalkboards** is much less expensive compared to markerboards or glass boards. Chalk is also less expensive than markers."

BULLETIN BOARD

A bulletin board (pinboard, pin board, noticeboard, or notice board in British English) is a surface intended for the posting of public messages, for example, to advertise items wanted or for sale, announce events, or provide information. Bulletin boards are often made of a material such as cork to facilitate addition and removal of messages, as well as a writing surface such as blackboard or whiteboard. A bulletin board which combines a pinboard (corkboard) and writing surface is known as a combination bulletin board.

Bulletin boards can also be entirely in the digital domain and placed on computer networks so people can leave and erase messages for other people to read and see, as in a bulletin board system.

Bulletin boards are particularly prevalent at universities. They are used by many sports groups and extracurricular groups and anything from local shops to official notices. Dormitory corridors, well-trafficked hallways, lobbies, and freestanding kiosks often have cork boards attached to facilitate the posting of notices. At some universities, lampposts, bollards, trees, and walls often become impromptu posting sites in areas where official boards are sparse in number.

Internet forums are a replacement for traditional bulletin boards. Online bulletin boards are sometimes referred to as message boards. The terms bulletin board, message board and even Internet forum are interchangeable, although often one bulletin board or message board can contain a number of Internet forums or discussion groups. An online board can serve the same purpose as a physical bulletin board.

Magnet boards, or magnetic bulletin boards, are a popular substitute for cork boards because they lack the problem of board deterioration from the insertion and removal of pins over time.

Uses

Bulletin boards are a powerful learning tool for classrooms ranging from preschool to high school and beyond. They can be **used** to relay information to students, reinforce lessons, display student work, and more.

Flannel board

Covered in colored cloth, a flannel board is a beautiful way to teach very young children about the alphabet, allegorical tales and more. A flannel board, or felt

board, helps a child explore stories, use their imagination, improve fine motor skills and open up their creativity with shapes, colors and objects. Sturdy but covered in soft cloth, a flannel board is a benefit to small children as well as teachers who are looking for a way to change up typical teachable moments.

Uses

Teachers often reach for the flannel board to assist children with learning fables, the alphabet and how to count to 10 as well as by 10, the basics of a young child's curriculum. The visual aid assists with fine motor skills as well as increases the child's learning abilities. It can be used as a counting board, alphabet board, sorting shapes space and more. Little hands can manipulate the soft fabric easily on the flannel board.

MAGNETIC BOARD

Sheets of ferromagnetic material with specially-painted light surfaces on which material can be written or drawn using suitable markers or pens.

Uses

Magnetic boards serve a variety of purposes; they can be used for presentations, used as bulletin boards, as teaching aids, or even as personal organisers. They can be mounted on the wall, placed on an easel, or just propped up against the wall. They are easy to clean and need minimal maintenance.

PEG BOARD

a board having a regular pattern of small holes for pegs, used chiefly for games or the display of information.

Uses

One main use of a pegboard is to improve fine motor skills. For toddlers, this task does not come so easy. To grasp the peg and successfully place it in a small hole is a big accomplishment for most toddlers. Practicing and learning how to do this task improves hand-eye coordination and fine motor skills.

Another use of a pegboard is to teach early math skills. Math doesn't need to be taught by writing numbers down on a piece of paper, it can be learned by other means. With a pegboard, toddlers learn basic math skills such as matching and sorting by making patterns and placing pegs in a sequence. Toddlers will also learn other basic math functions such as counting how many pegs are on the board. This builds a foundation for future math skills that will be learned later in life.

Pegboards can also generate a lot of concentration. Manipulating pegs on a board can prove a challenge for most toddlers. A lot of focus is needed to make the connection and it can be very rewarding to manipulate the pegs right. Therefore, using a pegboard can increase concentration and independent play.

3D aids

OBJECTS

objects in classroom instruction by educators to improve students' understanding of other cultures and real-life situations. A **teacher** of a foreign language often employs realia to strengthen students' associations between words for common **objects** and the **objects** themselves.

Uses

As an addition to other forms of classroom materials, teaching with objects offe rs a direct, tactile experience for students. Teaching with objects is also a powerful way to facilitate concept learning, the skill of classifi- cation which helps children develop high levels of reasoning and assessment abilities.

SPECIMEN

An individual animal, plant, piece of a mineral, etc. used as an example of its species or type for scientific study or display.

Uses

They provide the means for establishing correct initial concepts in the minds of the pupils. Specimens. A specimen is a sample or a part of an object-for example, a piece of coal, a piece of marble, the skin of a bird, a leaf, or a piece of mineral.

MODELS

A model of teaching can be defined as the depiction of teaching and learning environment, including the behaviour of teachers and students while the lesson is presented through that model. Models of teaching are the specific instructional plans which are designed according to the concerned learning theories.

Uses

Models of teaching provide well-developed ways of teaching that guide the development of learning experiences and the identification of structures that support learning. Teaching models indicate the types of learning and outcomes that could be anticipated if they are used.

UNIT - 4

BIOLOGY LABORATORY

The Laboratory

A laboratory is a place that has controlled conditions in which scientific research, experiments, and measurement may be carried out. Scientific laboratories can be found in schools and universities, in industries, in government facilities, and even aboard ships and spacecraft

Location, planning, organization and maintenance

General Principles of Lab Construction

Laboratory design and construction plays an essential and critical role in ensuring that laboratories and associated areas are safe places to work and visit.

Safe design principles are fundamental to laboratory design. These principles consider the safety of those who construct, maintain, clean, repair and demolish a laboratory building or structure, as well as those who work in or visit the laboratory. Laboratory personnel, project managers, design managers, architects, engineers, and others involved in the laboratory design and construction process, have an important role to play in identifying health and safety risks that could arise throughout the life cycle of the laboratory building or structure and where practicable, eliminating or reducing risks during the design and construction phase.

Management of health and safety in laboratories is therefore an ongoing responsibility shared by a number of people who control the design, construction, use and maintenance of these areas.

Planning

School science laboratories are an expensive investment and are expected to last for many years. A poor design will impact generations of pupils, teachers and technicians." – The Association for Science Education.
Every classroom is important, but special attention should be given to the design of school science laboratories. If safety recommendations aren't adhered to then they can become unsafe.

In this article we will talk about the essential elements of a school lab, and also give you tips about which furniture and finishes are best for a safe, effective and clean science laboratory.

Pupil Practical Area

This is the area where students carry out practical experiments following demonstrations and instructions from the teacher.

As they spend most of their time in this area the furniture has to perfectly fit the needs of the students. The practical area consists of several components:

High tables or fitted benches – A surface where equipment can be laid out and experiments carried out safely, normally consisting of fitted benching or freestanding tables. Often, the tables are grouped around service pedestals for easy access to services. Fitted benching can be installed in many different ways, but the most common are in long rows or horseshoe shapes islands.

Make sure students and teachers have easy access to gas, water, electricity and drainage in order to effectively carry out their experiments.

Storage is often underneath the work surface for space efficiency. Science laboratories often have a mixture of shelving, drawers and tray units for optimum storage.

The layout must allow teachers and pupils to move easily throughout the room. Safe working distances must be considered and an eye wash unit must be located within a 10 second walking distance.

Stools that suit the bench height should normally be supplied in plastic or wood finish for durability and safety

Fume cupboards – or fume hoods – are essential for the safety of the students and teachers when conducting experiments. Toxic fumes are evacuated through the fume cupboard protecting students from the chemical toxicity.

Pupil Theory Area

Depending on the school, and the size of the laboratory, it may be possible to have a practical space and a theory space. In the case of separate working areas, the theory area normally consists of freestanding classroom tables and chairs or stools, and the practical areas consists of fitted storage with services.

Teaching Area

The teacher should have everything needed to carry out demonstrations in front of the students; this includes a sink, access to gas and electricity as well as all the equipment needed. Moreover, the emergency cut-off and fire extinguisher should be near the teacher so they can react quickly to any emergency. The optimum layout comprises of a fitted demonstration desk with services and lockable storage located by a whiteboard.

Storage

Having the right furniture to store all of the equipment is crucial to keeping the lab clean. Some equipment can be dangerous to students and teachers if it is not stored safely, so here are some tips about what you should do to keep your science laboratory safe and clean:

Bags and coats: Should be placed near the entrance door away from the practical area. Pupils should each have enough space for their coat and bag without causing a potential trip hazard in the lab.

Science equipment: Many types of equipment such as Bunsen burners, mats and tripods should be stored in tray units or cupboards. Fitted furniture is the most popular choice of storage as it is space efficient and can be customised to fit any space.

Chemicals: Due to their toxicity, they should always be stored in dedicated chemical storage cupboards, clearly labelled and separated from the other equipment.

Work Surfaces

As they are used on a daily basis benches cannot last forever, but with good maintenance they usually last for more than 10 years. A good quality work surface should be durable, standing up to experiments on a daily basis for years. A bench surface needs to be resistant to:

Chemicals: The use of chemical products can damage a bench surface

Water: Water is often used during scientific experiments so the bench has to stand up to water and other liquids

Hot objects: Bunsen burners and other equipment which product heat can damage the work surface

Abrasion: A work surface needs to be scratch and impact resistant to withstand experiments over many years.

Here are three different desktop materials you could use:

SGL (Solid Grade Laminate) – Due to its excellent impact, wear and scratch resistance, this work surface is very durable and has a solid core. Its surface isn't porous and can be easily cleaned. Moreover, as it is chemical resistant, SGL is the perfect choice for science laboratories. This is the most cost-effective option

Composite Stone – One of the key elements of this specific material is its non-porous surface and its excellent chemical resistance. Damage can often be repaired by qualified tradesmen. Composite stone also possesses seamless joints which therefore prevent the build-up of dust and dirt in seam lines

Granite – This is made from natural material and as it is solid stone, it is very hard wearing and durable. It has excellent burn resistance and does not harbour bacteria. Granite is also highly resistant to impact and can handle large amounts of weight.

However, MFC (Melamine Faced Chipboard, also known as particle board) isn't recommended for science labs as it doesn't have good enough chemical and impact resistance. Therefore, be sure to choose your work surface according to your usage and budget to ensure you have the optimum furniture for your science laboratory.

Colour Scheme

When choosing a colour scheme for your lab, be sure to take into account how chemicals will affect the surface over time,

Black or dark worktops make it difficult to clear up chemical spills and darker worktops also show scratches worse.

Lighter worktops allow students to easily see what's on their bench when they are working with chemicals, so accidents can be avoided. Opting for an SGL work surface is best as this won't stain easily.

There is a wide range of colours available for cupboard doors to suit all requirements, whether you prefer a bright or classic space / environment.

Flooring

The floor surface has to be taken into account in order to prevent injuries as spilt water or chemicals could be a potential hazard in a laboratory. Here are a few things to consider when choosing the floor surface.

The floor area should be at least $90m^2$

Vinyl is resistant to most chemicals, and is the standard laboratory material as carpet is not practical and tiles can become slippery

Vinyl in a lab needs to pass a pendulum test of greater than 36 for slip resistance (or R10)

The flooring could be used to denote practical and theory areas

It should be laid in sheets for safety and ease of cleaning.

Layout and Traffic Flow

Safe minimum working distances apply to science laboratories to ensure safety, this is especially important when students are working with potentially dangerous equipment.

Experts will have knowledge of safe and efficient traffic flow and can advise on the best layout for a laboratory.

For example, a physics lab might have a mixture of fitted storage and freestanding tables that can be moved to one side when conducting experiments.

Professionals can help you to create a bespoke layout – however, there are certain layouts or benching designs which have been proved to work well and are often adapted to other school layouts.

Organization

- Keep all your pipettes and tools on the side of your dominant hand.
- Place the trash bin on the same side.
- Set common solutions at the other side of the bench.
- Stow stock solutions and less commonly used solutions or devices on the upper shelves.
- Keep a minimal set of stands and tip boxes piled at the center and back area of the bench to maintain a centralized empty space.
- Lay your lab notebook as far as possible from the experimentation area and potential chemical spills. (Consider the dollar value of the data inside it.)
- Retain your own scissors, labeling tape, paraffin, Kimwipes, as well as a marker. This eliminates the most frequent walks around the lab and

encourages good labeling habits at the bench. (It's not a bad idea to write your name on these items, too.)

Maintenance

1. Cleaning

Regular cleaning of lab equipment ensures that it is ready for use when needed, that stubborn stains/substances do not get a firm hold, and that experiments are not contaminated by impurities carried over from previous experiments.

Make certain that;

- The equipment is always cleaned before and after each use.
- Cleaning reagents and cleaning aids used are specific for laboratory equipment care.
- In addition to cleaning lab equipment before and after each use, a schedule is required for more in-depth cleaning. This might involve dissembling certain machines to clean hard-to-reach parts.
- Always follow instructions from the manufacturer on cleaning policy. Certain parts of the equipment might require very specific solvents, cleaning materials, or drying procedure.

2. Calibration

Calibration involves comparing the measurements of an equipment against the standard unit of measure, for the purpose of verifying its accuracy and making necessary adjustments. Regular calibration of laboratory equipment should be done because over time, biases develop in relation to the standard unit of measure. This guards against invalid data and ensures safety during experimentation. An independent specialist, that can provide calibration certificates where necessary, should be engaged in the process.

Calibration should be done when;

- The recommended time by the manufacturer elapses.
- The equipment is hit by a force, dropped on the ground, or involved in any accident or an event of safety concern.
- There are unusual patterns or sounds while the equipment is in use.
- Measurements obtained are questionable.
- Highly critical measurements, where data accuracy is of utmost importance, are to be carried out.

3. Repairs and Refurbishments

Lab equipment is generally costly and repairs and refurbishment prolong the lifespan of equipment, saving the lab the expense of new purchases.
The following are points to consider;

- Repair and/or refurbish faulty or worn out lab equipment without any delay. Faulty machines may stop working suddenly in the middle of an experiment leading to loses and they can also be a source of safety concerns.
- Minor repairs can be done by a dedicated staff, while major repairs should be directed to specialist with knowledge on the specific machine or equipment.
- Refurbish old equipment to give them a new lease of life by cleaning thoroughly, polishing where necessary, lubricating movable parts, and replacing small worn out bits.

4. Quality Replacement

Equipment that cannot be repaired or refurbished should be replaced. It is advisable to buy equipment from well known sources that can guarantee quality and offer technical support. High-quality lab equipment is easier to maintain and its durability translates to reduced costs in the long term. Non-faulty equipment that is too old should also be replaced, while some wear and

tear might not be noticeable during its operation, outdated machines are not reliable and technical support in terms of servicing and acquisition of spare parts may be limited.

The care and maintenance of laboratory equipment should be a routine and embedded within the standard operating procedure of the lab. This will ensure that the life span of the equipment is prolonged and data collected within the laboratory is reliable.

Practical preparation

- Check with your course information to see if you are expected to do any preparatory work before the first class (e.g. look over your lecture notes on topic x)
- Check the guidance that your school / course provides about the safety equipment (such as lab coats or safety spectacles) or equipment that you are expected to buy and bring to your first class (such as a dissecting kit or drawing pencils)
- Health and Safety procedures in laboratory and practical environments are strictly adhered to and you will not be allowed to participate in the class if you are not correctly dressed or prepared. For example, if you have long hair you will be expected to tie it back.
- Turn up for your laboratory class in good time and be ready to work with a colleague or be assigned to a working group (this is common in laboratory classes)
- Listen and take notes from any initial briefing given at the start of the class. The demonstrator or teacher for the session may well try to steer you away from common difficulties or give you advice on how best to tackle the experiment.

- Plan ahead - read the schedule or protocol through before you start (ideally before you go to class) so you know what is required next and can be ready with equipment or materials when they are needed.

Laboratory registers

The records to be maintained in the laboratory are :

- Consumable stock register
- Permanent stock register
- Order register
- Breakable stock register
- Requirement register

1.Permanent stock register

It include all articles which are non breakable or non consumable Eg:

- Test tube racks
- Wooden stands
- Microscope
- Telescope
- Spectrometers
- Working and still models

2.Breakable stock register

It include the articles of glass ware like

- Flasks
- Test tube
- Beakers
- Pipettes
- Burettes
- Funnels

3.Consumable stock register

- Chemicals
- Acids
- Alcohols
- Distilled water
- Potassium permanganate etc

4.Order Register

Order sent for the purchase of new apparatus

5.Requirement Register

- This includes items required for this priority should be given to those of immediate need.
- The most appropriate method of collecting suggestions for new resources for the science staff, is to note the ideas in a required register

Safety in the lab

- Basic safety rules for laboratory conduct should be observed whenever working in a laboratory. Many of the most common safety rules are listed below.
- Know locations of laboratory safety showers, eyewash stations, and fire extinguishers. The safety equipment may be located in the hallway near the laboratory entrance.
- Know emergency exit routes.
- Avoid skin and eye contact with all chemicals.
- Minimize all chemical exposures.
- No horseplay will be tolerated.
- Assume that all chemicals of unknown toxicity are highly toxic.
- Post warning signs when unusual hazards, hazardous materials, hazardous equipment, or other special conditions are present.
- Avoid distracting or startling persons working in the laboratory.
- Use equipment only for its designated purpose.
- Combine reagents in their appropriate order, such as adding acid to water.
- Avoid adding solids to hot liquids.
- All laboratory personnel should place emphasis on safety and chemical hygiene at all times.
- Never leave containersof chemicals open.
- All containersmust have appropriate labels. Unlabeled chemicals should never be used.
- Do not taste or intentionally sniff chemicals.
- Never consume and/or store food or beverages or apply cosmetics in areas where hazardous chemical sare used or stored.
- Do not use mouth suction for pipetting or starting a siphon.

- Wash exposed areas of the skin prior to leaving the laboratory.
- Long hair and loose clothing must be pulled back and secured from entanglement or potential capture.
- No contact lenses should be worn around hazardous chemicals – even when wearing safety glasses.
- Laboratory safety glasses or goggles should be worn in any area where chemicals are used or stored. They should also be worn any time there is a chance of splashes or particulates to enter the eye. Closed toe shoes will be worn at all times in the laboratory. Perforated shoes or sandals are not appropriate.
- Determine the potential hazards and appropriate safety precautions before beginning any work.
- Procedures should be developed that minimize the formation and dispersion of aerosols.
- If an unknown chemical is produced in the laboratory, the material should be considered hazardous.
- Do not pour chemicals down drains. Do NOT utilize the sewer for chemical waste disposal.
- Keep all sink traps (including cup sink traps and floor drains) filled with water by running water down the drain at least monthly.
- Do not utilize fume hoods for evaporations and disposal of volatile solvents.
- Perform work with hazardous chemicalsin a properly working fume hoodto reduce potential exposures.
- Avoid working alone in a building. Do not work alone in a laboratory if the procedures being conducted are hazardous.
- The PEL and the Threshold Limit Values (TLV) will be observed in all areas. If exposure above a PEL/TLV is suspected for an ongoing process, please contact EHS immediately.

- Laboratory employees should have access to a chemical inventory list, applicable SDSs, Department Laboratory Safety Manual, and relevant SOPs.
- Access to laboratories and support areas such as stockrooms, specialized laboratories, etc. should be limited to approved personnel only.
- All equipment should be regularly inspected for wear or deterioration.
- Equipment should be maintained according to the manufacturer's requirements and records of certification, maintenance, or repairs should be maintained for the life of the equipment.
- Designated and well-marked waste storage locations are necessary.
- No cell phone or ear phone usage in the active portion of the laboratories, or during experimental operations.
- Clothing made of synthetic fibers should not be worn while working with flammable liquids or when a fire hazard is present as these materials tend to melt and stick to exposed skin.
- Laboratory coats should not be stored in offices or break rooms as this spreads contaminates to other areas.
- Computers and instrumentation should be labeled to indicate whether gloves should be worn or not. Inconsistent glove use around keyboards/keypads is a source of potential contamination.
- Avoid wearing jewelry in the lab as this can pose multiple safety hazards.

Common accidents and first aid

- Test plumbed eyewashes weekly; keep a log.
- Remove chemical bottles from work area of Facilities personnel working in laboratories.

- Stock first aid kits with Band-Aids, 4X4 gauze, roller bandages, and ace bandages (no creams, ointments, etc.).
- Report minor injuries to Student Health Services (SHS) after first aid has been administered.
- Bypass Student Health Services and call 911 for serious injuries and true emergencies (fires, explosions, major spills, etc.).
- For Bleeding and Wound Care
- Wear clean gloves.
- Cover area with gauze (or clean paper towels).
- Apply pressure to bleeding area — have person sit or lie down.

If wound is large or person is dizzy or weak, call 911 to transport person to SHS or Emergency Room.

Burns – Heat/Chemical

Heat burns: Run cool water over area for 5 minutes, then report to SHS. If burn area is large, cover with a cool, wet cloth and call 911.

