Module for Post-Graduate Diploma in Education Programme

ESC711P:
METHODS OF TEACHING SCIENCE

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TABLE OF CONTENT

UNIT 1: CONCEPTS OF TEACHING AND LEARNING

In one's quest to be a teacher, it is important he or she is aware of what goes into teaching and learning in order for him or her to be a successful teacher. This unit therefore seeks to introduce students to the concepts of teaching and learning. The unit exposes students to principles and maxims of teaching, characteristics of learning and highlights the underpinning concepts of selected learning theories

Learning outcome(s)
By the end of the unit, the participant will be able to:

- Demonstrate an understanding of the concept of teaching
- Enumerate the principles and maxims of teaching
- Demonstrate classroom implications of the principles of teaching
- Describe learning and its characteristics.
- Identify roles of teachers in each of the selected learning theory.
- Describe the classroom implications of the theories of learning.

SESSION 1: THE PROCESS AND PRINCIPLES OF TEACHING

Teaching can be defined as the act of imparting instructions to learners which ultimately leads to acquisition of knowledge, skill, and attitude on the part of the learner. It can also be seen as the process of guiding a learner to acquire or change a particular knowledge, skill or attitude. These definitions imply that in teaching, students are helped to either acquire new knowledge, skill and attitude or change a particular knowledge, skill or attitude which is not appropriate.

Learning outcomes
By the end of the session, the participant will be able to:

1. Define teaching
2. Explain, at least, three principles of teaching.

The two definitions above indicate different roles of the teacher. In the first definition, the teacher serves as the source of knowledge and her duty is to impart what she has into the learner. In the second definition, the teacher's role is one of a guide. Somebody who directs, molds and leads students to develop and acquire the required knowledge. In teaching, the teacher, students, content and classroom environment interact in a multifaceted complex yet systematic and orderly manner to achieve the expected educational goal. Thus, for teaching to be successful teachers need to be aware that teaching is a planned activity, tripolar process, interactive process, motivates learners to learn, involves

communication and guidance and it is an art as well as a science. Let us now break these listed issues down.

Planned activity: Without proper planning no one can be a successful teacher. Therefore, rigorous and meticulous planning is required of the teacher in order for her to achieve her lesson objectives. This planning may involve the selection of appropriate teaching techniques, teaching and learning materials among other things.

Tripolar process: Teaching involves the teacher, learner and content. There should be systematic and effective interaction among these members for effective teaching and learning to occur. The teacher seeks to teach the content to the learner in the act of teaching. Thus, these three poles should be in good harmony in order for the aim of teaching to be achieved.

Interactive process: Teaching stimulates interaction between the teacher and the learner in the context of the curriculum. This interaction activates students mentally and physically resulting in effective learning. Learning will be affected if teachers do not consciously initiate and maintain good and efficient interaction in the classroom.

Motivation to learn: Teaching is an activity that is intended to motivate the learner to learn. Successful teaching is where the learners are provoked to search for more information and are willing to master the content taught without being told to do so.

Communication: The act of teaching depends heavily on communication between teacher and learners. The teacher has to communicate information, facts, concepts, and knowledge to students. If the communication process is not effective, learning will be hampered. Thus, for effective teaching teachers need to choose and use appropriate words and language that learners will be able to easily grasp the meaning.

Guidance: Teaching is guiding students to acquire certain characteristics. The teacher acts as a guide in order to help the students to overcome difficulties and challenges they may encounter in their attempt to learn.

Art as well as science: Teaching is an art and a science. As an art, the teacher requires mastery of certain skills to be able to deliver efficient teaching. The teacher is supposed to convert raw materials into refined and polished products. She is a creative agent in the classroom whose duty is to create individuals who can contribute meaningfully to societal development. As a science, teaching can be systematically studied and improved through research in order to improve the skills required for effective teaching. Again, teaching requires special training and has peculiar principles underlying how to go about it successfully.

PRINCIPLES OF TEACHING

We concluded the discussion on teaching by indicating that teaching is a science because the skills, practices and activities underlying teaching can be studied and improved through research. Due to such research, educationists have come up with general principles that serve as foundation for effective teaching. The next session will look at some of such principles.

Principle of goal setting
We noted earlier that teaching is a planned activity and therefore for successful and effective teaching to happen there should be clear cut learning objectives. This is because learning objectives are the driving force which controls the direction and methodology of the teaching process. Therefore, goal setting is an important aspect of the teaching process.