Chemical burns (acid or alkaline): Flush with large amounts of cool running water for 15 minutes. For small area, report to SHS. For larger area or if person is weak or dizzy, call 911 for transport.

Eye Splash Chemical

Flush with lukewarm (body temperature) running water; turn head side to side and have water run across both eyes. Flusheyes for at least 15 minutes before going for further treatment at SHS or Emergency Room.

Eye – Foreign Body (dust or metal, paint, wood chips)

Cover or close eye.

Report to EHS for evaluation.

Practical ethics

We derive humongous benefits from the sacrifice of millions of animals around the world. Yes, food is the obvious thing here, but there's more. Everything from makeup, to glue, to life-saving medication is in one way, shape, or form derived from the sacrifices of animals, including biological studies on animals. Here you're going to learn about the basic ethical guidelines and regulations regarding the humane procurement and treatment of animals involved in such studies.

Procurement

Animals that will be used in biological studies have to be ethically and lawfully procured, or obtained. There are many layers as to why this is important. They could be someone's lost pet. Animal species that are obtained for studies must also be cross-checked as to their conservation status. Those species that are threatened or endangered should not be used in biological studies simply because there are so few of them left.

Animals that are procured for laboratory studies should also be sourced from certified vendors that purpose-breed animals for such studies. Not only does this ensure that no pets are accidentally obtained but this is also important for the studies themselves as these kinds of animals are of a known genetic quality and their medical history is well-documented. Genetics and medical history can greatly influence the outcome of a biological study, and this is why obtaining animals from such vendors is often preferred. This way, a second

study that sacrifices even more animals may be avoided if the first study uses appropriate animals that do not bring the study's results into question.

UNIT – V

BIOLOGY PRACTICAL WORK

TYPES OF PRACTICAL WORK

- ✓ **Demonstrations** – A teacher may decide to do a demonstration for reasons of safety or due to lack of time or resources. They may also be the most suitable method for consolidating understanding or providing challenge. Try to actively involve pupils through questioning or through participating in conducting the experiment or activities before or during the demonstration (e.g. predicting if statements are true or false and then using observations to confirm or change their decision).
- ✓ **Structured practical** – Pupils do an experiment in groups. The teacher may give them instructions to follow, advice on recording and analysis and questions to help them relate their observations to theory. These may be suitable for practising skills and techniques, supporting particular inquiry skills, and gaining experiences.
- ✓ **Rotating (circus) practical** – Pupils in groups move from one experiment to the next at 'stations' in the classroom. The experiments should be related and instructions should be brief. Similar questions at each experiment will help pupils gradually build their understanding of a key concept, e.g. particle theory of matter or adaptation. Some of the stations may include a card sort or problem to solve rather than an experiment.
- ✓ **Investigation** – Pupils plan, carry out and analyse their own experiment. They may have freedom to choose what they investigate or the teacher may limit the materials available or specify a topic to investigate. The teacher

has a role as a facilitator rather than teacher. They will usually give pupils guidance on 'the scientific method' or carrying out a 'fair test'.

- ✓ **Problem solving** – this is similar to an investigation, but pupils have more freedom of approach. It may be a practical problem, such as dropping an egg from the top of a building without breaking it, which can be solved in a number of ways. This can be motivating and a good vehicle for the promotion of communication skills.

ORGANIZING THE BIOLOGY PRACTICAL WORK

Whenever you are planning an experiment, you should try it out yourself before the lesson. Simple experiments are often more complicated than you might think. You will also need to do a risk assessment. This means thinking about the potential hazards and taking steps to reduce them.

When dealing with chemicals other than water, students should wear safety goggles. If safety goggles are not available, you need to use very dilute solutions (0.1 M). The chemical that is most likely to cause permanent eye damage is sodium hydroxide (above a concentration of 0.4 M).

The following procedures to be followed while preparing the students to biology practical work are as follows:

- ✓ Avail all the apparatus and resources in the laboratory.
- ✓ Teacher has to take proper training before demonstration in front of the students.
- ✓ Check electricity, water and gas facility.
- ✓ Guide the students regarding current practical work.
- ✓ Teach the students to avoid laboratory accidents and teach regarding

precautionary measures.

- ✓ Teach about laboratory discipline.
- ✓ Prepare instructional cards and give it to all the students and ask them to follow the procedures who indulge in practical work.
- ✓ Keep the glass wares and other apparatus clean.
- ✓ Ask the students to read the procedure carefully and meaningfully before doing the practical work.
- ✓ Observation capacity is an essential quality in biology practical work, which is to be developed.
- ✓ Give them an activity to do at their desks and, while they are doing it, you distribute the apparatus they will need.
- ✓ Spread out the different items around the room and ask one person from each group to collect what they need. By spreading it out, you will avoid the potentially dangerous situation of lots of people gathering in the same place.
- ✓ Give out the chemicals yourself with a teaspoon on to small pieces of paper that they can take back to their place. This will ensure that they get the right amount and will avoid a lot of mess!

IMPORTANCE OF PRACTICAL WORK

Importance of practical work in biology from the smallest of organisms to the largest, at a molecular level through to the study of populations and their interactions with a changing world, the inherent variability associated with the practical study of life processes and biological material requires specific teaching of appropriate mathematical, statistical and modeling skills.

Practical work in biology is important to because it:

- Illustrates the beauty and complexity of the living world
- Promotes understanding of how to extract information from complex living systems
- Provides experience of analyzing and evaluating variable data
- Highlights and promotes discussion of ethical issues
- Gives students the skills to tackle global challenges

PROBLEMS IN CONDUCTING PRACTICAL WORKS

Poor understanding and grasp of practical concepts by learners: this was attributed to stem from student's entry behavior. Jennings, (1998) in his statements on the goals of science education states that science and its processes should provide an opportunity for learners to develop thinking and process skills which include deductive, logical and hypothetical thinking. As such due to poor grasp and understanding of practical concepts by learners these goals are hardly achieved.

- **Lack of laboratories in schools:** from the findings it was established that at the time of the study some schools had no laboratories at all. Joan Solomon, (1993) observes that science teaching must take place in the laboratory, about that at least there is no controversy. Science simply belongs there as naturally as cooking belongs to the kitchen. From this it is evident that without a laboratory it is difficult for teachers to engage students in practical activities, impacting negatively on instruction.
- **Limited space in the laboratory:** from the study it was established that some schools had comparatively smaller laboratories that could not accommodate a standard class of up to forty students. Schools laboratories' should be big enough to allow practical activities to be done

by all students at the same time other than doing it shifts in the case of smaller laboratories.

- **No laboratory technicians in schools:** at the time of the study some school had no laboratory technicians. In such situations teachers are forced to assume the role of technicians, as such laboratory practice and instruction is compromised due to time constraints in balancing between teaching and being a technician
- **Single science laboratory:** from the study it was established that all schools sampled had a single laboratory serving all the sciences. In such cases the time allocated for each science subject cannot sufficiently provide for the day to day practical activities. Some respondents noted that the single science laboratory system was better suited to the already phased out secondary school curriculum that incorporated Physical and Biological sciences.
- **Untrained laboratory technicians:** from the study it was established that, more than half of the technicians in the sampled schools were not trained in school's laboratory practice. Effective laboratory practice requires skills and professionalism that may not be achieved by untrained personnel as such instruction is compromised.
- **Shortage of teachers:** at the time the study it was established that some schools had no Physics teachers. This is further supported by the fact that an article shortage of science teachers bite carried in the Daily Nation Newspaper dated 1st, March 2011, pp: 5 points out a shortage of twelve thousand science and mathematics tutors in secondary schools. In the same article the Kenyan minister of Education observes this as being the biggest contributing factor to declining results in the disciplines.

- **Inadequate textbooks/practical guides:** the study established a shortage of Physics text books and practical guides. Effectiveness in Physics laboratory instruction requires that learners be provided with enough practical guides and textbooks. These resources give a wide range of practical activities together with detailed procedures to be followed hence boost practical instruction.
- **Insufficient laboratory resources:** the study established that more than seventy percent of the sampled schools had insufficient laboratory equipment, apparatus and chemicals. Tsuma, (1997) points out that a science laboratory is an indispensable facility in science education, if well equipped with the right kind of apparatus and chemicals then it should provide the best setting for teachers to assist students in acquiring scientific knowledge and skills. From this it is evident that inadequate laboratory resources jeopardize Physics practical instruction.
- **Minimal or no funds allocated for purchase repair and maintenance of laboratory equipment:** in a number of schools some apparatus in use were in very poor working conditions while others had been grounded, this impacts negatively on practical instruction.
- **Time:** it was established that due constraints emanating from other challenges e.g. inadequate laboratory equipment, single science laboratory and / or small laboratory space, time was wasted during shifts and in many cases practical activities wouldn't be as conclusive as required.
- The study established that some teachers avoided practical instruction as they opted for other instructional methods. This trend is detrimental to Physics teaching and learning, being a science Physics instruction should be practical oriented.

- It was also established that low syllabus coverage contributed to ineffectiveness in practical instruction.

GUIDELINES FOR TEACHERS IN BIOLOGY PRACTICAL WORK

Biology educators and technical support staff are vital contributors to the progress of science. As such, they require training to be competent and confident to respond positively to the unpredictability of working with biological material and embrace the opportunities afforded by the breadth of the biosciences

- Partnerships are promoted between biology and mathematics educators to support appropriate mathematics teaching for practical biology
- Educators are provided with professional development, including contemporary issues in biology and the opportunities that they provide for practical investigations
- Educators, technicians and students have access to experimental protocols and guides to practical techniques, underpinned by clear Health and Safety guidance and including resources linking teaching to research
- motivate pupils, by stimulating interest and enjoyment
- teach laboratory skills
- enhance the learning of scientific knowledge
- give insight into scientific method and develop expertise in using it
- develop 'scientific attitudes', such as open-mindedness and objectivity
- An effective teacher plans practical work with specific learning objectives in mind. By using different pedagogical approaches the same practical task can be used to achieve different learning outcomes.
- Supervise the practical work throughout until it complete.

EVALUATION OF PRACTICAL WORK

There are two types of evaluation in practical work of biology. They are as follows :

1. Direct Assessment of Practical Skills (DAPS)
2. Indirect Assessment of Practical Skills (IAPS)

CONTENT	TYPES OF EVALUATION IN PRACTICAL WORK	
	DIRECT ASSESSMENT OF PRACTICAL SKILLS (DAPS)	**INDIRECT ASSESSMENT OF PRACTICAL SKILLS (IAPS)**
Principle of the Evaluation	A student's competency at the manipulation of real objects is directly determined as they manifest a particular skill	A student's competency at the manipulation of real objects is inferred from their data and/or reports of the practical work they undertook
Evaluation undertaken	Observations of students as they undertake a piece of practical work	Marking of student reports written immediately after they undertook a piece of practical work or marking of a written examination paper subsequently taken by students
Advantages	High validity Encourages teachers to ensure that students gain expertise at the practical skills that will be assessed	More straightforward for those who are undertaking the assessment

Disadvantages	More costly Requires teachers or others to be trained to undertake the assessment Has greater moderation requirements	Lower validity Less likely to raise students' level of practical skills

PRACTICAL RECORD WORK IN BIOLOGY

Importance of record work

Learning to record the procedure and findings of an experiment done in the class is very important. So is writing down discussion of the results and inferences. It gives the following information to the students to lead the practical work appropriately.

You may use following style for writing the exercise in your record book.

- ✓ Aim of the exercise.
- ✓ Materials and method used for performing the exercise.
- ✓ Procedure followed.
- ✓ Observations which you made during performing the exercise and diagram wherever asked.
- ✓ Precautions taken during experimentation.

UNIT 6

RESEARCH IN SCIENCE EDUCATION

Research

Introduction

Research purifies human life. It improves its quality. It is search for knowledge. If shows how to Solve any problem scientifically. It is a careful enquiry through search for any kind of Knowledge. It is a journey from known to unknown. It is a systematic effort to gain new knowledge in any kind of discipline. When it seeks a solution of any educational problem it leads to educational research.

Curiosity, inquisitiveness are natural gifts secured by a man. They inspire him to quest, increase his thirst for knowledge / truth. After trial and error, he worked systematically in the direction of the desired goal. His adjustment and coping with situation makes him successful in his task. Thereby he learns something‘s, becomes wise and prepares his own scientific procedure while performing the same task for second time.

Research is the voyage of discovery‖. It is the quest for answers to unsolved problems. Research is required in any field to come up with new theories or modify, accept, or nullify the existing theory. From time immemorial it has been seen so many discoveries and inventions took place through research and world has got so many new theories which help the human being to solve his problems. Graham Bell, Thomas Edison, JC Bose, John Dewey, Skinner, Piaget Research like have given us theories which may cause educational progress research needs expertise.

Educational Research - Meaning

Educational research refers to the systematic collection and analysis of data related to the field of education. Research may involve a variety of methods and various aspects of education including student learning, teaching methods, teacher training, and classroom dynamics.

Characteristics of Educational research

- Educational research attempts to solve a problem.
- Research involves gathering new data from primary or first-hand sources or using existing data for a new purpose.
- Research is based upon observable experience or empirical evidence.
- Research demands accurate observation and description.
- Research generally employs carefully designed procedures and rigorous analysis.
- Research emphasizes the development of generalizations, principles or theories that will help in understanding, prediction and/or control.
- Research requires expertise—familiarity with the field; competence in methodology; technical skill in collecting and analyzing the data.
- Research attempts to find an objective, unbiased solution to the problem and takes great pains to validate the procedures employed.
- Research is a deliberate and unhurried activity which is directional but often refines the problem or questions as the research progresses.
- Research is carefully recorded and reported to other persons interested in the problem.

Types of Educational Research

1) Fundamental Research

The word fundamental itself indicates that new theories are created and old theories are examined in this type of research. The purpose of fundamental research is to gain knowledge and not to solve practical problems. Hence fundamental research is not undertaken to solve the human and social problems.The basic purpose of this research is to gain knowledge. Fundamental research is usually carried on in a laboratory or some other sterile environment, sometimes with animals. This type of research, which generally has no immediate or planned application, may later in further research of an applied nature.

2) Applied Research

The research undertaken for practical use is called 'Applied research'. Since findings of this research are used to solve the practical problems in day to day life. The basic purpose of applied research is to gain knowledge for the practical use. The main objective of applied research is to judge the usability of the knowledge gained from the research and use to solve different problems faced by the human in his day to day life and other objective is to gain additional knowledge to solve the specific problem most educational research is applied research, for it attempts to develop generalizations about teaching-learning processes instructional materials, the behavior of children and ways to modify it.

3) Action Research

In education this movement has had its goal the involvement of both research specialist and class room teacher in the study and application of research to educational problems in a particular classroom setting. Action research is

focused on immediate application, not on the development of theory or on generalization of applications. It has placed its emphasis on a problem here and now in a local setting. Its findings are to be evaluated in terms of local applicability, not universal validity. Its purpose is to improve the practices to combine the research processes, habits of thinking, ability to work harmoniously with others, and professional spirit. Corey defined action research as "the process by which practitioner attempt to study their problems scientifically in order to guide, correct, evaluate their decisions and actions". According to Gooba (1996) Action Research is the democratization of the research process. This research is democratic, pro competence and more inclined towards humanity. Hence such research always helps local of those events that may help explain present events and anticipating future events. People to solve their local problems. This is the most important fact about action research.(Withed,Jack.,(2006).

Methods of Educational Research

The basis for educational research is the scientific method. The scientific method uses directed questions and manipulation of variables to systematically find information about the teaching and learning process. In this scenario questions are answered by the analysis of data that is collected specifically for the purpose of answering these questions. Hypotheses are written and subsequently proved or disproved by data which leads to the creation of new hypotheses. The two main types of data that are used under this method are qualitative and quantitative.

1. Qualitative research

Qualitative research uses the data which is descriptive in nature. Tools that educational researchers use in collecting qualitative data include: observations,

conducting interviews, conducting document analysis, and analyzing participant products such as journals, diaries, images or blogs.

Types of qualitative research

- Case study
- Ethnography
- Phenomenological research
- Narrative research
- Historical research

2. Quantitative research

Quantitative research uses data that is numerical and is based on the assumption that the numbers will describe a single reality. Statistics are often applied to find relationships between variables.

Types of quantitative research

- Descriptive survey research
- Experimental research
- Single-subject research
- Causal-comparative research
- Correlational research
- Meta-analysis

Status of research in science education in India

As the Indian society is reinventing itself, it is going through a massive change. To ensure sustainable growth, we need to move from service economy to knowledge economy. In this context, we are ushering a new education system in science and technology to bring Indian intelligentsia into knowledge production.

Indian education system, like in many other spheres of our society, is at the cross-roads trying to find a way to enhance the number and quality of future academic as well as industrial researchers of the country, while still maintaining a socialist approach to educate large masses of relatively underprivileged people.

According to the modern source of all knowledge, Wikipedia, education is the process by which society deliberately transmits its accumulated knowledge, skills and values from one generation to another. India is one of those rare civilizations, which had formal education since time immemorial. Indian education was founded with strong emphasis on logic and mathematics.

British brought the Greco-Roman system of knowledge to India in early 19th century, which is the foundation for modern science. India quickly picked this up and many Indians significantly contributed to science and mathematics. When India became independent, in 1947, the literacy was as low as 12% and may be lower. Absolutely there was no scope of any foreign investment to a country that people like Winston Churchill thought would survive only for few weeks. The need was to educate masses to build the nation and to build the infrastructure to stimulate further growth in the economy. The emphasis naturally was on technical education, which very quickly (50 years is very small time in the life of any nation, more so of one with a billion people) made India one of the largest economies in the world. Much of the new wealth is from providing services to the world. However, to ensure sustainable growth, we need to move from service-economy to knowledge economy.

While there is no doubt that there never had been better time than today in the recorded history to pursue science in India, the challenge is to secure the future. Planning for future is more challenging now than in 1950s. At that

time, the options were limited due to scarcity of resources. Very small number of trained manpower was available to steer the country's education initiatives. Now, very large number of accomplished scientists and technocrats are available to pursue a number of options to meet the aspirations of the people. It may sound cliché. India is a country of enormous diversity. No single model of science education and research would cater to the needs and aspirations of the entire nation. Still, a consensus seems to have emerged on the need to integrate high quality research with undergraduate teaching to improve science education in India and to enhance the number and quality of future academic as well as industrial researchers in the country. By dedicating certain amount of time for teaching, faculty is also expected to improve the quality of their research.

Since the beginning of this century, several new initiatives are being explored such as,

1. Establishment of large number of broad education centers: Central Universities, IISERs, NISER, IITs, NIPERs
2. Establishment of specialized centers of research and education in space technology, defense technology, translational research, biotechnology and stem cell biology
3. Expansion of existing institutes such as IITs, IISc and TIFR. The latter two would soon be initiating undergraduate education programs.

Only time will tell what would be the outcome of these initiatives. Most decisions in historical contexts would look either very good or bad, but at the time of making the decisions, we would be dabbling with only hypothetical situations. Any decision would be based on some logical thinking that suggests that a particular hypothetical scenario would be better than the other hypothetical one. Here, we could learn something from evolution. More the

genetic diversity better the chances that a species survives and proliferates. This is because we could always find few individuals carrying genetic variants that would help them to adapt (better than their ancestral population) to a new environment. This is precisely what we need to do. Wiser the nation if it invests on a broad-based education system, which nurtures both curiosity and creativity amongst its citizens. Such education system would create amongst the people the skills and competence in diverse fields and thereby improves the overall preparedness of the country in the long run.

Irrespective of diversity in the opinion on what and how to research and teach, there is no argument that on the three conceptual foundations, on which any scientific enterprise should be built.

(i) Strong emphasis on basic science: When it comes to science, "no national scientific enterprise can be sustainable in the long term if it does not contain generous room for curiosity-driven research. While the technological outcomes and social benefits of basic science are almost always long-term and rarely predictable, such science creates and consolidates overall competence and intellectual diversity"

(ii) Excellent academic ambiance: Success of any creative endeavor is dependent on large number of excellent people working in the same organization. This creates a threshold level of academic excellence and provides necessary forum for cross-fertilization of ideas, internal collaborations and unbiased internal criticism. A critical level of academic excellence is also necessary to pursue bigger questions in science, most of which would require interdisciplinary efforts. If we read the history of most academic places in India and other countries, an ambiance described above has been the foundation for success. Only way to create such an ambiance is by carefully choosing faculty

for their research accomplishments, promise, teaching proficiency and mentoring abilities. Ideally, faculty should have the ability and courage to challenge dogmas, inculcate concepts of scientific and mathematical inquiry in their research and teaching and promote critical thinking and reasoning amongst their students. Equally important is to ensure that our faculty upholds highest standards of integrity and ethics in their professional and personal life.