Principle of learning by doing
Students should be actively involved in the teaching-learning process. Teaching becomes efficient and leads to effective student learning when the students are mentally and physically active during teaching session. Teaching is highly facilitated when students actively participate in the teaching and learning process through the manipulation of materials.

Principle of association
This principle looks at linking and associating related concepts from different sections of the curriculum. This association should be done in a gradual and continuous fashion. The aim of such association is to foster integrated learning which can lead to better understanding of concepts in the curriculum.

Principle of group dynamics
The classroom is an aggregation of students from different social, religious, economic and background portraying different and varying temperaments, traits and behaviour. The teacher therefore needs to cater for individual differences within the class to ensure equity and fairness in the classroom. If the teacher is cautious about the group dynamics, she will be able to meet the needs of each student.

Principle of exercise and repetition
This principle of teaching iterates that teachers need to provide students the opportunity to exercise what has been taught. Teachers need to assign assignment to students in order to practice what has been taught which can facilitate retention of content taught. Moreover, if teachers realize that students were not able to comprehend the materials taught, then there will be the need for remedial teaching.

Principle of feedback and reinforcement
Prompt feedback and reinforcement improve learning. Students need to be informed whether their responses are accurate or not. Assignments and exercises need to be marked on time and given to students after which teachers need to discuss the test with the students. When students respond to questions and exercises, they need to be reinforced appropriately through the use of praise words and other incentives that the students find rewarding.

SESSION 2: MAXIMS OF TEACHING

Maxims are short, succinct statements conveying a general truth or rule of conduct. In teaching, there are general guidelines that teachers should follow in order to make the content easy for students to grasp and understand. These maxims help to create active classroom environment in which learners participate and are highly involved in the teaching and learning process. The outcome of these maxims if they are adhered to is an effective, interesting, meaningful learning. Learners' interests are aroused and their motivation levels are increased which could lead to meaningful learning. It is therefore necessary that teachers become familiar with these maxims and follow them in order to be successful in their profession.

Learning outcomes

By the end of the session, the participant will be able to:

1. Describe maxims of teaching.
2. Identify the implications of various maxims in the classrooms.

Now, let us discuss few of such maxims in teaching in this session.

Proceed from known to the unknown

It is very difficult for students to grasp new knowledge in isolation. Therefore, teachers should present familiar concepts to introduce the lesson and build upon it to teach new information. It is prudent and imperative to use what students already know about a subject matter to arouse their interest in a lesson. The teacher should then proceed gradually to connect the new information to the already known one.

Proceed from simple to complex

Simple concepts should be taught first followed by complex concepts. This will ease the learning process and gradually lead students to understand complex issues that may be introduced later. The presentation of simple concepts also has the capacity to stimulate students to explore complex aspects of the concepts they have already learnt.

Proceed from easy to difficult

Teachers are supposed to possess pedagogical content knowledge which helps them to identify students' misconceptions, the nature of the subject they are teaching as well as the difficulties students encounter in learning certain concepts. The teacher therefore should be able to identify the difficult aspects of concepts he is about to teach. The teacher should then present the concepts by presenting what is easy first before proceeding to deliver the thorny and difficult areas of the concepts he is teaching.

Proceed from concrete to abstract

Teachers should first use concrete materials to stimulate learning among students before proceeding to present abstract information. This is because the concrete materials will facilitate students' conceptual understanding and help easy learning of concepts. Moreover, when concrete and actual materials have been used teachers can then discuss abstract information as well as use models and other forms of representations for the concepts taught.

SESSION 3: CONCEPT AND PRINCIPLES OF LEARNING

Our discussions so far have been on teaching. However, teachers teach with the aim and hope that students will learn. Thus, teaching and learning go hand in hand. This is because teaching aims at facilitating and maximizing students' learning and attainment. Therefore, for us to be effective teachers we should understanding learning. In this session, we will discuss the intricacies of student learning.

Learning outcomes

By the end of the session, the participant will be able to:

1. Demonstrate an understanding of learning as a construct.
2. Describe the seven principles of learning as identified by OECD.
3. Demonstrate the ability to apply the seven principles of learning in their classrooms

Now read on……
Learning is defined as the acquisition of new knowledge, information, skill and value that can be concretely represented by observable modifications in behaviour and attitude of a learner. Learning is also said to have taken place when there is a desirable observable change in behaviour, attitude, skill and habit of a learner after instruction has taken place.