(iii) Free and fair organizational system: Academic freedom, a democratic and consultative administrative set up, unbiased periodic review of performance and strict accountability to the support provided are equally important for maintaining highest standards of academic excellence.

Educational research and innovation committee (ERIC)

NCERT projects take up specific projects in educational research. It also promotes and supports through funding and providing academic support to professionals working in the field. A standing committee of NCERT called Educational Research and Innovations Committee (ERIC) acts as a catalyst to promote and support research in priority areas of school and teacher education. The ERIC members include eminent researchers in education and allied disciplines from universities and research institutions and representatives of SIEs/SCERTs. The Department of Educational Research and Policy Perspectives (DERPP) acts as the Secretariat of ERIC and coordinates other activities for promoting educational research.

ROLES AND FUNCTIONS OF ERIC

The National Council of Educational Research and Training (NCERT) was established in 1961 as an autonomous organization fully funded by the

Ministry of Education and Social Welfare (now Ministry of Human Resource Development), Govt. of India. Research and Development, Training and Extension are three inter-woven functions of the NCERT. One of the Principal functions of NCERT has been to undertake, promote and coordinate educational research on various aspects of school education and teacher education.

In operational terms the scope of this objective is:

- To initiate, promote and direct programs and activities designed to bring about desirable changes in the educational system through research and innovations
- To promote quality in research having relevance to the educational system.
- To provide and develop leadership in educational research in the country
- In addition to promote educational research in its institutional networking, the NCERT has been taking measures to create and sustain interest in educational research amongst the researchers, both within the NCERT and outside.

In order to promote research, a Standing Committee known as Educational Research and Innovations Committee (ERIC) was set up in the year 1974 with the following objectives:

- To lay down from time to time priority thrust areas in educational research
- To take such measures which are necessary to initiate, sponsor and coordinate research activities in the field of education

- To scrutinize and recommend grants to proposals related to research and innovationϖ projects received from the constituent units of the NCERT as well as from outside agencies and individuals
- To disseminate research findings and to promote their implementation in the educationalϖ system To promote activities in the development of leadership and expertise in research
- To exercise proper control over the conduct of research projects and utilization of research
- grants To take such other measures as may be required from time to time to help the Council inϖ meeting its objectives of promoting and disseminating educational research 3 The ERIC Standing Committee consists of eminent educationists from various disciplines and institutions.
- It comprises of eight eminent educationists nominated by President, NCERT, two Directors from SCERTs, invitees nominated by the Director, NCERT, five Heads of NIE Departments, Principals, Deans of NCERT Hqs. and Joint Directors of the Council and its constituent units. Term of a Standing Committee is for three years.

APPROACHES OF RESEARCH

In order to make educational research relevant, effective and meaningful, ERIC shall give priority to the following research approach :

- ✓ Policy Research in Education
- ➢ Development of policy concerns
- ➢ Effectiveness of policy issues

- Dissemination of findings related to policy issues Qualitative and participatory approaches involving triangulation of methodologies
- ✓ Case Studies
- ✓ Inter-disciplinary, Collaborative, Multi-centric, and Pan-Indian researches
- ✓ Studies involving use of quantitative and qualitative approaches
- ✓ Collaborative Action Research Projects involving several agencies/organizations
- ✓ Innovations related to qualitative improvement of content and process of school education

Utilization of science educational research

1. Students are encouraged to actively engage with ideas and evidence.
2. Students are challenged to develop meaningful understandings.
3. Science is linked with students' lives and interests.
4. Students' individual learning needs and preferences are catered for.
5. Assessment is embedded within the science learning strategy.
6. Science is represented in its different aspects.
7. The classroom is linked with the broader community.
8. Learning technologies are exploited for their learning potentialities

UNIT – VII

ICT RESOURCES IN LEARNING BIO–SCIENCE

Dale's Cone of Experience (modified)

Direct Purposeful Experiences.

These are first hand experiences which serve as the foundation of learning. In this level, more senses are used in order to build up the knowledge. Also, in this level, the learner learned by doing things by him/herself. Learning happens through actual hands-on experiences. This level explains and proves one of the principles in the selection and use of teaching strategies, the more senses that are involved in learning, the more and the better the learning will be. This level also proves that educational technology is not limited to the modern gadgets and software that are commercially available nowadays. This shows that even the simple opportunity that you give to each child could help them learn.

The Contrived Experiences.

In this level, representative models and mock-ups of reality are being used in order to provide an experience that as close as reality. This level is very practical and it makes learning experience more accessible to the learner. In this stage, it provides more concrete experiences, even if not as concrete as direct experiences, that allows visualization that fosters better understanding of the concept.

The Dramatized experiences.

In this level, learners can participate in a reconstructed experiences that could give them better understanding of the event or of a concept. Through dramatized experiences, learners become more familiar with the concept as they emerge themselves to the "as-if" situation.

The Demonstrations.

It is a visualize explanation of important fact, idea, or process through the use of pictures, drawings, film and other types of media in order to facilitate clear

and effective learning. In this level, things are shown based on how they are done.

The Study Trips.

This level extends the learning experience through excursions and visits on the different places that are not available inside the classroom. Through this level, the learning experience will not be limited to the classroom setting but rather extended in a more complex environment.

The Exhibits

The level of study trips is followed by exhibits. It is a somewhat a combination of some of the first levels in the cone. Actually, exhibits are combination of several mock ups and models. Most of the time, exhibits are experiences that is "for your eyes" only but some exhibits includes sensory experiences which could be related to direct purposeful experiences. In this level, meanings ideas are presented to the learners in a more abstract manner. This experience allows student to see the meaning and relevance of things based on the different pictures and representations presented.

The television and motion pictures etc.

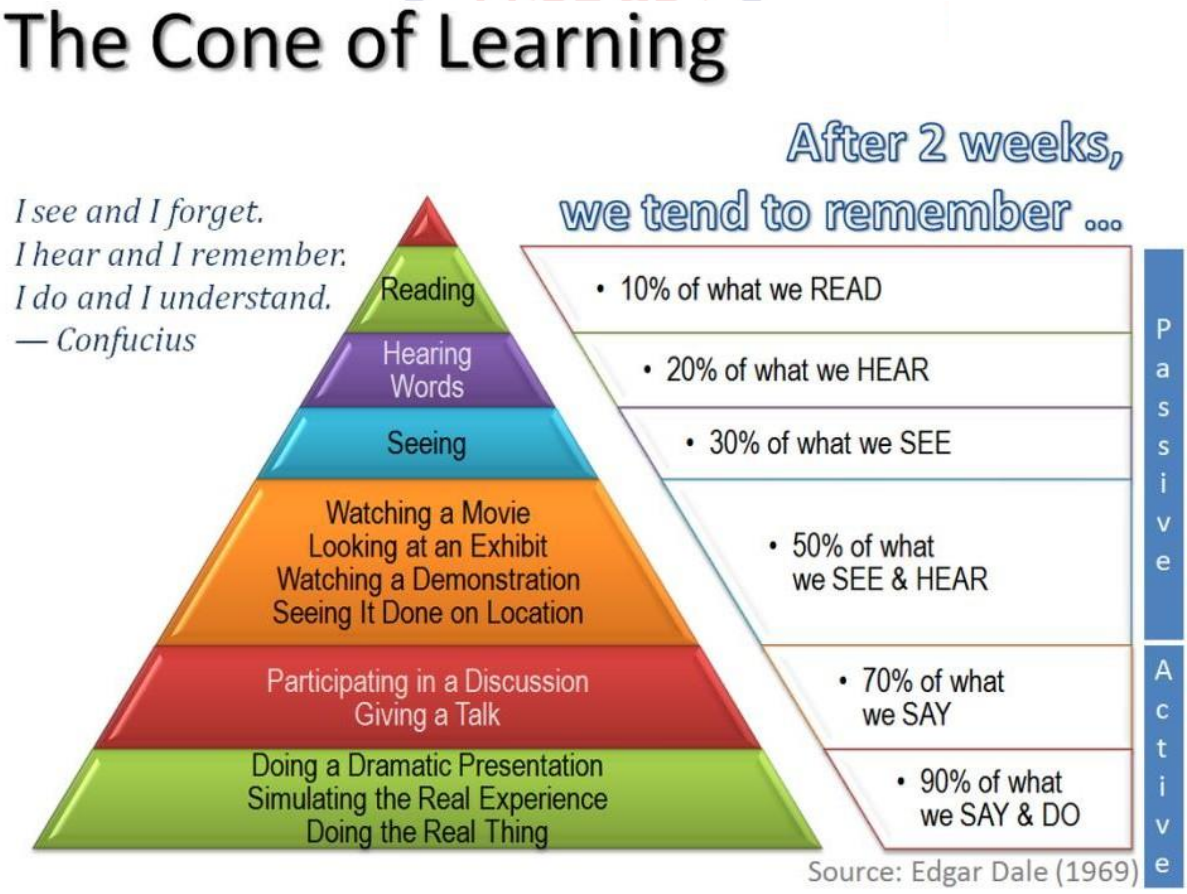
The next levels would be the level of television and motion pictures and still pictures, recordings, and Radio. For television and motion pictures, it implies values and messages through television and films. On the other hand, still pictures, recordings and radio are visual and audio devices that can be used by a group of learner that could enhance and extend learning experience

The Visual symbolic and Verbal symbolic

The last two levels would be the Visual symbolic and Verbal symbolic. These two levels are the most complex and abstract among all the components of the Cone of Experience. In the visual symbolic level, charts, maps, graphs, and diagrams are used for abstract representations. On the other hand, the verbal symbolic level does not involve visual representation or clues to their meanings. Mostly, the things involved in this level are words, ideas, principles, formula, and the likes.

After going through the different components of the Cone of Experience, it could be said that in facilitating learning, we can use variety of materials and medium in order to maximize the learning experience. One medium is not enough so there's nothing wrong with trying to combine several medium for as long as it could benefit the learners.

Through understanding each component of the Cone of Experience, it could be said that Educational Technology is not limited to the modern gadgets that we have right now but rather it is a broad concept that includes all the media that we can use to attain balance as we facilitate effective and meaningful learning.



TEACHING BIO–SCIENCE WITH:

In days of yore education was engulfed in the four walls of a classroom. Enough has been said about how education must be transformed and must step out of the boring classroom closet so that it begins to interest one and all. Thanks to the advancements in the field of technology, education no more remains mundane. The invention of television is undoubtedly a milestone, more importantly because it brought education into our living rooms! The television can be a very influencing and powerful tool, if used by children in a wise manner. Today there is a host of educational channels not just for kids but for adults too, that showcase issues like current affairs, history and culture, travel, science, societal affairs and 'edutainment' (that's a mix of education and entertainment). So here are the 10 best educational channels that you should watch.

Audio broadcasting in Biological Science

The following radio channels giving lot of audio contents to the school students. they are as follows:

Radio Stations

Name	Frequency	Language
Radio Jamia (*see Jamia Millia Islamia*)	90.4 MHz	Multilingual
Delhi University Community Radio	90.4 MHz	Multilingual
Radio SD 90.8	90.8 MHz	Hindi
Radio City	91.1 MHz	Hindi
Big FM	92.7 MHz	Hindi
Red FM	93.5 MHz	Hindi
Radio One	94.3 MHz	English

Hit FM	95.0 MHz	Hindi
Apna Radio (*Indian Institute of Mass Communication*)	96.9 MHz	Multilingual
Radio Mirchi	98.3 MHz	Hindi
Vividh Bharti (*All India Radio*)	100.1 MHz	Multilingual
AIR FM Rainbow	102.6 MHz	Hindi
Fever 104	104.0 MHz	Hindi
Oye 104.8	104.8 MHz	Hindi
Gyan Vani	105.6 MHz	Hindi
AIR FM Gold	105.6 MHz	Hindi
Radio Nasha	107.2 MHz	Hindi

FM	107.4 MHz	Hindi
Gurgaon Ki Awaz	107.8 MHz	Hindi

Educational television

1. VIGYAN PRASAR

Vigyan Prasar's (VP) programme Science on Television has emerged as one of its major activities. The objective is to bring out video science programmes on different aspects of science and technology in different Indian languages to demystify science and inculcate scientific temper. In this digital era, majority of people in the world are receiving science and technology knowledge through television and new electronic media. So it can be argued that science communication- Television remains the medium with most impact. With this view, VP has been started utilizing television for science communication since

its inception and produced several S&T based programmes. Science can become people's science only when they find involvement and appreciation in the making of science communication. Our science serials/science films/documentary films are an attempt to bridge the gap between labs and people. "Science is everywhere and for everyone" is the guiding principle of this activity.

2. NATIONAL GEOGRAPHIC

The 125 year old channel, undoubtedly takes away the crown. Commercially known and also trademarked as Nat Geo, s owned by the National and the Fox Cable Networks division of Fox. The legendary channel broadcasts shows and documentaries with factual content involving nature, science, culture, and history, plus some reality programming. Nat Geo has left no stone unturned in covering a vast section of areas like Video,Photography,Animals,Environment,Travel,Adventure,Television and kids, proving it to be a holistic channel concentrating on various aspects with equanimity.

3. **Ovation** is an American television channel that promotes 'art and contemporary' culture based shows. Started in the year 1996,owned by Hubbard Media Group and Company, the American show is popular for shows like the 'Art of:' series show- Art of:Mixology; Art of: Graffiti; Art of:Sneakers;Art of:Animation;Art of: Tattoo etc which is a hit among art enthusiasts.

4. Nasa tv

Owned by National Aeronautics and Space Administration, a United States government agency NASA TV is a television service was started in early 1980s to provide NASA managers and engineers with real-time videos of missions. The network airs a large amount of educational programming, and provides live coverage of an array of manned missions, including the Space Shuttle and International Space Station (ISS), robotic missions, and international launches.

5. World tv

Previously called PBS World, the channel is a US based channel that was launched in 2007. World specializes in broadcasting TV non-fiction, science, nature, news, public affairs and documentaries. 'American Experience' is a favored show that throws light on lesser known history facts along with various award winning documentaries which have been extensively researched and about important historic events and people. 'one' a show which acts as a platform for independent film makers to show case their documentary making skills, the show has not just won numerous awards but also has been critically acclaimed. An estimate of 500 films has been telecast ed since its debut. 'Independent Lens' is another program similar to the Frontline series. Shows broadcasting wild life based documentaries a huge hit, 'Nature' is a weekdays sixty minute program that educates viewers about ecosystems and its living beings. The program boasts of nominations for the Emmy Awards.

6. Science tv

Another US based channel, Science is owned by Discovery Communications. True to its name, the channel airs science related serials and movies. The channel boasts of an interesting bunch of programs such as 'Beyond Tomorrow', the show is all about the latest discoveries and inventions in the fields of science and technology; 'Cosmos: A Personal Voyage' a program that focuses on universe related aspects such as the birth of the universe, the galaxies, etc; 'Dark Matters: Twisted but True' show cases peculiar experiments and shows strange sciences often which causes disbelief among viewers; 'Destroyed in Seconds' this show is all about events that brought only destruction like volcanic eruptions, plane crashes,floods,tsunamis,etc.

7. NAT GEO WILD

A channel dedicated to animal related programs, is a sister network of National Geographic channel. Launched in Hong Kong first, the channel now stretches across the globe broadcasting wildlife across various continents.

'The Incredible Dr. Pol' this show is about a vet who tirelessly works to provide relief to farm animals. The senior citizen refuses to retire and has his life revolving around these animals. 'America the Wild', the show promises a wild experience to its viewers as it shows wildlife that is hardly seen or seen never before. A few more shows include 'Croc Catchers',' Stranger Than Nature',' Africa's Deadliest','Shark Attack Experiment',' Built For The Kill' etc. The list seems to be never ending. The mere titles of these shows give you a goose bumps. Nat Geo Wild is one of the most adventurous and thrilling channels you'll ever come across! This definitely is a much watch!

8. ANIMAL PLANET

With a wacky slogan 'Surprisingly Human' this channel is all about animals, animals and only animals. Animal Planet has been broadcasting documentary programming mainly focusing on animals. With its origin in the US, animal planet has a wide network that spreads over 70 countries across the globe. A personalizing touch has been given to the channel by creating country specific versions of it. While its competitor NAT GEO WILD focuses more on the animals in the wild, Animal Planet shows revolve around domesticated animals.

9. DISCOVERY

The world is awesome. So says the slogan of the Discovery channel. Discovery broadcasts documentary television programming focused primarily on popular science, technology and history. Programming on the flagship Discovery Channel in the U.S. is primarily focused on reality television series, such as speculative investigation (with shows such as Mythbusters, History and Best Evidence), automobiles, and occupations (such as Dirty Jobs and Deadliest Catch); it also features documentaries specifically aimed at families and younger audiences.

Functions of Science on Television Division are as follows:

- Production of Science & Technology based films/ serials /science news programmes/documentary films /quiz shows/spots etc.
- To attract film makers/institutions towards making S&T based films.
- Telecast of S&T based video programmes on different channels to enhance the scientific content on Indian television.
- Dubbing of VP programmes in various other Indian languages.
- To encourage film based science communication by organizing special screening of films in schools, college and science clubs etc.
- Networking, Collaborations with other organizations for resource sharing.
- Duplication of video programmes to CDs/VCDs/DVDs etc. for sale.

Multimedia

Multimedia is content that uses a combination of different content forms such as text, audio, images, animations, video and interactive content. Multimedia contrasts with media that use only rudimentary computer displays such as text-only or traditional forms of printed or hand-produced material.

Multimedia can be recorded and played, displayed, interacted with or accessed by information content processing devices, such as computerized and electronic devices, but can also be part of a live performance. Multimedia devices are electronic media devices used to store and experience multimedia content. Multimedia is distinguished from mixed media in fine art; for example, by including audio it has a broader scope. In the early years of multimedia the term "rich media" was synonymous with interactive multimedia, and "hypermedia" was an application of multimedia.

USES OF MULMEDIA IN LEARNING

- Deeper understsnding
- Improved problem solving

- Increased positive emotions
- Access to a vast variety of information
- World exploration

Audio

There are many audio resources available on the Internet. These resources can be interwoven into your general classroom curriculum to enhance your daily lessons.

- Dialogues
- Songs
- Rhymes
- Instructions and demonstrations of games and other activities

Animated videos

Educational animations are animations produced for the specific purpose of fostering learning.

The popularity of using animations to help learners understand and remember information has greatly increased since the advent of powerful graphics-oriented computers. This technology allows animations to be produced much more easily and cheaply than in former years. Previously, traditional animation required specialised labour-intensive techniques that were both time-consuming and expensive. In contrast, software is now available that makes it possible for individual educators to author their own animations without the need for specialist expertise. Teachers are no longer limited to relying on static graphics but can readily convert them into educational animations.

Uses of animated videos

- Emphasises development of students' skills and understanding of creating and responding.
- Enables students to apply Imagination & Rational Thinking.

- Enables students to invent and explore multiple solutions to a problem.
- Enables students to understand the value of reflection and critical judgment in creative work.
- Facilitates positive peer interaction, including receiving and using feedback.
- Encourages self-motivation to create and problem solve.
- Uses artistic literacy as a natural enhancement to learning in other content areas.
- Fosters positive attitudes toward Art & Animation.
- Introduces career possibilities.

SIMULATION AND GAMES

Simulation

Simulations are instructional scenarios where the learner is placed in a "world" defined by the teacher. They represent a reality within which students interact. The teacher controls the parameters of this "world" and uses it to achieve the desired instructional results. Students experience the reality of the scenario and gather meaning from it.

A simulation is a form of experiential learning. It is a strategy that fits well with the principles of Student-Centred and constructivist learning and teaching.

Simulations take a number of forms. They may contain elements of:

- ✓ a game
- ✓ a role-play, or
- ✓ an activity that acts as a metaphor.

Simulations are characterised by their non-linear nature and by then controlled ambiguity within which students must make decisions. The inventiveness and commitment of the participants usually determines the success of a simulation.

Uses simulations

Simulations promote the use of critical and evaluative thinking. Because they are ambiguous or open-ended, they encourage students to contemplate the implications of a scenario. The situation feels real and thus leads to more engaging interaction by learners.

Simulations promote concept attainment through experiential practice. They help students understand the nuances of a concept. Students often find them more deeply engaging than other activities, as they experience the activity first-hand, rather than hearing about it or seeing it.

Simulations help students appreciate more deeply the management of the environment, politics, community and culture. For example, by participating in a resource distribution activity, students might gain an understanding of inequity in society. Simulations can reinforce other skills indirectly, such as Debating, a method associated with some large-scale simulations, and research skills.