Thus, for learning to be said to have taken place, the learner must demonstrate that he has acquired new knowledge, skills or information that has led to a change in his or her behavior. Learning is therefore not just memorizing information without the information having some effect on your behavior and/or attitude. Learners are therefore expected to use information they gain meaningfully in different contexts to solve problems and issues they may encounter.

Principles of learning
Just as teaching has principles that dictate how it should be done, learning too has similar guidelines. The Organisation for Economic Co-operation and Development (OECD) in 2016 came up with seven (7) principles that should inform how learning should be promoted and facilitated among students. The principles are identified as: learners at the centre, the social nature of learning, emotions are integral to learning, recognizing individual differences, stretching all students, assessment for learning and building horizontal connections. Now let us discuss these principles.

Learners at the centre
This principle argues that the learning environment recognises the learners as its core participants, encourages their active engagement and develops in them an understanding of their own activity as learners. This means that learners are the central focus of the classroom and teachers should organize instruction and activities to meet the cognition and growth level of the students.

The social nature of learning
The second principle notes that the learning environment is founded on the social nature of learning and actively encourages well organised cooperative learning. Learning has been found to improve significantly if students are allowed to work in groups through collaboration. If cooperative group works are structured well they facilitate students' understanding of concept as well as promote behavioural and attitudinal outcomes.

Emotions are integral to learning
This principle asserts that learning professionals within the learning environment should be highly attuned to the learners' motivations and the key role of emotions in achievement. The underlying reason behind this principle is that learning occurs as a result of a complex matrix of emotion, motivation and cognition. The principle argues that how students feel about themselves, their fears, their perceived strengths and weaknesses and their aspirations affect how they learn as well as how much they can learn.

Recognizing individual differences
The principle of recognizing individual differences alludes to the fact that the learning environment is acutely sensitive to the individual differences among the learners in it, including their prior knowledge. We have already noted when discussing teaching that teachers should take note of the group dynamics of the students they teach. This principle of learning is also reiterating the same idea. The principle of recognizing individual differences argue that students in a class will have different characteristics including their maturity levels, prior knowledge, learning styles, interest, motivation, socio-economic

background, cultural among others. So, teachers need to create a conducive environment that caters for the needs of these different learners in order for each student to reach his or her maximum potential.

Stretching all students

Even as the teacher aims to meet the needs of every student, he should also ensure that every student is challenged and motivated to reach their maximum potential. The principle of stretching all students emphasizes that the learning environment should be made up of programmes that demand hard work and challenge from all but without excessive overload. In such a situation, high achieving students can be made to offer support to low achieving students in a cooperative environment. In order to stretch all students, teachers need to avoid over-load and excessive pressure on students.

Assessment for learning

This principle indicates that the learning environment should operate with clarity of expectations using assessment strategies consistent with these expectations with strong emphasis on formative feedback to support learning. Teachers should outline learning objectives for each lesson so that learners will be aware of what is expected of them. This should therefore lead to teachers assessing what was taught and what he expected from the learners. In assessing students, the principle of assessment for learning emphasizes formative assessment in which teachers regularly assess students in the course of the program without waiting to the end of course. Teachers should then provide prompt feedback to learners after assessment and use the information gathered to inform subsequent teaching.

Building horizontal connections

The principle of building horizontal connections directs that the learning environment should strongly promote "horizontal connectedness" across areas of knowledge and subjects as well as to the community and the wider world. For effective and successful learning, learners should be able to use the information gained in the classroom in different contexts and in the outside world. Teachers should therefore strive and let learners see connections and associations between what is being taught in class and what pertains in the real world. Again, teachers should also link similar and related concepts in different subject areas as well as different topics so that learners can have integrated knowledge.

Teachers should endeavor and enforce these principles of learning in their classrooms. This is because these principles have the capacity to improve student learning by creating a conducive environment, arouse and maintain learner interest, increase the motivation levels of students and help teachers to be effective guides.

SESSION 4: CHARACTERISTICS OF LEARNING

For certain behaviours to be described as learning, they must exhibit peculiar traits and attributes. This session will take a brief look at some characteristics of learning.

Learning outcomes

By the end of this session, you will be able to:

1. Discuss at least three characteristics of learning.
2. Relate the characteristics of learning to teacher behaviour in the classroom.

Now read on….