Advantages of simulations and games

1. They increase student motivation.
2. They facilitate the affective aspect of learning.
3. They enhance interpersonal relations and promote interpersonal reward structures for learning.
4. They do at least as well as conventional techniques in achieving cognitive outcomes.
5. They tend to produce improved communication and discussion within the classroom.
6. They tend to produce a more integrated view of the broader context within which sociological concepts fall.
7. They promote individual discovery in learning from the learner's own perspective.

Games

Games are a ubiquitous part of life in our culture, and experts suggest they will become even more deeply embedded in the coming years. Games help people develop a disposition toward collaboration, problem-solving, communication, experimentation, and exploration of identities, all attributes that promote success in a rapidly-changing, information-based culture

e- poster

n electronic poster (E-Poster) is a poster in PowerPoint format, allowing the inclusion of movies, and other multi-media formats, and presenters are encouraged to take advantage of the versatility of this medium. All multi-media E-Posters will be presented at numbered monitors in the Exhibition Hall. The time allotted for E-poster presentations is 60 minutes, and authors are requested to be at their assigned computers for the period of time specified in the acceptance message. During this time you will be available for discussion of your E-Poster. A formal presentation is not necessary.

Uses

For the authors:

Preparation of the poster by using a pre-defined model and the preferred edition software

Enhanced presentations with the possibility of including videos

Online submission in an easy, quick and secure way

No need for printing, carrying and posting the poster on conventional boards

More attractive, interesting and interactive presentations

Higher work visibility, thanks to the searching options that make it easily accessible

For the event organisers:

ePosters brings the event to the forefront of technology

No need to worry about space and posters' conventional boards

Better quality of the presentations

Higher impact due to the online availability of conference works before, during and after the event in a simple and atractive format

For the scientific community:

All the posters presented become available online, and in this way the scientific information can be easily accessed and referenced in the literature

For the event professional organisers:

With ePosters the professional organiser offers its clients all the advantages and benefits of the most modern digital technology, making a difference in the service provided and guaranteeing a high satisfaction level;

With no extra effort for the organiser staff

For the sponsors:

ePosters offers additional promotion opportunities, both at the conference site and on the internet, and associates sponsors' brand with a high-quality technological and environmental image

For the environment:

ePosters turns your event more sustainable and environmentally-friendly, by avoiding the economical and environmental costs of printing conventional posters

BLENDED LEARNING

1. E - Book

An **electronic book**, also known as an **e-book** or **eBook**, is a book publication made available in digital form, consisting of text, images, or both, readable on the flat-panel display of computers or other electronic devices. Although sometimes defined as "an electronic version of a printed book", some e-books exist without a printed equivalent. E-books can be read on dedicated e- reader devices, but also on any computer device that features a controllable viewing screen, including desktop computers, laptops, tablets and smartphones.

Applications of e-books

- Informational Texts. There is a much greater emphasis on students reading nonfiction content than ever before. E-books give teachers access to a large volume and wide array of titles to match what they need.
- Student Choice. E-book series offer flexibility in the classroom. For example, in the Britannica Guides Series, there are 10 different titles, all set up in the same structure. Teachers can use the series to teach text features, vocabulary, and research skills, while each student can read the title that they find the most interesting.
- Search by MARC Records. E-books provide free linked MARC records, enabling search, discovery, and access to collections from your library catalog. E-books also make citing easy, providing APA and MLA citations.
- In-class Teaching Tools. E-books are great to explore with the whole class. Teachers and students can insert questions and notes, highlight key sections, bookmark passages, and save it all for review. In addition, e-books are easy to share across platforms like Pinterest, Facebook, Twitter, LinkedIn, and email.
- Partner Subscriptions. Thousands of Britannica's nonfiction e-books for every age, reading level, and subject can also be used on any one of a number of popular platforms, including: EBSCO, Follett, GALE, MACKIN, OverDrive, and ProQuest.
- Funding Resources. Britannica Digital Learning and DonorsChoose.org have partnered to connect educators with a thriving community of donors that are eager to fund all of your e-book needs.
- Student-Tailored Options. Teachers can select e-books by GRL, Lexile level, and grade level to find books on the same subject at multiple reading levels. In addition, visually impaired readers can change the font size for more ease while reading.
- They're Great for Everyone. E-books are environmentally friendly, they are

more affordable than paper-based books, and they take some of the weight off… literally! Books are so heavy!

2. Web

Websites play a vital role in study of science subjects. It gives a lot of deep sense of science learning practically and novally. The following websites gives bottomless learning in science education. They are as follows:

1. **Edheads is great for younger aspiring scientists**

Edheads is widely considered one of the best science websites for interactive learning for children. It has a large collection of interactive science-related activities that will keep children entertained whilst also expanding their little minds. Activities include things like creating a line of stem cells, designing a cell phone, investigating a crash site and even performing brain surgery (minus the gore of course). They will also get to tinker with some basic machines and investigate the weather.

2. **Curiosity Machine will teach you about AI**

If you are looking for some great science websites for interactive learning then these eleven should, at the very least, scratch and itch. Most of these are aimed at younger learners but some will be as, if not more, entertaining for adults.

1. **Edheads is great for younger aspiring scientists**

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2. **Curiosity Machine will teach you about AI**

Curiosity Machine helps children build, share and receive feedback from experts. Its main focus is on teaching children, and their parents, about the power of Artificial Intelligence.

Its main focus to bring family members together to learn and build their own AI.

It has a specific "Family Challenge" which is a "free, hands-on AI education program that brings families, schools, communities, and technology know-it-alls together to give everyone the chance to learn, play and create with AI."

3. Teachers TryScience is full of online experiments

Teachers TryScience is a website specifically designed to spark any young mind's interest in science, technology, engineering, and math. At its very core, it aims to bring design-based learning to children at home or at school.

According to its own website it helps children "to solve a problem in environmental science, students might need to employ physics, chemistry, and earth science concepts and skills."

To this end, it has a large collection of interactive experiments, field trips, and other adventures. It also includes lesson plans, strategies, and tutorials for teachers to better help them deliver awe-inspiring science lessons for their ever curious students.

4. The Exploratorium is the go-to site for interactive learning

The Exploratorium is the website arm of the San Francisco Exploratorium. This site offers hands-on experiences that will help teach children about basic, and more complex, scientific principles.

It covers subjects from many disciplines of science from biology and earth science to astronomy. The site also has a parent and teacher section that will provide free resources to help you plan and incorporate its interactive material to boost your child's learning.

5. Science Kids will engage your kid's mind

Science kids is another interactive learning website that focusses on teaching children the wonders of science. The site has a great variety of interactive science games covering subjects from living things to physical processes and everything in between.

The great thing about this site's content is that it not only educates young minds but helps them put that knowledge to practical use to cement it in their memory. One particularly useful game will have your child design and build a virtual electrical circuit.

Each subject comes in modules that are then subdivided into subcategories. Living things, by way of example, is divided into food chains, microbes, and the human body etc.

3. Wikis

Wikipedia is an opportunity to teach students essential 21st century skills that most will use in their careers and personal lives. Wikipedia is a valuable public resource, and in a classroom environment, students learn how to contribute to it and how to use it properly. Curricula can and should include Wikipedia. Wikipedia belongs in education.

Applications / Uses OF WIKIS

Student engagement

These are some of the reasons that using Wikipedia in the classroom is so engaging, according to students:

- **The global audience** — students appreciate that their work could be viewed by thousands of people.
- **The usefulness of the assignment** — students like that their work serves a purpose; it isn't just graded and forgotten.
- **The résumé builder** — students add a new skill to their professional portfolio.
- **The "cool" factor** — students like showing their work to family and friends.
- **The feedback** — students like getting input from the broader world.
- **The different experience** — students appreciate an alternative assignment format and learning new things.

STUDENT LEARNING

Students learn a variety of skills by using Wikipedia in the classroom. Some of the main ones are:

- **Reading** — students get better at reading by reading more, and while working on Wikipedia, they read a lot!
- **Writing** — students practice writing in an expository, encyclopedic, summary style.
- **Critical thinking** — in contrast to many class assignments which require an argumentative or persuasive paper, Wikipedia's neutralitypolicy helps students think about class content in a new way.
- **Information literacy** — students identify bias and partisanship; students recognize whether an article is credible or not.
- **Literature review** — students practice finding and summarizing appropriate sources for their topic.
- **Collaboration** — students work with other people to develop high quality encyclopedia articles.
- **Community of practice** — students can connect with people in the Wikipedia community who work and study in the same field.
- **Citation** — students learn how to reference and use reliable sources correctly.

- **Copyright** — students learn the basics of copyrights and free licenses and the importance of attribution.
- **Coding** — students learn to use wiki markup, a computer programming language and form of coding, as well as the mechanics of working with wikis.
- **Online etiquette** — students learn how to work well with people whom they only know online and may never meet in person; this is an essential skill in today's online environment.
- **Online citizenship** — students participate in a large-scale knowledge project as peers and encounter challenges that are unique to an online environment.

4. Moodle

Moodle is a free and open-source learning management system (LMS) written in PHP and distributed under the GNU General Public License. Developed on pedagogical principles, Moodle is used for blended learning, distance education, flipped classroom and other e-learning projects in schools, universities, workplaces and other sectors.

Advantages of moodle

Proven and trusted worldwide

Powering tens of thousands of learning environments globally, Moodle is trusted by institutions and organisations large and small, including Shell, London School of Economics, State University of New York, Microsoft and the Open University. Moodle's worldwide numbers of more than 90 million users across both academic and enterprise level usage makes it the world's most widely used learning platform.

Designed to support both teaching and learning

With over 10 years of development guided by social constructionist pedagogy, Moodle delivers a powerful set of learner-centric tools and collaborative learning environments that empower both teaching and learning.

Easy to use

A simple interface, drag-and-drop features, and well-documented resources along with ongoing usability improvements make Moodle easy to learn and use.

Free with no licensing fees

Moodle is provided freely as Open Source software, under the GNU General Public License. Anyone can adapt, extend or modify Moodle for both commercial and non-commercial projects without any licensing fees and benefit from the cost-efficiencies, flexibility and other advantages of using Moodle.

Always up-to-date

The Moodle project's open-source approach means that Moodle is continually being reviewed and improved on to suit the current and evolving needs of its users.

Moodle in your language

Moodle's multilingual capabilities ensure there are no linguistic limitations to learning online. The Moodle community has begun translating Moodle into more than 120 languages (and counting) so users can easily localise their Moodle site, along with plenty of resources, support and community discussions available in various languages.

All-in-one learning platform

Moodle provides the most flexible tool-set to support both blended learning and 100% online courses. Configure Moodle by enabling or disabling core features, and easily integrate everything needed for a course using its complete range of built-in features, including external collaborative tools such as forums, wikis, chats and blogs.

Highly flexible and fully customisable

Because it is open-source, Moodle can be customised in any way and tailored to individual needs. Its modular set up and interoperable design allows developers to create plugins and integrate external applications to achieve specific functionalities. Extend what Moodle does by using freely available plugins and add-ons - the possibilities are endless!

Scalable to any size

From a few students to millions of users, Moodle can be scaled to support the needs of both small classes and large organisations. Because of its flexibility and scalability, Moodle has been adapted for use across education, business, non-profit, government, and community contexts.

Robust, secure and private

Committed to safeguarding data security and user privacy, security controls are constantly being updated and implemented in Moodle development processes and software to protect against unauthorised access, data loss and misuse. Moodle can be easily deployed on a private secure cloud or server for complete control.

Use any time, anywhere, on any device

Moodle is web-based and so can be accessed from anywhere in the world. With a default mobile-compatible interface and cross-browser compatibility, content on the Moodle platform is easily accessible and consistent across different web browsers and devices.

Extensive resources available

Access extensive Moodle documentation and user forums in multiple languages, free content and courses shared by Moodle users across the world, as well as hundreds of plugins contributed by a large global community.

Backed by a strong community

The Moodle project is well-supported by an active international community, a team of dedicated full-time developers and a network of certified Moodle Partners. Driven by open collaboration and great community support, the project continues to achieve rapid bug fixes and improvements, with major new releases every six months.

SOCIAL MEDIAS

Social Media tools are tools that allow for social interaction and easy creation of content by users. Examples of popular Social Media tools are Twitter, Facebook, Blogger, Wordpress and Pinterest.

Social Media can be an effective tool for teaching and learning in higher education. It can help connect students to information and help them generate a dialogue with their teacher and other students about a course. It can also help students and faculty build professional networks that connect them to communities beyond the U of S.

Examples for social medias

- **USask Wordpress:** Blogs for students and staff.
- **Twitter:** Share resources, connect with others, elicit feedback from students, all in 140 characters or less
- **Diigo:** Your bookmarks go where you go (access them from any computer or mobile device) and you can share them with students, colleagues and others.
- **Feedly:** Subscribe to Websites, Twitter feeds and podcasts much like you subscribe to magazines.
- **Google Docs / Drive:** Collaborate on documents with colleagues and students and your documents are accessible from anywhere.
- **Piazza:** Students ask question and other students or the instructor can provide answers and resources.

ICT Tools used in the classroom

Schools use a diverse set of ICT tools to communicate, create, disseminate, store, and manage information.(6) In some contexts, ICT has also become integral to the teaching-learning interaction, through such approaches as replacing chalkboards with interactive digital whiteboards, using students' own smartphones or other devices for learning during class time, and the "flipped classroom" model where students watch lectures at home on the computer and use classroom time for more interactive exercises.

When teachers are digitally literate and trained to use ICT, these approaches can lead to higher order thinking skills, provide creative and individualized options for students to express their understandings, and leave students better prepared to deal with ongoing technological change in society and the workplace.

The following ICT tools used in the classroom :

1. social networks
2. edublogs
3. Wikipedia
4. Ipad
5. Smart board

Advantages of ICT In teaching – learning process

Opens the door to lifelong learning • Enables simulation, role-playing and decision making exercises • Facilitates Virtual Communities and Communities of Practice • Gives access to huge amount of information • Trains skills in new literacies, that are of paramount importance in today's society

UNIT – 8

PROFESSIONAL DEVELOPMENT OF BIOLOGICAL TEACHER

PROFESSIONAL DEVELOPMENT PROGGRAMMES OF SCIENCE TEACHER

1.CONFERENCE

A **conference** is a meeting of people who "confer" about a topic. Conference types include:

- Convention (meeting), meeting of a, usually large, group of individuals and/or companies in a certain field
- Academic conference, in science and academic, a formal event where researchers present results, workshops, and other activities.
- Athletic conference, a competitive grouping of teams, often geographical
- Authors' conference, or writers' conference, where writers gather to review their written works and suggest improvements
- Conference call, in telecommunications, a call with more than two participants at the same time
- Conference hall, room where conferences are held
- Free conference, between the two houses of a bicameral legislator
- News conference, an announcement to the press (print, radio, television) with the expectation of questions, about the announced matter
- Parent-teacher conference, a meeting with a child's teacher to discuss grades and school performance
- Peace conference, a diplomatic meeting to end conflict
- Professional conference, a meeting of professionals in a given subject or profession dealing with related matters or developments

- Settlement conference, a meeting between the plaintiff and the respondent in lawsuit, wherein they try to settle their dispute without proceeding to trial
- Trade fair, or trade conference
- Unconference, or Open Space conference, a participant-driven meeting that tries to avoid one or more aspects of a conventional conference

MEMBERS OF PROFESSIONAL ORGANIZATION

TEACHER AS COMMUNITY OF LEARNERS

Recently, a nationally recognized expert in classroom management visited the campuses of Envision Schools to help coach our teachers. Though he had plenty of advice about how we can make our learning environments more structured so student learning is accelerated, he was also effusive about the sense of respect he witnessed between students, between students and teachers, and between adults in the schools.

Like many visitors to our organization's campuses, he sensed a strong sense of community. A learning community does not just happen; it is created intentionally at every level of a school and organization. At Envision Schools, we employ several strategies to create this type of environment:

Explicit Value

We are explicit that we hold community as a core value. We describe it in our literature, and leaders and teachers state it to students and their parents constantly at events, in private meetings, and in letters home. We also explicitly state to the adults in our organization that we are a professional learning community and that we plan our professional development to help foster and sustain our core value of community.

School and Organizational Structures

We organize our schools and our schedules to build a sense of community. Schools are organized by teams or families, in which a group of educators share a cohort of students. Teachers serve as advisers to sixteen students, and the advisories meet two to three times a week in our lower division (grades nine and ten) and daily in the upper division (grades eleven and twelve). Each week, teachers have three hours of common planning time with content-area colleagues and four hours of facilitated collaboration time with their team or family colleagues. We also build time into our master schedule for at least one community meeting (either by team, division, or whole school) each week.

We meet as a whole network of schools five times each year, and teachers collaborate and share curriculum and project ideas across our schools almost every week, either in person or virtually through email, instant messaging, or our Project Exchange online community.

Classroom Activities and Community Meetings

In the classrooms and advisories where we see the strongest sense of community and respect, we observe teachers regularly facilitating activities to develop these qualities. Most of these teachers greet their students at the door with a handshake or even a hug. These classrooms and advisories have norms or agreements posted prominently in the room. The norms ("Respect each other," for example, and "Listen") are not just words on a poster; teachers and students hold each other accountable to them daily.

Students are often organized in circles -- and often without desks. Every class begins with a brief check-in, during which the students and the teacher share how they are feeling, even if it's just a nonverbal thumbs-up or thumbs-down. Teachers explicitly teach collaboration skills that help groups working on

projects to be more successful, and they simultaneously build community. Teachers also confront issues of diversity, race, and class in the context of their curriculum, teaching collaboration while explicitly building a learning community.

Community meetings offer school leaders an opportunity to teach and build the whole school learning community. Each school has developed its own rituals and formats for their meetings: Some schools start each meeting with a chime and an inspirational reading. Others have students facilitate the meetings, and they begin with a quote of the day.

Schools use community meetings to address critical schools issues, to explicitly teach values such as community, and to share information. Sometimes, they're just about fun -- like one featuring an adviser Hula Hoop contest. Community meetings also serve as an opportunity to showcase student performance in the context of a project. Though every school's community meeting looks different, the outcomes are the same: Students and teachers feel more connected and part of a community.

As with most aspects of high-quality schools, building community begins with a vision and happens because the school leaders and the teachers intentionally design structures and activities to reach the vision. When our students graduate, we challenge them to lead the formation of community wherever they go, for the rest of their lives. Once you have the privilege to experience true community, you have the obligation to create it.

Role of Reflective practice in Professional development

Teachers are the greatest assets of any education system. They stand in the interface of thetransmission of knowledge, skills and values. Teacher education plays a vital role in reformingand strengthening the education system of any country. Training of teachers has emergingglobal trends in education and the overall needs and aspirations of the people. The Quality of education depends on the quality teachers and teaching. The way teachers are trained is an important aspect to improve quality.

Reflective practice has become a focus of interest and a powerful movement in teachereducation. The complexity of teaching requires teachers to question their practices for their ownprofessional development in order to improve and to increase learner performance. Reflectivepractice is the ability to reflect on an action so as to engage in a process of continuous learning.A key rationale for reflective practice is that experience alone does not necessarily lead to learning; deliberate reflection on experience is essential.

Reflective practice is an important tool in practice-based professional learning settings wherepeople learn from their own professional experiences, rather than from formal learning orknowledge transfer. It is the most important source of personal professional development andimprovement. It is also an important way to bring together theory and practice; through reflection a person is able to see and label forms of thought and theory within the context of his or her work. A person who reflects throughout his or her practice is not just looking back on past actions and events, but is taking a conscious look at emotions, experiences, actions, and responses, and using that information to add to his or her existing knowledge base and reach a higher level of understanding.

Reflective practice is used at both the pre-service and in-service levels of teaching. Coaching andpeer involvement are two aspects of reflective practices seen most often at the pre-service level.In a 1993 study on how student teachers develop the skills necessary for reflective teachingduring their field experiences, Ojanen explores the role of the teacher educator as a coach.

Teacher educators can most effectively coach student teachers in reflective practice by usingstudents' personal histories, dialogue journals, and small and large-group discussions abouttheir experiences to help students reflect upon and improve their practices.

Kettle and Sellars(1996) studied the development of third- year teaching students. They analyzed the students'reflective writings and interviewed them extensively about their reflective practices. They found

that the use of peer reflective groups encouraged student teachers to challenge existing theoriesand their own preconceived views of teaching while modeling for them a collaborative style ofprofessional development that would be useful throughout their teaching careers. Severalresearch studies have proved that critical reflection upon experience continues to be an effectivetechnique for professional development.

Freidus (1997) describes a case study of oneteacher/graduate student struggling to make sense of her beliefs and practices about whatconstitutes good teaching. Her initial pedagogy for teaching was based on the traditions andpractices of direct teaching. Her traditional socialization into teaching made it difficult for her tounderstand that her views of good teaching were being challenged in her practice.Implementingreflective teaching technique in her classroom enabled her to acknowledge and validate what shewas learning.

Strategies to practice reflection

The findings of the research on reflective practices helped the researchers to identify differentstrategies that can be practised in the pre-service training programme. The first step towards theprocess of reflection is to gather information about what happens in the class followed byanalysis of the data. Here are some different ways of doing this.

1 Reflective journal /diary

This is the easiest way to begin a process of reflection since it is purely personal. Studentteachers encounter many issues in classroom settings. After each activity/ practice lesson, thestudent teacher has to write in a notebook about what happened. They can describe about ownreactions and feelings and those things which happened during each sessions. Diary writing does require a certain discipline in taking the time to do it on a regular basis.

2 Collaborative learning

Brookfield (1995) maintains the importance of continual dialogue with peers about teaching inthe mutually cooperative environment rather than a competitive one. Collaboration with peermembers increases the probability that students teachers will be successfully reflective and moreconfident in their professional development. While discussing their experience with their peers, they can describe their own experiences and check, reframe and broaden their own theories ofpractice.

3 Recording Lessons

Video or audio recordings of lessons can provide very useful information for reflection. Throughwatching their own or other peer members' audio and video recordings, student teachers candevelop their awareness of teaching. A teacher may do many things in class but may not beaware of many things happening in the class which the teacher may not normally see. Aclassroom video can vividly picture the whole process of teaching. It can trigger teachers'reflective

thinking, reflect on their weaknesses and help them get some inspiration and ideas fortheir teaching improvement.

SPECIAL QUALITIES OF A SCIENCE TEACHER

Besides possessing the personal qualities, every science teacher should fulfill the following broad requirements.

1. Practical knowledge of child psychology and of the learning process.

2. Trained in the modern methods and techniques.

3. Basic academic requirements.

1. A science teacher must have practical knowledge of child psychology and of the process of learning. The science teacher should be able to eater to individual differences in the class. Knowledge of child psychology helps a teacher to guide the students according to their interests, capabilities and help in educational, vocational and personal problems. Besides these, a science teacher should be of a scientific temper, rational in approach to problems, free of bias and superstitions, innovative, inquisitive about the world around him. A Science teacher should regularly evaluate his teaching so that he can keep improving and also help him identify his weakness.

2. A science teacher must be trained in modern methods and techniques of science. New methods and techniques are being employed in the teaching of science. Science Clubs, improvisation of apparatus, programmed instruction, teaching machines and many other new concepts are coming in. It is, therefore, desirable that a science teacher is trained and well versed in:

(i) Development of aquaria, vivaria, terraria.

(ii) Knowledge of preserving specimens of plants and animals.

(iii) Techniques of evaluation.

(iv) Maintenance and use of science libraries.

(v) Lesson and unit planning.

(vi) The various teaching methods in use today.

3. The basic academic qualifications are laid down by the education department or the employer. In all the cases, the science teachers in high schools be at least B.Sc. and higher secondary schools M.Sc.

In order to describe more other qualities of a science teacher we are explaining herewith more details as under:

There are qualities which are general qualities which a teacher must be endowed with to be an effective teacher. However, a science teacher must possess some specific qualities to become a successful science teacher.

1. Sincerity of purpose:

A teacher should have love for his profession. He should be seriously and sincerely committed to his duties and work. As such be must be on the path of excellence both for his own personal achievements and that of his pupils.

2. Studious and learned:

A very desirable quality of a teacher is his taste for reading. He should have the habit of keeping himself in touch with the latest development especially belonging to his own subjects. He should be a voracious reader of the knowledge available to him from multi-dimensional sources.

3. A good communicator of ideas:

A teacher should be clear in speech and should be able to convey his ideas to his pupils with ease and effectiveness. His blackboard and sketching should be quite neat, bold and effective.

4. Plain speaking:

A teacher by nature should be truth loving and plan speaking. He must have enough courage to say the right thing as right and wrong ones as wrong. There should not be any ambiguity in his thoughts and saying.

5. Impartial behaviour and attitude:

A teacher should not have any biases and prejudices of any kind towards any of his students. He should not distinguish and discriminate one people from the other and should try to drop all notions of favouritism or antagonism by giving a solid proof of his impartial behaviour and attitude towards all of his students.

6. Hard worker and responsible:

The teacher should be his own example of hard work and sincerity. He should inspire his students to acquire a taste for learning, doing safe work as well as sharing responsibilities with all his keenness and sincerity.

7. Affectionate behaviour:

The teacher should create an atmosphere of good will, love and cooperation in the matter of dealing with his students. He should not get irritated on minor faults and mistakes of his pupils but should try to create an environment of mutual trust and affection congenial for proper work and learning.

8. Patience:

A teacher should not lose his patience and unnecessarily get disturbed over minor mistakes and shortcomings of his pupils but must demonstrate a lot of patience in dealing with them. On the other hand, the pupils should not always live in constant fear of the teacher but must try to receive proper guidance from their teacher.

9. Leadership and love for discipline:

The teacher must possess the traits of a good leader in whom the students may have a genuine faith. He should be able to inspire the students to seek knowledge with sincerity. A disciplined and sincere teacher will be able to inculcate the values of sincerity, discipline and obedience among students. This will channellise the energy of students towards constructive activities.

10. Self confidence:

A teacher must have confidence in his abilities. This confidence must be demonstrated through his behaviour in general and his classroom teaching in particular.

11. Mastery of his subject:

A science teacher should have profound knowledge of his subject of study so that he may not cut a sorry figure before his students. He should be able to keep his head high and be able answer all the questions and problems put to him by his students up to their satisfaction in all branches of his subject.

12. Knowledge of other subjects:

A science should not only be an expert in his subject but should also have a good working knowledge of the other related subjects. For example, the physics teacher should have good knowledge of Mathematics and Biology teacher should know much about chemistry in order to do more justice with his teaching. Moreover, a teacher equipped with the essential knowledge of the all related subjects will able to handle his students efficiently as the subjects of the curriculum are supplementary to each other in fulfilling the objectives of teaching at a particular stage and the application of one subject is easily found in the other.

13. Scientific thinking and attitude:

A good science teacher tries to imbibe scientific thinking and attitude in his own actions thoughts. For imbibition of such traits, a science teacher must attempt to provide science education in such a way as to inculcate in the pupils a habit of testing the validity of certain beliefs and facts by their own independent observations and experimentation.

14. Efficiency in the preparation and use of teaching aids:

The science teacher should have sufficient skill and dexterity in improvising and constructing his own aids in teaching of science according to the local needs and situations. Needless to say that he should have full self- confidence in handling all types of demonstration equipments and materials as well as in using all types of audio visual aids for making the science teaching as effective as possible.

15. Taste of scientific activities:

A good science teacher should have taste and love for organizing and participating in scientific activities like establishment of science museum and science club, organising scientific excursions and science fairs and engaging in the purposeful scientific hobbies. Such activities constitute real education and help in the proper development of scientific attitude among the students.

16. Knowledge of psychology related to science:

The teacher should have knowlege of the science of behaviour of his students in order to handle them effectively in the teaching- learning process. He should try to impart knowledge and skills to then according of their mental abilities, capacities, interests and attitudes, as well as emotional and social make up.

If the teacher is well equipped he may help the students to undergo a battery of intelligence tests a science stream of the curriculum. In this way, if scientific knowledge is imparted to the deserving students it will make the tasks of the teacher and the taught easier.

Apart from this the knowledge of other tests and psychological measurement will help the teacher to understand the ability, and behaviour potential of the child at the different stages of his learning or development and consequently he may bring changes in his own mode of behaviour and methods of teaching.

17. Knowledge of methods of teaching science:

It is also essential for a science teacher for being trained in the latest techniques, strategies and methodology of teaching science including the use of the all type of aid material and developed technology.

Science Teacher's Dairy:

Just like other teachers the science teacher should also keep a dairy. In this dairy the record of syllabus drawn up the science teacher be maintained. It should clearly indicate the particulars of quarterly and weekly distribution of work. A copy of the time-table be also kept in diary. The time for 1. outdoor activities. 2. projects and other allied activities and 3. class room and laboratory work.

The dairy should also show the details of written work, questions set. Entries of any comments on assignments and practical work must also find a place in teacher's diary.

A record of diary work be entered in the diary regularly and it should be dated. In keeping this record teacher should clearly mention the details of lecture-cum- demonstration work, individual experimental work, slides etc. to be shown and any such other details. He should also enter in his diary those parts of the proposed work that have been accomplished. Those parts of the proposed work that could not be accomplished and any other extra work that has been attempted.

The results of class tests and house examinations must also be recorded in teacher's diary. Science teacher can also keep a record of apparatus or chemicals to be ordered for his reference in his diary. Such a record will be quite useful for him when he is placing the orders at the beginning of the year.

TEACHER AS A RESEARCHER

Many teachers are making grassroots attempts to read, use, and generate research these days. Educational researchers love this. In turn, they are engaging with teachers, by organising events especially for teachers at

educational research conferences and collaborating with teachers in classroom research.

Schools all around Australia are currently hosting research projects involving classroom teachers. But it can be difficult for teachers to engage in research because it takes a lot of time and energy, not just in the classroom but also due to the paperwork and meetings involved.

However, I believe if we don't work with each other, teachers risk reinventing wheels or becoming trapped within an echo chamber, and researchers risk irrelevance.

There is so much to be gained by collaborating with each other. Together, teachers and researchers can develop a research literate teaching culture. Of course many teachers are already working collectively to improve their access, engagement with, and undertaking of research.

In this post I want to look at what teachers are doing and how researchers might engage with them.

Formal and informal research

Educational researchers are often interested in large-scale research questions involving multiple teachers or schools, whereas classroom teachers are often looking to participate in or conduct informal research that is specific to their own classroom context and practice.

Teachers regularly carry out informal research in their daily work in the classroom.

Informal Research

By the nature of their role, teachers are informal researchers**.** Every day a teacher enters their classroom with a new lesson to try, a new strategy to test, a new thought about how to manage young Harry's distractibility or Neville's anxieties, help Ginny understand a difficult Herbology concept, and develop Hermione's broomstick flying skills.

However we know that teachers with better research skills, who are critically reflexive, and who look outside their own experience will find and evaluate possible solutions to teaching and classroom issues more quickly and efficiently. This can make their teaching more effective.

Looking outside to what others have done is a central part of this process. However, the constant trial and error teachers undertake to improve their classroom teaching is barely spoken about or shared. Usually, it's undertaken independently, and the results a quiet accomplishment. Sometimes, it's done collaboratively, and the results are shared with the community of teachers, students and their families. Occasionally, research is undertaken more formally, purposefully, with a broad goal of improving school or system-wide policies or processes.

Formal Research

Formal research is "hard and it is technical and there are a lot of i's to dot and t's to cross" (e.g. ethics applications, access to literature, participant recruitment and informed consent, and the difficult work of analysing and interpreting complicated data). It is rigorous, and accountability for validity and reliability are deeply entrenched within the system. With so many hurdles to jump, it can take a long time to complete a formal research project.

TEACHER AS COMMUNITY OF LEARNERS

Each of the literacy meetings gave teachers hands-on experience using practical approaches to improve reading comprehension. In one typical forty-five minute session, the teachers, after discussing the assigned reading, practiced applying the techniques they were learning about. They read a poem together, each pointing out where they used background knowledge, predicting, and visualizing as strategies for reading comprehension. The meeting ended with small groups talking about ways to teach reading comprehension across disciplines. The teachers seemed energized as they spilled out of the library, continuing to chat about what they'd learned as they moved on to a day in the classroom.

Building on a Foundation of Safety and Trust

The literacy meetings are characteristic of the learning-focused professional development activities. One reason the adults at this school can do such intensive intellectual work together is that they've built trust and collaborative skills over many years. "For any learning to take place, we have to feel safe "Without safety, we won't take risks or try new things. What I realized was that my job as principal was to build a community of safety and trust among adults, just as the teachers' job was to build that community with the children."

"Every conversation we have about teaching helps us with our practice. We are building a community where everyone feels they not only have the obligation to learn, but also have the opportunity and support they need to do it."

ACTION RESEARCH IN BIOLOGICAL SCIENCE

In schools, **action research** refers to a wide variety of evaluative, investigative, and analytical research methods designed to diagnose problems or

weaknesses—whether organizational, academic, or instructional—and help educators develop practical solutions to address them quickly and efficiently. Action research may also be applied to programs or educational techniques that are not necessarily experiencing any problems, but that educators simply want to learn more about and improve. The general goal is to create a simple, practical, repeatable process of iterative learning, evaluation, and improvement that leads to increasingly better results for schools, teachers, or programs.

Action research may also be called a *cycle of action* or *cycle of inquiry*, since it typically follows a predefined process that is repeated over time. A simple illustrative example:

- Identify a problem to be studied
- Collect data on the problem
- Organize, analyze, and interpret the data
- Develop a plan to address the problem
- Implement the plan
- Evaluate the results of the actions taken
- Identify a new problem
- Repeat the process

Unlike more formal research studies, such as those conducted by universities and published in peer-reviewed scholarly journals, action research is typically conducted by the educators working in the district or school being studied—the participants—rather than by independent, impartial observers from outside organizations. Less formal, prescriptive, or theory-driven research methods are typically used when conducting action research, since the goal is to address practical problems in a specific school or classroom, rather than produce

independently validated and reproducible findings that others, outside of the context being studied, can use to guide their future actions or inform the design of their academic programs. That said, while action research is typically focused on solving a specific problem (high rates of student absenteeism, for example) or answer a specific question (Why are so many of our ninth graders failing math?), action research can also make meaningful contributions to the larger body of knowledge and understanding in the field of education, particularly within a relatively closed system such as school, district, or network of connected organizations.

The term "action research" was coined in the 1940s by Kurt Lewin, a German-American social psychologist who is widely considered to be the founder of his field. The basic principles of action research that were described by Lewin are still in use to this day.

COLLABORATION OF SCHOOL WITH COLLEGES , UNIVERSITIES AND OTHER ORGANIZATIONS

While schools colloboratively working with colleges , universities and other organizations, the school teachers and schools get the following advantages:

1. Conducting faculty development programmes.
2. Framing community oriented curriculum.
3. Doing innovative research on academic isssues.
4. Bridging schools with the society.
5. Provide ideas to improve schools infrastructures.

UNIT - 9 EXPLORING LEARNERS

IDENTIFICATION OF DIVERSE LEARNERS IN CLASSROOM

ADDRESSING THE DIVERSITY OF LEARNERS IN THE CLASSROOM

There are many kinds of learners in the classroom. They are :

- Slow learners
- Gifted children
- Mentally, Visually and Hearing impaired learners
- Mutliple Disabilities
- Orthopedic Impairment

IDENTIFICATION OF DIVERSE LEARNERS IN CLASSROOM

1. Slow learners

Definitions

A slow learner is a child of below average intelligence, whose thinking skills have developed significantly more slowly than the norm for his/her age. This child will go through the same basic developmental stages as other children, but will do so at a significantly slower rate. However, this development, while being slower, nevertheless be relatively even.

On the other hand, a child with specific learning disability, is one of average or above average intelligence who has specific difficulties which can make learning very difficult. There may be deficits in any of the basic central nervous system functions, which have to do with the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical abilities ie attention, memory, language, auditory and visual perception, motor coordination and planning, spatial orientation, impulse control and sequencing. In short, if there is a discrepancy between the child's potential and actual achievement.

CHARACTERISTICS

1. Developmental

-- may have immature language patterns or speech problems

2. Social

poor judgement, immature social behaviour, prefers company of younger children

3. Personal

frustration, aggression, anxiety

4. Academic

may show proficiency with particular tasks rather than a subject areas, poor memory, difficulties understanding several steps in a task

5. Learning

needs to have new information linked to old, difficulties transferring information learned in one situation to other situations.

Learning Disabled

1. Academic

- reading -- confuses similar words and letters, loses place, repeats words, does not read fluently, persists in using fingers to follow along, does not like to read
- spelling -- uses incorrect order of letters in words, it has difficulty of associating correct sound with appropriate letter, reverses letters

2. Mathematics

- has difficulty associating number with symbol, cannot remember number facts, confuses columns and spacing, has difficulties with story problems, has difficulty comprehending maths concepts

3. Physical

- perceptual motor difficulties
- visual perception difficulties
- poor visual decoding
- general coordination deficits (balance, eye -- hand)
- poor auditory memory (difficulty following sequence of directions)
- attention deficit
- mixed dominance (hand, foot, eye)
- lack of adequate eye movement control

4. Psychological

- emotional instability (violent reactions)
- difficulty learning by ordinary methods
- low social acceptance (disturbed peer relations)
- low self-concept/self-esteem
- general disorganisation (time and actions)

5. Social/emotional/behavioural

- hyperactivity (gross, noisy, constant movements)
- hypoactivity (quiet, nervous, fidgety)
- impulsivity
- poor concentration span (distractability)
- low frustration tolerance
- emotional lability (highs and lows)
- seems paradoxical (may remember past events in minute detail is I cannot remember number facts and spelling just learnt, may build the most intricate models that may be so clumsy s/he trips over his/her feet, make other most fanciful stories start cannot sit still long enough to hear one)

There are similarities between the two groups e.g. errors in number and letter production, reading errors, behavioural aspects, but the differences are what influence

the type of instruction used.

Education for slow learners

1. **Alternatives to traditional home work tasks.** Homework is an endless source of problems the kids and their parents. Remember, this child has probably worked twice as hard as every other child just to keep up through the day and does not need another couple of high stress hours when s/he gets home. Modify tasks, or if this is too time- consuming, cut back the amount a child has to do. Minimise written work in particular.

2. **The opportunity for intensive sessions** with the child, using individual or small group sessions. Overteach! You may think you will die of boredom and frustration by remember, you're being paid for this! Use interesting, challenging, self-correcting, extension work for the rest of the class while you spend time over teaching (NOT overtelling)

3. **Allow the child to use crutches** e.g. reminders stuck to the desktops, markers to keep place, taped readalongs, calculators

4. **Consider alternative responses and assessments.** Do more oral work and have short, easy to read/write assignments.

5. A **good supply of reference books and supplementary readers** appropriate in terms of interest level and competency level.

6. **Teach the child specific reading techniques** e.g. pre-reading routine, word attack technique, self-correcting skills and give very specific instructions to a teacher aide if you are having him/her work with this type of child.

7. **Try implementing a Parent Tutor program, Peer Tutor program, Teacher Aide program** (although remember to give you a plenty of training and very specific

instructions when working with LD children)

8. **Praise** the child at every opportunity. Grab every chance to let this child shine in in the classroom. LD children, in particular, show learning abilities as well as disabilities.

9. **Implement a buddy system** to ease your supervision of daily work. But do you let the child choose his/her own buddy -- within reason

10. **Chat to the child.** Let him/her know privately that you are on his/her side if she/he keeps trying for him/herself

11. **Chat to parents.** Let them know the same thing and see if they have any extra information that will help you. Engage their help in providing a quiet, well organised place a home in which the child can work and in supervising home tasks. But remember, don't make it too onerous. Find plenty of positives to talk to them about the same time as the problems.

12. **Adjust your expectations.** Slow learners will always be behind their chronological peers -- which doesn't mean they can't be expected to improve. It just means it will be slow. LD children can, with the right help, be expected to attain chronologically appropriate academic levels in time.

Identification of a slow learner

An Educational Assessment gives a detailed description of the child in school setting and information about:

- The child's level of attainment in the basic subjects interms of what he can do , what his special difficulties appear to be and what steps have already been tried
- The child's level of language development and speech
- Standards of achievement in other areas
- Emotional and social behaviour both in and out of the class room
- Interest in and attitudes towards school

- Previous school history
- The child's interest and background
- Degree of parental cooperation

Exceptional children

The Council for Exceptional Children lists the following terms and definitions taken from the individuals with Disabilities Education Act.

- Autism
- Deaf-blindness
- Deafness
- Emotional Disturbance
- Intellectual Disability
- Hearing Impairment
- Mutliple Disabilities
- Orthopedic Impairment
- Other Health Impairment
- Specific Learning Disability
- Speech or Language Impairment
- Traumatic Brain Injury
- Visual Impairments including blindness
- Development Delay
- At-risk
- Gifted and Talented

2. GIFTED CHILDREN

Definition

"Children who give evidence of high performance capability in areas such as intellectual, creative, artistic, leadership capacity, or specific academic fields, and who require services or activities not ordinarily provided by the school in order to fully develop such capabilities."

Characteristics

- Cognitve
- Creative
- Affective
- Behavioral
- Hidden Gifts

Identifying gifted students

TAG students demonstrate an outstanding or above-average aptitude and/or competence in one or more areas. NAGC identifies those areas of giftedness into the following six domains External link :

- **General Intellectual Ability:** High IQ scores, a wide-range of general knowledge and high levels of vocabulary, memory and abstract reasoning
- **Specific Academic Aptitude:** Outstanding performance on achievement and/or aptitude tests in one specific content area, such as math or science
- **Creative and Productive Thinking:** Synthesize new ideas by bringing together seemingly abstract, independent or dissimilar elements. Student characteristics include preference for complexity, positive self-image and openness to experience
- **Leadership Ability:** Successfully direct individuals or groups to a common goal or decision and capable of negotiating in difficult situations. Student characteristics include self-confidence, tendency to dominate and ability to adapt to new situations.
- **Visual and Performing Arts:** Demonstrate special talents in art, music, dance, drama and similarstudies
- **Psychomotor Ability:** Kinesthetic learners with strong practical, spatial and mechanical skills

Education for gifted children

- **Enrichment:** Gifted students remain in general education classes with their peers but are assigned additional/higher-level material.
- **Acceleration:** Students are advanced to a higher-level class that covers material more suited to their abilities and preparedness. May include skipping grades or completing curriculum in a shorter amount of time.
- **Pull-Out:** Gifted students are assigned to a class with a special curricular focus outside the regular classroom for two to six hours per week.
- **Full Time/Self Contained:** Gifted students are taught full time in a separate class or independent school, such as Long Island School for the Gifted.
- **Summer Enrichment:** Summer programs for gifted students often focus on one particular area of study and are offered through colleges/universities, non-profit organizations and local summer camps.
- **Homeschooling:** Though a controversial method, families of gifted students may opt to homeschool their children if they believe the school district and/or school system does not meet the needs of their children.

3. UNDER ACHIEVER

An **underachiever** is a person who fails to achieve his or her potential or does not do as well as expected.Of particular interest is **academic underachievement**. Studies of individuals who have not realized their apparent potential have identified learning disabilities, ADHD, and many other educational problems, and subsequently enabled methods of addressing these problems. Current theories among academic scholars prefer to address underperformance problems with remedial help.

Identification of under achiever

Typical methods of identifying UGSs rely on standardized measures (for example, IQ tests, achievement tests), teacher perceptions (for example, checklists, grades, assessment of motivation, assessment of daily work, comparisons with other students), and self-perceptions (for example, personal information and insight, comparisons with peers). The most common method of identifying UGSs in the early twenty-first century involve examining the difference between achievement test scores and intelligence test scores.

UNDERACHIEVEMENT CAUSES

A variety of factors contribute to the underachievement of high ability students, including emotional and social problems, lack of an appropriate curriculum, and learning and self-regulation difficulties. The attitudes of teachers and counselors toward a child may also be responsible for the gap occurring between student potential and performance.

EDUCATION FOR UNDER ACHIEVING LAERNERS

- **Supportive Strategies**. Classroom techniques and designs that allow students to feel they are part of a "family," versus a "factory," include methods such as holding class meetings to discuss student concerns; designing curriculum activities based on the needs and interests of the children; and allowing students to bypass assignments on subjects in which they have previously shown competency.

- **Intrinsic Strategies**. These strategies incorporate the idea that students' self- concepts as learners are tied closely to their desire to achieve academically. Thus, a classroom that invites positive attitudes is likely to encourage achievement. In classrooms of this type, teachers encourage attempts, not just successes; they value student input in creating classroom rules and responsibilities; and they allow students to evaluate their own work before receiving a grade from the teacher.

- **Remedial Strategies**. Teachers who are effective in reversing underachieving behaviors recognize that students are not perfect - that each child has specific strengths and weaknesses as well as social, emotional and intellectual needs. With remedial strategies, students are given chances to excel in their areas of strength and interest while opportunities are provided in specific areas of learning deficiencies. This remediation is done in a "safe environment in which mistakes are considered a part of learning for everyone, including the teacher. (Delisle)

4. Intellectually Disabled Learners or Mentally Retarded

Definition

Mentellectual disability (**ID**), also known as **general learning disability** and **mental retardation** (**MR**),is a generalized neurodevelopmental disordercharacterized by significantly impaired intellectual and adaptive functioning.

Identification of Intellectually Disabled Learners or Mentally Retarded

- Delays in reaching or failure to achieve milestones in motor skills development (sitting, crawling, walking)
- Slowness learning to talk or continued difficulties with speech and language skills after starting to talk
- Difficulty with self-help and self-care skills (e.g., getting dressed, washing, and feeding themselves)
- Poor planning or problem solving abilities
- Behavioral and social problems
- Failure to grow intellectually or continued infant-like behavior
- Problems keeping up in school
- Failure to adapt or adjust to new situations

- Difficulty understanding and following social rules

Education for Intellectually Disabled Learners or Mentally Retarded

Method # 1. Individualisation:

Considering, first of all, special methods in the education of the Educable. Mentally- Retarded, it is immediately apparent that the dominant theme in the teaching … approaches has to be the individualization of education. This does not mean that the children should receive individual instruction though this becomes possible…with small classes, and may in fact prove necessary.

Method # 2. Learning by Doing:

Another basic principle of special education is that the children should learn by doing. Activity methods are employed which put the emphasis on learning through experience. The mentally handicapped child, whose shortcomings lie in the area of relational and abstract thought, will always have difficulty in learning where he is required to play a passive role, and where the methods of communication is largely verbal.

Method # 3. Need for Learning Readiness:

Again, it is important in introducing academic work to the mentally handicapped, that we take cognizance of the concepts of maturation and learning-readiness. These children have the ability to learn to read, to write and to count, provided that the way is prepared for the introduction of these subjects through appropriate readiness programmes.

Method # 4. Repetition:

Since mentally handicapped children do tend to have poorer memories than ordinary children, teaching method must provide for a considerable amount of repetition if learned material is to be retained. This, however, is no justification for rote learning procedures devoid of insight. Understanding should always precede measures designed to improve retention. Even in the case of mentally retarded, if they are well-motivated and the material is interesting and has meaningful associations, the memory span can be much increased.

Method # 5. Short Periods:

Although the mentally retarded child has limited powers of concentration, and for this reason formal teaching periods should be kept fairly short, at the same time it is remarkable how long he can persevere when he finds the subject stimulating. We should not see in this an invitation to sugar-coat the unpalatable pill of knowledge, but rather a challenge to our understanding of his needs and genuine interests.

Method # 6. Concrete Problems:

It is also true to say that mentally retarded children do show lack of imagination and foresight and consequently have difficulty in transferring the learning experience of one situation to a similar but new and an unfamiliar one. Real life problem should be introduced whenever possible so that the immediate application of what is to be learned can be more easily appreciated.

Method # 7. Graded Curriculums:

Since these children learn more slowly than the average child the work undertaken in the basic subjects of reading and arithmetic must be carefully graded to ensure steady progress and allow of feelings of success. This raises many difficulties for the teacher since the text-books in current use are designed for ordinary children and are much too steeply graded and often too sophisticated for the mentally retarded child.

Method # 8. Projects:

One of the most fruitful approaches to the teaching of mentally retarded children is through introduction of Projects or Centres of Interest. There is still a great deal of controversy as to how this can best be done without serious disruption of the basic subject programme.

Method # 9. Teaching the Trainable Mentally-Retarded:

Much of what has been said is pertinent also to the education of the Trainable Mentally- Retarded group of children. At this point, however the importance of warm pupil-teacher relationships needs to be stressed. An understanding of the nature and needs of these children and a willingness to meet them provide the necessary basis for the development of suitable methods. Needless to say, we

cannot aim so high in our ultimate objectives and our methods will on the whole have a more practical orientation.

5. Hearing Impaired students

Definition

Hearing impairment refers to the inability or limited ability to hear. Some hearing impaired students have mild hearing loss and may be able to use hearing aids to amplify sounds, while others have no sound perception in one or both ears. A person who has no sound perception in both ears is deaf. People may be born deaf or may develop hearing loss from disease, aging, exposure to noise, or trauma. Teachers may find it useful to know the origin or background of a student's hearing impairment.

Causes

- **Genetic disorders.** Some genetic (inherited) disorders interfere with the proper development of the inner ear and/or the auditory nerve.
- **Injuries to the ear or head.** Injuries such as a skull fracture can cause hearing loss.
- **Complications during pregnancy or birth.** Some babies are born with hearing impairment due to infections or illnesses that the mother had while she was pregnant, which can interfere with the development of the inner ear. Premature babies are also at higher risk for hearing impairment.
- **Infections or illnesses.** Certain conditions, such as repeated ear infections, mumps, measles, chickenpox, and brain tumors, can damage the structures of the inner ear.
- **Medications.** Certain medications, such as some antibiotics and chemotherapydrugs, can cause hearing loss.
- **Loud noise.** A sudden loud noise or exposure to high noise levels (such as loud music) over time can cause permanent damage to the tiny hair cells in the cochlea, which then can't transmit sounds as effectively as they did before.

Identifying Hearing impaired learners

- You feel that people mumble or that their speech is not clear, or you hear only parts of conversations when people are talking.
- You often ask people to repeat what they said.
- Friends or family tell you that you don't seem to hear very well.
- You don't laugh at jokes because you miss too much of the story.
- You need to ask others about the details of a class or meeting you attended.
- People say that you play music or your TV too loudly.
- You can't hear the doorbell or telephone.

Education for Hearing impaired

- **Bilingual–Bicultural** or **BiBi** deaf education programs use sign language as the native, or first, language of Deaf children. In the United States, for example, BiBi proponents claim that American Sign Language (ASL) is the natural first language for deaf children, despite the majority of deaf and hard of hearing being born to hearing parents. In this same vein, the spoken or written language used by the majority of the population is viewed as a secondary language to be

- acquired either after or at the same time as the native language. In BiBi education, sign language is the primary method of instruction. The bicultural aspect of BiBi education emphasizes Deaf culture and strives to create confidence in deaf students by exposing them to the Deaf community.

- **Auditory-verbal therapy** is a method for teaching deaf children to listen and speak using their residual hearing in addition to the constant use of amplification devices such as hearing aids, FM devices, and cochlear implants. Auditory-verbal therapy emphasizes speech and listening.

Motivating learners to bring their previous knowledge into classroom

In order to gauge how much students have learned, it is not enough to assess their knowledge and skills at the end of the course or program. We also need to find out what they know coming in so that we can identify more specifically the knowledge and skills they have gained during the course or program.

You can choose from a variety of methods to assess your students' prior knowledge and skills. Some methods (e.g., portfolios, pre-tests, auditions) are direct measures of students' capabilities entering a course or program. Other methods (e.g., students' self-reports, inventories of prior courses or experiences) are indirect measures. Here are links to a few methods that instructors can employ to gauge students' prior knowledge.

1. Performance-based prior knowledge assessments
2. Prior knowledge self-assessments
3. Classroom assessment techniques (CATs)
4. Concept maps
5. Concept tests

1. Performance-Based Prior Knowledge Assessments

The most reliable way to assess students' prior knowledge is to assign a task (e.g., quiz, paper) that gauges their relevant background knowledge.

These assessments are for diagnostic purposes only, and they should not be graded. They can help you gain an overview of students' preparedness, identify areas of weakness, and adjust the pace of the course.

To create a performance-based prior knowledge assessment, you should begin by identifying the background knowledge and skills that students will need to succeed in your class. Your assessment can include tasks or questions that test students' capabilities in these areas.

2. Prior Knowledge Self-Assessments

- Prior knowledge self-assessments ask students to reflect and comment on their level of knowledge and skill across a range of items. Questions can focus on knowledge, skills, or experiences that: you assume students have acquired and are prerequisites to your course
- you believe are valuable but not essential to the course
- you plan to address in the course

The feedback from this assessment can help you calibrate your course appropriately or direct students to supplemental materials that can help them address weaknesses in their existing skills or knowledge.

The advantage of a self-assessment is that it is relatively easy to construct and score. The potential disadvantage of this method is that students may not be able to accurately assess their abilities. However, accuracy improves when the response options clearly differentiate both types and levels of knowledge.

Writing Appropriate Questions for Self-Assessments

Writing appropriate questions for prior knowledge self-assessments can seem daunting at first. Identifying specific terms, concepts, or applications of skills to ask about will help you write effective questions.

3. ***Using Classroom Assessment Techniques***

Classroom Assessment Techniques (CATs) are a set of specific activities that instructors can use to quickly gauge students' comprehension. They are generally used to assess students' understanding of material in the current course, but

with minor modifications they can also be used to gauge students' knowledge coming into a course or program.

CATs are meant to provide immediate feedback about the entire class's level of understanding, not individual students'. The instructor can use this feedback to inform instruction, such as speeding up or slowing the pace of a lecture or explicitly addressing areas of confusion.

4. Using Concept Maps

Concept maps are a graphic representation of students' knowledge. Having students create concept maps can provide you with insights into how they organize and represent knowledge. This can be a useful strategy for assessing both the knowledge students have coming into a program or course and their developing knowledge of course material.

Concept maps include *concepts*, usually enclosed in circles or boxes, and *relationships* between concepts, indicated by a connecting line. Words on the line are *linking words* and specify the relationship between concepts.

5. Using Concept Tests

Concept tests (or ConcepTests) are short, informal, targeted tests that are administered during class to help instructors gauge whether students understand key concepts. They can be used both to assess students' prior knowledge (coming into a course or unit) or their understanding of content in the current course.

Usually these tests consist of one to five multiple-choice questions. Students are asked to select the best answer and submit it by raising their hands, holding up a color card associated with a response option, or using a remote control device to key in their response.

The primary purpose of concept tests is to get a snapshot of the current understanding of the class, not of an individual student. As a result, concept tests are usually ungraded or very low-stakes. They are most valuable in large classes where it is difficult to assess student understanding in real time.

Involving learners in teaching learning process

Research has demonstrated that engaging students in the learning process increases their attention and focus, motivates them to practice higher-level critical thinking skills, and promotes meaningful learning experiences. Instructors who adopt a student-centered approach to instruction increase opportunities for student engagement, which then helps everyone more successfully achieve the course's learning objectives.

Active learning requires students to participate in class, as opposed to sitting and listening quietly. Strategies include, but are not limited to, brief question-and-answer sessions, discussion integrated into the lecture, impromptu writing assignments, hands-on activities, and experiential learning events. As you think of integrating active learning strategies into your course, consider ways to set clear expectations, design effective evaluation strategies, and provide helpful feedback.

1. MAKE IT MEANINGFUL

In aiming for full engagement, it is essential that students perceive activities as being meaningful. Research has shown that if students do not consider a learning activity worthy of their time and effort, they might not engage in a satisfactory way, or may even disengage entirely in response (Fredricks, Blumenfeld, & Paris, 2004). To ensure that activities are personally meaningful, we can, for example, connect them with students' previous knowledge and experiences, highlighting the value of an assigned activity in personally relevant ways. Also, adult or expert modeling can help to demonstrate why an individual activity is worth pursuing, and when and how it is used in real life.

2. FOSTER A SENSE OF COMPETENCE

The notion of competence may be understood as a student's ongoing personal evaluation of whether he or she can succeed in a learning activity or challenge. (Can I do this?) Researchers have found that effectively

performing an activity can positively impact subsequent engagement (Schunk & Mullen, 2012). To strengthen students' sense of competence in learning activities, the assigned activities could:

- Be only slightly beyond students' current levels of proficiency
- Make students demonstrate understanding throughout the activity
- Show peer coping models (i.e. students who struggle but eventually succeed at the activity) and peer mastery models (i.e. students who try and succeed at the activity)
- Include feedback that helps students to make progress

3. PROVIDE AUTONOMY SUPPORT

We may understand autonomy support as nurturing the students' sense of control over their behaviors and goals. When teachers relinquish control (without losing power) to the students, rather than promoting compliance with directives and commands, student engagement levels are likely to increase as a result (Reeve, Jang, Carrell, Jeon, & Barch, 2004). Autonomy support can be implemented by:

- Welcoming students' opinions and ideas into the flow of the activity
- Using informational, non-controlling language with students
- Giving students the time they need to understand and absorb an activity by themselves

4. EMBRACE COLLABORATIVE LEARNING

Collaborative learning is another powerful facilitator of engagement in learning activities. When students work effectively with others, their engagement may be amplified as a result (Wentzel, 2009), mostly due to experiencing a sense of connection to others during the activities (Deci & Ryan, 2000). To make group work more productive, strategies can be

implemented to ensure that students know how to communicate and behave in that setting. Teacher modeling is one effective method (i.e. the teacher shows how collaboration is done), while avoiding homogeneous groups and grouping by ability, fostering individual accountability by assigning different roles, and evaluating both the student and the group performance also support collaborative learning.

5. ESTABLISH POSITIVE TEACHER-STUDENT RELATIONSHIPS

High-quality teacher-student relationships are another critical factor in determining student engagement, especially in the case of difficult students and those from lower socioeconomic backgrounds (Fredricks, 2014). When students form close and caring relationships with their teachers, they are fulfilling their developmental need for a connection with others and a sense of belonging in society (Scales, 1991). Teacher-student relationships can be facilitated by:

- Caring about students' social and emotional needs
- Displaying positive attitudes and enthusiasm
- Increasing one-on-one time with students
- Treating students fairly
- Avoiding deception or promise-breaking

6. PROMOTE MASTERY ORIENTATIONS

Finally, students' perspective of learning activities also determines their level of engagement. When students pursue an activity because they want to learn and understand (i.e. mastery orientations), rather than merely obtain a good grade, look smart, please their parents, or outperform peers (i.e. performance orientations), their engagement is more likely to be full and thorough (Anderman & Patrick, 2012). To encourage this mastery orientation mindset, consider various approaches, such as framing success in terms of learning (e.g. criterion-referenced) rather than performing (e.g. obtaining a good grade). You can also place the emphasis on individual

progress by reducing social comparison (e.g. making grades private) and recognizing student improvement and effort.

Encouraging learners to raise and ask questions

Get your students truly engaged by giving them opportunities to ask questions and implementing these tips!

Have you ever planned a lesson involving a class discussion that flopped? Have you ever heard crickets after presenting a prompt? Classroom discussion is a great way to develop a variety of 21st century skills including not only communication, but also critical thinking. Students become more engaged and their curiosity is captured. The key to success may be easier than you think: questions!

An essential part of sparking any discussion and keeping it rolling is getting your students engaged by having them ask questions. Questions allow students to dig deeper, explore, and correct misconceptions. What is unfortunate is that many students do not feel comfortable asking questions. Use these tips to encourage more questioning from your students.

1.create a safe environment

Often students do not ask questions because they are afraid or uncomfortable. Ensure that your classroom is an environment in which students feel secure. Set some ground rules for your students that include respecting all questions, valuing all questions, and utilizing active listening. Practice asking questions at the start of a new unit by having your class think of as many questions about the new topic as they can. Write them all on the board without answering them. Keep going until they run out. This is a great first step to getting your students comfortable and thinking outside of the box.

2. Praise All Questions

As an extension to creating a safe environment, be sure to give positive praise to ALL questions. This includes both the questions that are deep and those that are a little off track. By providing praise, you will encourage the questions to continue. Select some questions as inspiration for your next lab or project. Use a student question on your next test. Show your students that asking questions is valued in any and every way that you can.

3. Teach How to Ask Questions

Sometimes student may not know how to start to ask a question. This is true for both younger students and those in high school! You can assist your students by posting question starters in a visible place in the room. These stems can include "why does…", "how does ____ work", and "what is the difference between…". Another great way to teach questioning is by modeling asking questions to your students. Using Bloom's Taxonomy is a great place to start.

4. End with Student Reflection

While encouraging your students to ask questions is a great first step, ultimately we want it to become a habit. This is where reflection comes in. At the end of a great questioning session or class discussion, ask students to take five minutes to reflect on how questioning helped their thinking. This may even lead to new questions and curiosity that will keep them engaged in the future.

Follow these tips in your classroom to encourage your students to ask questions. Not only will they be actively participating, but they will be more motivated to learn. Find out more about improving your students' communication skills here!

Questioning Techniques

Closed questions (aka the 'Polar' question)

Closed, or 'polar' questions generally invite a one-word answer, such as 'yes' or 'no'. For example, 'do you drive?' or, 'did you take my pen?' They could also include answers to factual or multiple choice questions, such as 'what's your name', or 'would you like tea, coffee, or water?'

They're popular as icebreaker questions in group situations because they're easy to answer. Of course, most questions can be opened up for further discussion, including closed questions — but more on that later.

Open questions

Open-ended questions require a little more thought and generally encourage wider discussion and elaboration. They can't be answered with a simple yes or no response. For example: 'what do you think of your boss?' Or 'why did you choose that car?'

Useful for: critical or creative discussion, finding out more information about a person or subject

Probing questions

These questions are useful for gaining clarification and encouraging others to tell you more information about a subject. Probing questions are usually a series of questions that dig deeper and provide a fuller picture. For example: 'when do you need the finished project, and is it ok if I email it to you?'

Useful for: seeing the bigger picture, encouraging a reluctant speaker to tell you more information, and avoiding misunderstandings

Leading questions

These questions are designed to lead the respondent towards a certain desired positive or negative route.

In the workplace, you might encounter leading questions such as: 'do you have any issues with the project?', or 'did you enjoy working on that project?' The former subtly prompts the respondent towards a negative response; the latter

towards a positive. Asking 'how did you get on with that project' will get you a more balanced answer.

Leading questions could also involve an appeal at the end that's designed to coerce the respondent into agreeing with the speaker. For example, 'this project is going well, isn't it?' encourages the respondent to say 'yes'. This works particularly well because psychologically, we prefer saying yes over no. So when we're put on the spot, we'll usually opt for the former.

Useful for: building positive discussions, closing a sale, steering a conversation towards an outcome that serves your interest

A word of warning: It's important to use leading questions carefully; they can be seen as an unfair way of getting the answer you want.

Loaded questions

Loaded questions are seemingly straightforward, closed questions — with a twist: they contain an assumption about the respondent. They're famously used by lawyers and journalists to trick their interviewee into admitting a fundamental truth they would otherwise be unwilling to disclose.

Funnel questions

As with a funnel, these questions begin broadly before narrowing to a specific point — or vice versa.

When meeting someone new, we usually begin with specific, closed questions, such as 'what's your name?' and 'what do you do?' – before broadening out into more open-ended questions, such as 'why did you choose to be a firefighter?' as you become more comfortable talking to each other.

The reverse — beginning with a broad question before honing in on something specific — is often used when questioning witnesses to gain the maximum amount of information about a person or situation. For example, 'what do you do for a living? Do you work nights? Did you see a break-in? Was there more than one person?' And so on.

Funnel questions can also be used to diffuse tension: asking someone to go into detail about their issue distracts them from their anger and gives you the information you need to offer them a solution, which in turn calms them down and makes them think something positive is being done to help them.

Useful for: building relationships, discovering very specific information, diffusing arguments

Recall and process questions

Recall questions require the recipient to remember a fact. For example, 'what's seven times seven?' and 'where did you put the keys?' or 'What's your login password?' Process questions, on the other hand, require the respondent to add their own opinion to their answer. These types of questions can be used to test the respondent's depth of knowledge about a particular topic. For example: 'what are the advantages of asking a closed question?' or 'why are you the right person to lead this project?'

Useful for: encouraging critical thought and in-depth evaluation of a subject in tests, interviews or discussions

Rhetorical questions

These are a different beast altogether because they don't really require an answer. They're simply statements phrased as questions to make the conversation more engaging for the listener, who is drawn into agreeing with you.

For example, 'isn't it nice working with such a friendly team?' is more engaging that 'this team is friendly', which doesn't require any mental participation from the respondent.

Rhetorical questions are often used by coaches or public speakers for effect to get the audience thinking and agreeing. In this way, they're a not-too-distant cousin of the leading question.

UNIT – 10

TOOLS AND TECHNIQUES OF ASSESSMENT OF LEARNING BIOLOGICAL SCIENCE

PERFORMANCE BASED ASSESSMENT TECHNIQUES

ASSESSMENT OF PROJECT WORK

Project work challenges students to think beyond the boundaries of the classroom, helping them develop the skills, behaviors, and confidence necessary for success in the 21st-century. Designing learning environments that help students question, analyze, evaluate, and extrapolate their plans, conclusions, and ideas, leading them to higher–order thinking, requires feedback and evaluation that goes beyond a letter or number grade. The term "authentic assessment" is used to describe assessment that evaluates content knowledge as well as additional skills like creativity, collaboration, problem-solving, and innovation.

Authentic assessment documents the learning that occurs during the project-building process and considers the real-world skills of collaboration, problem solving, decision making, and communication. Since project work requires students to apply knowledge and skills throughout the project-building process, you will have many opportunities to assess work quality, understanding, and participation from the moment students begin working.

For example, your evaluation can include tangible documents like the project vision, storyboard, and rough draft, verbal behaviors such as participation in group discussions and sharing of resources and ideas, and non-verbal cognitive tasks such as risk taking and evaluation of information. You can also capture snapshots of learning throughout the process by having students

complete a project journal, a self-assessment, or by making a discussion of the process one component of the final presentation.

Developing Assessment

As you design the project, it is helpful to begin with the end in mind. What performances do you want to see? Then, determine exactly how students will demonstrate each performance as they build a product or solve a problem to complete the task.

Most of our assessment focuses on content mastery. Techniques we are all familiar with include the evaluation of the final product and having students complete quizzes or tests. Other benchmarks for content mastery you can use include the number of citations a student references, amount and quality of research, use of experts, validity and effectiveness of arguments, meeting the topic, and answering the essential question.

Creating Rubrics

Because many performances cannot easily be quantified, you want to be as specific about your expectations as possible. Creating a rubric for the final product and various components of project work can ensure a more accurate, specific, and useful assessment.

A rubric is an authentic assessment tool that:

- Provides clear expectations for a project.
- Examines the product as well as the entire project-building process.
- Enumerates the performances on which students will be evaluated.
- Explains what constitutes excellence during the project process.
- Helps students understand what they need to do to excel.
- Helps remove subjectivity and bias from the evaluation process.

Sharing and clarifying the performances that will be assessed during a project removes mystery from the evaluation process, helping students focus on specific actions they can take to improve their performance.

Involving students in assessment

Involving students in project assessment boosts motivation, improves meta-cognition, and promotes self-directed learning. Students who are asked to reflect on their own performance learn to evaluate their strengths and weaknesses and are able to pinpoint where to focus their efforts to see the greatest results.

You might have students provide feedback and critiques by asking them to keep a project journal or work log, evaluate themselves using the project rubric, and answer additional self-assessment questions. An open-ended self-assessment allows students to share learning that occurred during the process that was not included in the rubric. As they reflect and evaluate, students should describe their learning and contemplate decisions they have made individually and as a team.

You may also want to have students complete a peer evaluation for components of the project, such as the project presentation. Students can also evaluate the writing, design, and effective communication during the creation and presentation of the final product. Combining your assessment of the process and the end product with student reflections and evaluations will help you create a more accurate assessment of student performance.

Audience assessment

Authentic project work should reflect the questions, problems, and needs of the world beyond the classroom. If the work is something that has real value, make sure there is a wider audience for the final product presentation. Having

students create web pages to display their ideas and findings enables their products to easily reach a wider audience. If the project deliverable involves an oral presentation, invite peers, family, or community members to attend.

You may also want to invite subject matter experts in the area of project work to participate in the final product's assessment. Developing public-service announcements? Invite employees from a local advertising agency. Designing a new school? One of your classroom parents may just be an architect.

ASSESSMENT OF PARTICIPATION COLLABORATIVE LEARNING

Assessment activities can be categorized as either formative or summative, both of which are appropriate for cooperative learning exercises as they provide opportunities to enhance key components of cooperative learning exercises such as positive interdependence and individual accountability (which is one of the five key elements of cooperative learning).

- **Formative assessment** activities are used to provide feedback, evaluating learning progress in order to motivate students to higher levels.
- **Summative assessment** activities are used to judge final products for completion, competency and/or demonstrated improvement.

Nearly any evaluation can be developed to fulfill either formative or summative assessment goal. For example, written reports can include a revise and resubmission process which provides students with feedback on which aspect of their work is in need of improvement prior to evaluation of the final product. Assessment activities can be implemented at different stages of the cooperative learning exercise and can be conducted by either the instructor, the student, or group peers.

Timing of assessment activities

Pre-Exercise Assessment

Developing assessment strategies that are implemented before the exercise is to take place are most appropriate when cooperative learning exercises are more complex, time intensive, and make use of more sophisticated content. The success of such exercises hinges, in part, on the preparation of students and pre-exercise activities can provide a signal as to the importance and complexity of this work to students.

"Tickets to participate" are a form of assessment that requires individual students to complete a task prior to the start of the cooperative learning exercise. The purpose of these assignments are to prepare students, focusing their attention on content relevant to the exercise and reducing the likelihood of unprepared students. Those who fail to complete the assignment are placed in a group together and required to complete the exercise. In all likelihood, such unprepared students will create output that is of lower quality than their otherwise prepared peers resulting in a valuable lesson learned.

Assessment During the Exercise

Assessment can occur at either the individual or group level during the cooperative learning exercise, facilitated through careful monitoring and intervention or by a formal break in the exercise with all groups checking in on their progress.

Assigning roles to group members, such as summarizer, reflector, elaborator, and/or recorder/secretary provides a more formal mechanism for evaluating the progress of the group.

It is also possible to make individual accountability part of your group-work monitoring by periodically requesting random student reports or oral exams (graded at the instructor's discretion).

- When setting up groups, have the students within each group count off. So in each group, one student has the number "1," another the number "2," and so on.
- At an appropriate point in the exercise, walk up to a group and pick a number at random and that person must report on the group's progress or answer a question about what the group is doing.

Post-Exercise Assessment

In order to make sure that all students are working towards the same standards, it is helpful to provide a detailed description (possibly a rubric or checklist) of how the project will be graded. (Find more information about developing rubrics)

- **Individual accountability:** In many or most cooperative learning classes, students still take individual tests or quizzes (in part to make sure that everyone is doing the reading). Group projects can also result individual products. With the peer review method, for example, the paper is the responsibility of the author, and sometimes the reviewers comments on their own are also subject to grading. (Learn more about using peer review)
- **Group accountability:** Gradable group products include presentations, posters, and papers.

CONSTRUCTION OF TEST ITEMS

Open Questions

Open questions in the sense, the examiner will not prepare the questions in advance and they will ask questions without any preparation at the time of examination.

Structured Questions

On the contrary, this type of question will be planned and structured in advance.

Construction Of Test Items

- Designing tests is an important part of assessing students understanding of course content and their level of competency in applying what they are learning. Whether you use low-stakes and frequent evaluations–quizzes– or high-stakes and infrequent evaluations–midterm and final–careful design will help provide more calibrated results.
- Multiple choice exams
- Essay questions
- Assessing your test
- **Here are a few general guidelines to help you get started:**
- **Consider your reasons for testing**.
    - Will this quiz monitor the students' progress so that you can adjust the pace of the course?
    - Will ongoing quizzes serve to motivate students?
    - Will this final provide data for a grade at the end of the quarter?

- Will this mid-term challenge students to apply concepts learned so far?
- The reason(s) for giving a test will help you determine features such as length, format, level of detail required in answers, and the time frame for returning results to the students.

- **Maintain consistency** between goals for the course, methods of teaching, and the tests used to measure achievement of goals. If, for example, class time emphasizes review and recall of information, then so can the test; if class time emphasizes analysis and synthesis, then the test can also be designed to demonstrate how well students have learned these things.
- **Use testing methods that are appropriate to learning goals**. For example, a multiple choice test might be useful for demonstrating memory and recall, for example, but it may require an essay or open-ended problem-solving for students to demonstrate more independent analysis or synthesis.
- **Help Students prepare**. Most students will assume that the test is designed to measure what is most important for them to learn in the course. You can help students prepare for the test by clarifying course goals as well as reviewing material. This will allow the test to reinforce what you most want students to learn and retain.
- **Use consistent language** (in stating goals, in talking in class, and in writing test questions) to describe expected outcomes. If you want to use words like *explain* or *discuss*, be sure that you use them consistently and that students know what you mean when you use them.

- **Design test items that allow students to show a range of learning**. That is, students who have not fully mastered everything in the course should still be able to demonstrate how much they have learned.

Multiple choice exams

- Multiple choice questions can be difficult to write, especially if you want students to go beyond recall of information, but the exams are easier to grade than essay or short-answer exams. On the other hand, multiple choice exams provide less opportunity than essay or short-answer exams for you to determine how well the students can think about the course content or use the language of the discipline in responding to questions.
- If you decide you want to test mostly recall of information or facts and you need to do so in the most efficient way, then you should consider using multiple choice tests.
- **The following ideas may be helpful as you begin to plan for a multiple choice exam:**
- Since questions can result in misleading wording and misinterpretation, try to have a colleague answer your test questions before the students do.
- Be sure that the question is clear within the stem so that students do not have to read the various options to know what the question is asking.
- Avoid writing items that lead students to choose the right answer for the wrong reasons. For instance, avoid making the correct alternative the longest or most qualified one, or the only one that is grammatically appropriate to the stem.
- Try to design items that tap students' overall understanding of the subject. Although you may want to include some items that only require

recognition, avoid the temptation to write items that are difficult because they are taken from obscure passages (footnotes, for instance).

- Consider a formal assessment of your multiple-choice questions with what is known as an "item analysis" of the test. For example:
  - Which questions proved to be the most difficult?
  - Were there questions which most of the students with high grades missed?
- This information can help you identify areas in which students need further work, and can also help you assess the test itself: Were the questions worded clearly? Was the level of difficulty appropriate? If scores are uniformly high, for example, you may be doing everything right, or have an unusually good class. On the other hand, your test may not have measured what you intended it to.

Essay questions

"Essay tests let students display their overall understanding of a topic and demonstrate their ability to think critically, organize their thoughts, and be creative and original. While essay and short-answer questions are easier to design than multiple-choice tests, they are more difficult and time-consuming to score. Moreover, essay tests can suffer from unreliable grading; that is, grades on the same response may vary from reader to reader or from time to time by the same reader. For this reason, some faculty prefer short-answer items to essay tests. On the other hand, essay tests are the best measure of students' skills in higher-order thinking and written expression."

(Barbara Gross Davis, Tools for Teaching, 1993, 272)

TEST ADMINISTRATION

We administer most of our tests in one of four ways:

- **Paper-delivered Tests**: Most of our paper-delivered tests, which test takers fill out with paper and pencil, are administered under standardized conditions at colleges or schools. Answer sheets are returned to ETS for scoring and analysis.
- **Single-purpose Tests**: Some single-purpose paper- and computer-delivered tests, such as placement exams, may be administered on a semi-secure basis under the applicable institution's control.
- **Computer-delivered Tests**: Many ETS computer-delivered tests are administered at ETS-authorized, technologically equipped test centers.
- **Internet-delivered Tests**: These tests can be given in a wide range of Internet-enabled testing venues, without the need for dedicated testing workstations.

DEVELOPING ASSESSMENT FRAME WORK

1. determining the kinds of inferences and conclusions about student performances that are desired in reports of NAEP results, and then using this vision of student achievement to guide the entire assessment development process
2. improving assessment of the subject areas as described in current frameworks and including an expanded conceptualization of student achievement in future frameworks and assessments
3. using multiple assessment methods, in addition to large-scale surveys, to improve the match of assessment purpose with assessment method
4. enhancing use of assessment results, particularly student responses to constructed-response items, performance-based tasks, and other

alternative assessment methods, to provide interpretive information that aids in understanding overall NAEP results, and

5. improving coherence across the many steps in the assessment development process as an essential prerequisite to successfully accomplishing goals 1 through 4.

Continuous and Comprehensive Evaluation (CCE)

Continuous and Comprehensive Evaluation (CCE) refers to a system of school-based evaluation of students that covers all features of students' development. It is a developmental process of assessment that stresses two-fold objectives i.e. on continuousness in evaluation and assessment of broad-based learning and behavioral outcomes on the other.

According to this scheme, the term `continuous' is meant to accentuate that evaluation of identified aspects of students' growth and development' is a continuous process rather than an incident, built into the total teaching-learning process and spread over the whole duration of the academic session.

The second term `**comprehensive**' means that the scheme tries to cover both the scholastic and the co-scholastic aspects of students' growth and development.

Aims of Continuous and Comprehensive Evaluation:

- The main aim of CCE was to assess every aspect of the child during their presence at the school.
- CCE helps in minimizing the stress on children.
- Make assessment comprehensive & regular.
- Provide space for the teacher for prolific teaching.
- Provide a tool for detection & corrections.
- Produce learners with greater skill

Objectives of Continuous and Comprehensive Evaluation:

Various are the objectives of Continuous and Comprehensive Evaluation:

- It makes the process of teaching and learning a learner-centered activity.
- To make the assessment process an essential part of the teaching-learning process.
- To make a fair judgment and take timely decisions for learner's growth, learning process, learning pace, and learning environment.
- To provide scope for learners for self-assessment.
- To use the evaluation process for improving student's achievement through detection and correction.

Features of Continuous and Comprehensive Evaluation:

- The 'continuous' aspect of CCE takes care of 'continual' and 'periodicity' features of assessment.
- The 'comprehensive' elements of CCE takes care of assessment of all-round development of the child's personality.
- The continuous and comprehensive evaluation includes both Scholastic as well as Co-Scholastic aspects of the pupil's growth. Scholastic aspects cover curricular areas or subject-specific areas, while co-scholastic aspects consist of Life Skills, Co-Curricular Activities, Attitudes, and Values.
- Assessment in Co-Scholastic areas is done using the number of techniques on the basis of recognized criteria, while assessment in Life Skills is done on the basis of indicators of Assessment and checklists.

Functions of Continuous and Comprehensive Evaluation:

- CCE helps the teacher to systematize efficacious teaching strategies.
- Continuous evaluation serves to detect weaknesses and permits the teacher to ascertain certain individual learners.
- Through continuous assessments, students can know their strengths and weaknesses.
- CCE helps in identifying changes in attitudes and value systems.
- CCE provides information on the progress of students in scholastic and co-scholastic areas which results in forecasting the future success of the learners.

Aspects of CCE

Continuous and Comprehensive Evaluation considers both the scholastic and co-scholastic aspects.

Scholastic assessment: Scholastic aspects include curricular areas or subject-specific areas. These areas focus on oral and written class tests, cycle tests, activity tests, and daily class performances of all subjects in order to improve writing and speaking skills. Scholastic assessment should be both Formative and Summative.

Formative Assessment:

Formative assessment consists of diagnostic testing, which is the extent of formal and informal assessment procedures conducted by teachers during the learning process in order to alter teaching and learning activities to improve student achievement. It typically involves qualitative feedback for both student and teacher that is the basis of the details of content and performance. It is commonly compared with summative assessment, which attempts to monitor educational outcomes, often for purposes of external responsibility.

Features of Formative Assessment:

- It makes provision for effective feedback.
- It provides a plan for the active involvement of students in their own learning
- It helps the student to support their peers' group and vice-versa.
- It helps in integrating diverse learning styles to decide how and what to teach.
- co-scholastic aspects include Life Skills, Co-Curricular Activities, Attitudes, and Values.
- It provides the student with a chance to improve their scores after they get feedback.
- It helps in the detection and correction of the assessment process.

Summative Assessment:

Summative assessment is an assessment of students where the focus is on the consequences of a program. The goal of summative assessment is to assess student learning at the end of an instructional unit by comparing it against a norm.

Features of Summative assessment:

- It can be done at the end of a unit or semester to display the sum of what they learn or whatnot.
- This is the contrasts with formative assessment, which summarizes the participants' development at a particular time.
- It is a conventional way of assessing students' work.

Co-scholastic assessment:

Co-Scholastic Areas of Assessment: The areas of Co-scholastic assessment focus on increasing the skills of a student in general knowledge, environmental education, physical education, art, music and dance, and computers. These are evaluated through quizzes, competitions, and activities.

School-based continuous and comprehensive evaluation system helps a learner in the following ways:

- It reduces stress on children.
- It makes evaluation comprehensive and regular.
- It provides a tool for the detection and correction of action.
- It provides space for the teacher for creative teaching.
- It produces learners with greater skills.

Characteristics of School-Based CCE:

School-based CCE has the following characteristics:

- It is comprehensive, broader, and continuous than the traditional system.
- It aims primarily to help learners for orderly learning and development.
- It takes care of the needs of the learner as responsible citizens of the future.
- It is more translucent, advanced, and provides more scope for interconnection among learners, teachers, and parents.

Measures of Central Tendency

In the previous section we saw that there are several ways to define central tendency. This section defines the three most common measures of central tendency: the mean, the median, and the mode. The relationships among these measures of central tendency and the definitions given in the previous section will probably not be obvious to you. Rather than just tell you these relationships, we will allow you to discover them in the simulations in the sections that follow.

This section gives only the basic definitions of the mean, median and mode. A further discussion of the relative merits and proper applications of these statistics is presented in a later section.

ARITHMETIC MEAN

The arithmetic mean is the most common measure of central tendency. It is simply the sum of the numbers divided by the number of numbers. The symbol "μ" is used for the mean of a population. The symbol "M" is used for the mean of a sample. The formula for μ is shown below:

$$M = \Sigma X / N$$

where ΣX is the sum of all the numbers in the population and N is the number of numbers in the population.

The formula for M is essentially identical:

$M=\Sigma X/N$

where ΣX is the sum of all the numbers in the sample and N is the number of numbers in the sample.

As an example, the mean of the numbers 1, 2, 3, 6, 8 is 20/5 = 4 regardless of whether the numbers constitute the entire population or just a sample from the population.

Table 1 shows the number of touchdown (TD) passes thrown by each of the 31 teams in the National Football League in the 2000 season. The mean number of touchdown passes thrown is 20.4516 as shown below.

$\mu=\Sigma X/N=634/31= 20.4516$

Table 1. Number of touchdown passes.

37 33 33 32 29 28 28 23 22 22 22 21 21
21 20 20 19 19 18 18 18 18 16 15 14 14
14 12 12 9 6

Although the arithmetic mean is not the only "mean" (there is also a geometric mean), it is by far the most commonly used. Therefore, if the term "mean" is used without specifying whether it is the arithmetic mean, the geometric mean, or some other mean, it is assumed to refer to the arithmetic mean.

MEDIAN

The *median* is also a frequently used measure of central tendency. The median is the midpoint of a distribution: the same number of scores is above the median as below it. For the data in Table 1, there are 31 scores. The 16th highest score (which equals 20) is the median because there are 15 scores below the 16th score and 15 scores above the 16th score. The median can also be thought of as the 50th *percentile*.

COMPUTATION OF THE MEDIAN

When there is an odd number of numbers, the median is simply the middle number. For example, the median of 2, 4, and 7 is 4. When there is an even number of numbers, the median is the mean of the two middle numbers. Thus, the median of the numbers 2, 4, 7, 12 is (4+7)/2 = 5.5. When there are numbers with the same values, then the formula for the third definition of the 50th percentile should be used.

MODE

The mode is the most frequently occurring value. For the data in Table 1, the mode is 18 since more teams (4) had 18 touchdown passes than any other number of touchdown passes. With continuous data such as response time measured to many decimals, the frequency of each value is one since no two scores will be exactly the same (see discussion of continuous variables). Therefore the mode of continuous data is normally computed from a grouped frequency distribution.

Table 2 shows a grouped frequency distribution for the target response time data. Since the interval with the highest frequency is 600-700, the mode is the middle of that interval (650).

Table 2. Grouped frequency distribution.

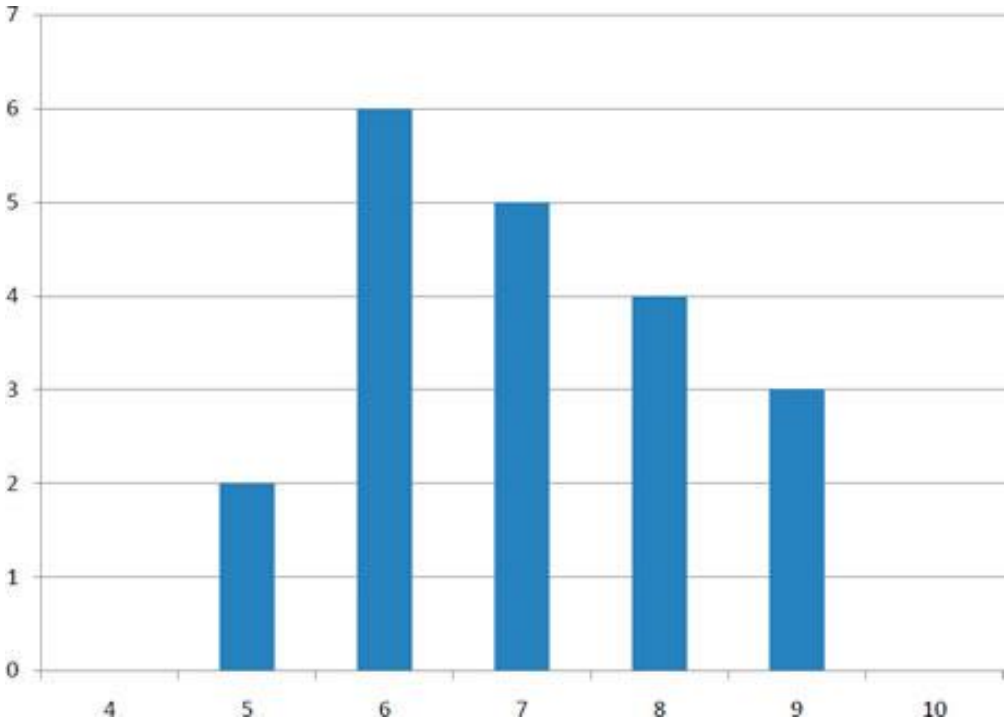
Range	Frequency
500-600	3
600-700	6
700-800	5
800-900	5
900-1000	0
1000-1100	1

Measures of Variability

VARIABILITY - MEANING

Variability refers to how "spread out" a group of scores is. To see what we mean by spread out, consider graphs in Figure 1. These graphs represent the scores on two quizzes. The mean score for each quiz is 7.0. Despite the equality of means, you can see that the distributions are quite different. Specifically, the scores on Quiz 1 are more densely packed and those on Quiz 2 are more spread out. The differences among students were much greater on Quiz 2 than on Quiz 1.

Quiz 1



Quiz 2

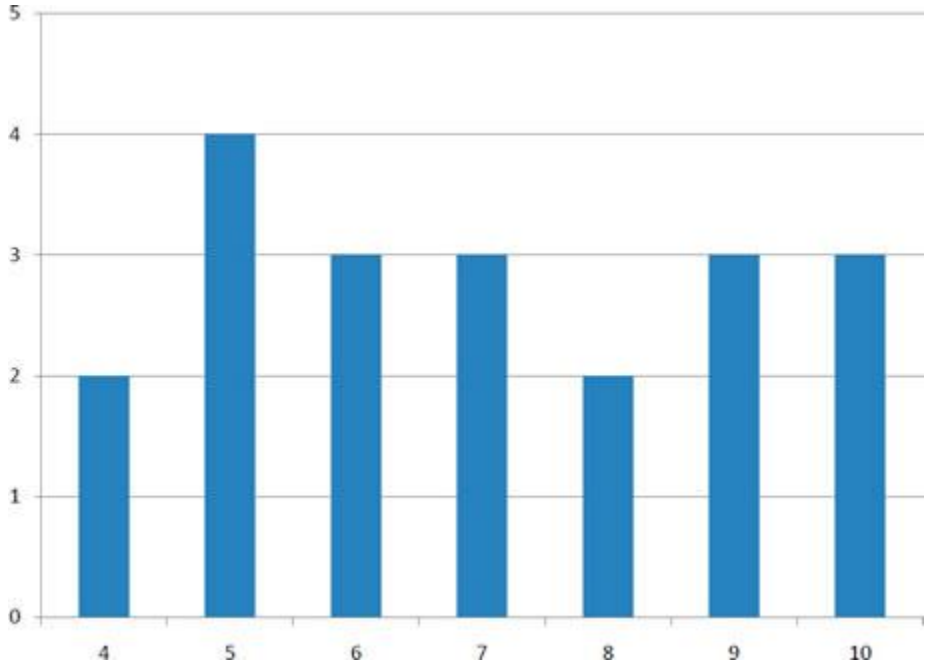


Figure 1. Bar charts of two quizzes.

The terms variability, spread, and dispersion are synonyms, and refer to how spread out a distribution is. Just as in the section on central tendency where we discussed measures of the center of a distribution of scores, in this chapter we will discuss measures of the variability of a distribution. There are four frequently used measures of variability: the range, interquartile range, variance, and standard deviation. In the next few paragraphs, we will look at each of these four measures of variability in more detail.

RANGE

The range is the simplest measure of variability to calculate, and one you have probably encountered many times in your life. The range is simply the highest score minus the lowest score. Let's take a few examples. What is the range of the following group of numbers: 10, 2, 5, 6, 7, 3, 4? Well, the highest number is 10, and the lowest number is 2, so 10 - 2 = 8. The range is 8. Let's take another example. Here's a dataset with 10 numbers: 99, 45, 23, 67, 45, 91, 82, 78, 62, 51. What is the range? The highest number is 99 and the lowest number is 23, so 99 - 23 equals 76; the range is 76. Now consider the two quizzes shown in Figure 1. On Quiz 1, the lowest score is 5 and the highest score is 9. Therefore, the range is 4. The range on Quiz 2 was larger: the lowest score was 4 and the highest score was 10. Therefore the range is 6.

INTERQUARTILE RANGE

The *interquartile range* (IQR) is the range of the middle 50% of the scores in a distribution. It is computed as follows:

IQR = 75th percentile - 25th percentile

For Quiz 1, the 75th percentile is 8 and the 25th percentile is 6. The interquartile range is therefore 2. For Quiz 2, which has greater spread, the 75th percentile is 9, the 25th percentile is 5, and the interquartile range is 4. Recall that in the discussion of box plots, the 75th percentile was called the upper hinge and the 25th percentile

was called the lower hinge. Using this terminology, the interquartile range is referred to as the *H-spread*.

A related measure of variability is called the *semi-interquartile range*. The semi-interquartile range is defined simply as the interquartile range divided by 2. If a distribution is symmetric, the median plus or minus the semi-interquartile range contains half the scores in the distribution.

VARIANCE

Variability can also be defined in terms of how close the scores in the distribution are to the middle of the distribution. Using the mean as the measure of the middle of the distribution, the variance is defined as the average squared difference of the scores from the mean. The data from Quiz 1 are shown in Table 1. The mean score is 7.0. Therefore, the column "Deviation from Mean" contains the score minus 7. The column "Squared Deviation" is simply the previous column squared.

Table 1. Calculation of Variance for Quiz 1 scores.

Scores	Deviation from Mean	Squared Deviation
9	2	4
9	2	4
9	2	4
8	1	1

8	1	1
8	1	1
8	1	1
7	0	0
7	0	0
7	0	0
7	0	0
7	0	0
6	-1	1
6	-1	1
6	-1	1
6	-1	1
6	-1	1
6	-1	1
5	-2	4
5	-2	4
Means		
7	0	1.5

One thing that is important to notice is that the mean deviation from the mean is 0. This will always be the case. The mean of the squared deviations is 1.5. Therefore, the variance is 1.5. Analogous calculations with Quiz 2 show that its variance is 6.7. The formula for the variance is:

$$\sigma^2 = \frac{\sum(X-\mu)^2}{N}$$

where σ^2 is the variance, μ is the mean, and N is the number of numbers. For Quiz 1, $\mu = 7$ and $N = 20$.

If the variance in a sample is used to estimate the variance in a population, then the previous formula underestimates the variance and the following formula should be used:

$$s^2 = \frac{\sum(X-M)^2}{N-1}$$

where s^2 is the estimate of the variance and M is the sample mean. Note that M is the mean of a sample taken from a population with a mean of μ. Since, in practice, the variance is usually computed in a sample, this formula is most often used. The simulation "estimating variance" illustrates the bias in the formula with N in the denominator.

Let's take a concrete example. Assume the scores 1, 2, 4, and 5 were sampled from a larger population. To estimate the variance in the population you would compute s^2 as follows:

$M = (1 + 2 + 4 + 5)/4 = 12/4 = 3.$

$s^2 = [(1-3)^2 + (2-3)^2 + (4-3)^2 + (5-3)^2]/(4-1)$

$= (4 + 1 + 1 + 4)/3 = 10/3 = 3.333$

There are alternate formulas that can be easier to use if you are doing your calculations with a hand calculator. You should note that these formulas are subject to rounding error if your values are very large and/or you have an extremely large number of observations.

$$\sigma^2 = \frac{\sum X^2 - \frac{(\sum X)^2}{N}}{N}$$

and

$$s^2 = \frac{\sum X^2 - \frac{(\sum X)^2}{N}}{N-1}$$

For this example,

$$\sum X^2 = 1^2 + 2^2 + 4^2 + 5^2 = 46$$

$$\frac{(\sum X)^2}{N} = \frac{(1+2+4+5)^2}{4} = \frac{144}{4} = 36$$

$$\sigma^2 = \frac{(46-36)}{4} = 2.5$$

$$s^2 = \frac{(46-36)}{3} = 3.333 \text{ as with the other formula}$$

STANDARD DEVIATION

The *standard deviation* is simply the square root of the variance. This makes the standard deviations of the two quiz distributions 1.225 and 2.588. The standard deviation is an especially useful measure of variability when the distribution is normal or approximately normal (see Chapter on Normal Distributions) because the proportion of the distribution within a given number of standard deviations from the mean can be calculated. For example, 68% of the distribution is within one standard deviation of the mean and approximately 95% of the distribution is within two standard deviations of the mean. Therefore, if you had a normal distribution with a mean of 50 and a standard deviation of 10, then 68% of the distribution would be between 50 - 10 = 40 and 50 +10 =60. Similarly, about 95% of the distribution would be between 50 - 2 x 10 = 30 and 50 + 2 x 10 = 70. The symbol for the population standard deviation is σ; the symbol for an estimate computed in a sample is s. Figure 2 shows two normal distributions. The red distribution has a mean of 40 and a standard deviation of 5; the blue distribution has a mean of 60 and a standard deviation of 10. For the red distribution, 68% of the distribution is between 35 and 45; for the blue distribution, 68% is between 50 and 70.

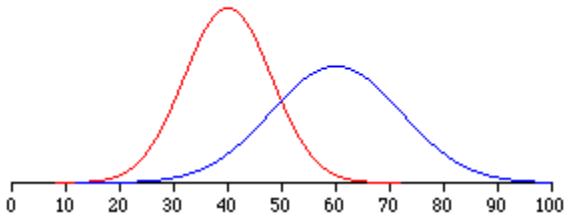


Figure 2. Normal distributions with standard deviations of 5 and 10.

ASSESSMENT OF EXPERIMENTAL WORK
& EVALUATION OF PRACTICAL WORK

The laboratory is a unique learning environment that enables and consolidates "learning through doing". Assessing this learning can enhance students' conceptual understanding of the theory–practice relationship, their higher level reasoning skills and the development of their practical competence in laboratory work.

It is important that you clarify the specific objectives of the laboratory context for learning, for both students and assessors. These objectives should form the basis for all assessment decisions made. Learning outcomes that can be assessed using laboratory work include:

- technical and manipulative skills in using laboratory equipment, tools, materials, computer software
- an understanding of laboratory procedures, including health and safety, and scientific methods
- a deeper understanding of abstract concepts and theories gained by experiencing and visualising them as authentic phenomena
- the skills of scientific enquiry and problem-solving, including:

- recognising and defining a problem
- formulating hypotheses
- designing experiments
- collecting data through observation and/or experimentation
- interpreting data
- testing hypotheses
- drawing conclusions
- communicating processes, outcomes and their implications.
- the complementary skills of collaborative learning and teamwork in laboratory settings
- understanding, and being prepared for, future possible roles in laboratory-based work.

GRADING

Grading in education is the process of applying standardized measurements of varying levels of achievement in a course. Grades can be assigned as letters (for example A through F), as a range (for example 1 to 6), as a percentage of a total number of questions answered correctly, or as a number out of a possible total (for example out of 20 or 100).

Types of Grading Schemes

Type of Grading	Definition	Historical Background
Percentage grading	Using a percentage scale (percent of 100), usually based on percent correct on exams and/or percent of points	Most common method in use in high schools and grading colleges c.1890–1910. Used today as a

	earned on assignments	grading method or as a way of arriving at letter grades.
Letter grading and variations	Using a series of letters (often A, B, C, D, F) or letters with plusses and minuses as an ordered category scale - can be done in a norm-referenced (standards-based) manner	Yale used a four-category variations system in 1813. In the 1920 letter grading was seen as the solution to the problem of reliability of percentage grading (fewer or criterion-referenced categories) and was increasingly adopted.
Norm-referenced grading	Comparing students to each other; using class standing as the basis for assigning grades (usually letter grades)	Was advocated in early grading 1900s as scientific measurement. Educational disadvantages were known by the 1930s.
Mastery grading	Grading students as "masters" or "passers" when their attainment reaches a prespecified level, usually allowing different amounts of time for different students to	Originating in the 1920s (e.g., Morrison, 1926) as a grading strategy, it became associated with the educational strategy of

	reach mastery	mastery learning (Bloom, Hastings, & Madaus, 1971).
Pass/Fail	Using a scale with two levels (pass and fail), sometimes in connection with mastery grading	In 1851, the University of Michigan experimented with pass/fail grading for classes.
Standards (or Absolute-Standards) grading	Originally, comparing student performance to a preestablished standard (level) of performance; currently, standards grading sometimes means grading with reference to a list of state or district content standards according to preestablished performance levels	Grading according to standards of performance has been championed since the grading 1930s as more educationally sound than norm-referenced grading. Current advocates of standards grading use the same principle but the term "standard" is now used for the criterion itself, not the level of performance. Since 2002, the scales on some standards-based report cards use the state accountability

		(proficiency) reporting categories instead of letters.
Narrative grading	Writing comments about students' achievement, either in addition to or instead of using numbers or letters	Using a normal instructional practice (describing students' work) in an assessment context.

Correlation

Correlation is a statistical technique that can show whether and how strongly pairs of variables are related. For example, height and weight are related; taller people tend to be heavier than shorter people. The relationship isn't perfect. People of the same height vary in weight, and you can easily think of two people you know where the shorter one is heavier than the taller one. Nonetheless, the average weight of people 5'5'' is less than the average weight of people 5'6'', and their average weight is less than that of people 5'7'', etc. Correlation can tell you just how much of the variation in peoples' weights is related to their heights.

Although this correlation is fairly obvious your data may contain unsuspected correlations. You may also suspect there are correlations, but don't know which are the strongest. An intelligent correlation analysis can lead to a greater understanding of your data.

Techniques in Determining Correlation

There are several different correlation techniques. The Survey System's optional Statistics Module includes the most common type, called the Pearson or product-moment correlation. The module also includes a variation on this type called partial correlation. The latter is useful when you want to look at the relationship between two variables while removing the effect of one or two other variables.

Like all statistical techniques, correlation is only appropriate for certain kinds of data. Correlation works for quantifiable data in which numbers are meaningful, usually quantities of some sort. It cannot be used for purely categorical data, such as gender, brands purchased, or favorite color.

Rating Scales

Rating scales are a controversial middle case. The numbers in rating scales have meaning, but that meaning isn't very precise. They are not like quantities. With a quantity (such as dollars), the difference between 1 and 2 is exactly the same as between 2 and 3. With a rating scale, that isn't really the case. You can be sure that your respondents think a rating of 2 is between a rating of 1 and a rating of 3, but you cannot be sure they think it is exactly halfway between. This is especially true if you labeled the mid-points of your scale (you cannot assume "good" is exactly half way between "excellent" and "fair").

Most statisticians say you cannot use correlations with rating scales, because the mathematics of the technique assume the differences between numbers are exactly equal. Nevertheless, many survey researchers do use correlations with rating scales, because the results usually reflect the real world. Our own position is that you can use correlations with rating scales, but you should do so with care. When working with quantities, correlations provide precise

measurements. When working with rating scales, correlations provide general indications.

Correlation Coefficient

The main result of a correlation is called the correlation coefficient (or "r"). It ranges from -1.0 to +1.0. The closer r is to +1 or -1, the more closely the two variables are related.

If r is close to 0, it means there is no relationship between the variables. If r is positive, it means that as one variable gets larger the other gets larger. If r is negative it means that as one gets larger, the other gets smaller (often called an "inverse" correlation).

While correlation coefficients are normally reported as r = (a value between -1 and +1), squaring them makes then easier to understand. The square of the coefficient (or r square) is equal to the percent of the variation in one variable that is related to the variation in the other. After squaring r, ignore the decimal point. An r of .5 means 25% of the variation is related (.5 squared =.25). An r value of .7 means 49% of the variance is related (.7 squared = .49).

A correlation report can also show a second result of each test - statistical significance. In this case, the significance level will tell you how likely it is that the correlations reported may be due to chance in the form of random sampling error. If you are working with small sample sizes, choose a report format that includes the significance level. This format also reports the sample size.

A key thing to remember when working with correlations is never to assume a correlation means that a change in one variable causes a change in another. Sales of personal computers and athletic shoes have both risen strongly over the years and there is a high correlation between them, but you cannot assume that buying computers causes people to buy athletic shoes (or vice versa).

The second caveat is that the Pearson correlation technique works best with linear relationships: as one variable gets larger, the other gets larger (or smaller) in direct proportion. It does not work well with curvilinear relationships (in which the relationship does not follow a straight line). An example of a curvilinear relationship is age and health care. They are related, but the relationship doesn't follow a straight line. Young children and older people both tend to use much more health care than teenagers or young adults. Multiple regression (also included in the Statistics Module) can be used to examine curvilinear relationships, but it is beyond the scope of this article.