Learning is adjustment

One of the aims of learning is to help the learner be a successful member of society. This can happen only when the learner is capable of fitting well into the given society. Thus, learning is said to

adjustment. This means that learning helps the individual to adjust properly in a new situation/environment.

Learning is progressive change in behaviour
When someone says he has learnt something, we expect to see the effect of the learning on the person's attitude and behaviour. Therefore, learning is said to be a progressive change in behaviour. This means that learning should lead to a change or modification in behaviour of the learner as a result of a change in his or her mental structure.

Learning is purposeful and goal-directed
Learning is not a haphazard activity but rather a conscious and intentional process. The learner must be purposeful by having aims and goals which will cause him/her to spend energy and time to achieve. Without purpose and goals, learning becomes difficult since there is no end target to which the learner is expending energy.

Learning is organizing experience
Learning is not just acquisition of facts, knowledge and skills and repeating or reproducing them in the same format as they were received. It is however the process of reorganizing the information received and transforming them into formats that are uniquely yours. The learner therefore needs to organize all the experiences he receives such that the new experiences formed out of the reorganization becomes his personal knowledge.

Learning is transferable
For learning to be said have occurred, the learner should be able to use the supposedly learnt information in new and novel situations. One of the characteristics of learning is that it should be transferable. When you learn something in the classroom, you should be able to use the new knowledge outside the classroom when a situation that demands the use of the new knowledge rises up. Until you able to use the new knowledge gained in new situations, learning cannot be said to have occurred.

SESSION 5: SELECTED LEARNING THEORIES

A learning theory is a proven and accepted coherent framework and set of integrated constructs and principles that describe, explain, or predict how people learn and acquire knowledge and skills. The teacher's knowledge of various learning theories will shape his or her worldview on teacher and influence how he or she will teach. In this session, we are going to discuss the learning theories of behaviourism, cognitivism and constructivism.

Learning outcomes
By the end of this session, you will be able to:

1. Demonstrate understanding of the theories of behaviourism, cognitivism and constructivism.
2. Discuss the role of teachers who subscribe to the various theories in the classroom.
3. Appraise the classroom implications of the learning theories.

Read on…..
The learning theories we will look at include: behavioural learning theory (Behaviourism), cognitive learning theory (Cognitivism) and constructivist learning theory(Constructivism).

Behaviourism

The basic assumptions underlying behaviourism are that observable behaviour, rather than internal mental events or verbal reconstructions of events, should be the focus of study.

They believe that behaviour should be studied in terms of its simplest elements (specific stimuli and specific responses). The process of learning is behavioural change. A particular response becomes associated with the occurrence of a particular stimulus, and occurs in the presence of that stimulus.

Behavioural view of learning

The behaviourists believe that learning is any relatively permanent change in behaviour that results from experience. For learning to occur: there should be behavioural change or the capacity to behave differently; the change should be permanent; the learning should result from experience. They also argue that learning is different from maturation and short-term changes. To them, learning cannot be observed but behavioural change that results from learning can be observed.

Teachers' role in behavioural classrooms

Teacher provides the correct stimuli to shape or condition the students into the desired end product.

Teachers are possessors of knowledge and it is their responsibility to impart facts and desired behaviors to students. Teachers control student behaviour and learning with stimulus control via evaluation, repetition, and reinforcement techniques.

State clear and observable instructional objectives as cue for making the teaching process meaningful.

Students' role in behavioural classrooms

The student responds to stimuli.

Students are passive recipients of stimuli.

CONSTRUCTIVISM

Constructivists indicate that knowledge is created rather than acquired. They believe that what we know of the real world stems from the interpretations of our experiences. To them, the mind filters inputs from the world to produce its own unique reality. Students therefore actively construct their knowledge from their personal experiences with others and the environment.

Role of the teacher

Teacher is a facilitator in the constructivists' classroom.

He guides learners to create the appropriate knowledge.

He provides meaningful contexts to students.

She must present information in different ways to suit different learners.

Role of the learner

The student must be actively involved in the learning process.

Learners must be motivated to learn.

Students need to interact with their peers and the world around them to connect new topics and concepts to their pre-existing knowledge and experiences.

COGNITIVISM

The cognitive learning theory places emphasis on understanding thought processes, and how the mind processes and stores information. According to this theory, humans learn by organizing information, and finding the connection between existing and new information.

The cognitive learning theory focuses on how children and adults process information and how the way they think affects their behaviour. Cognitive theory defines learning as a relatively enduring change in mental structures that occurs as a result of the interaction of an individual with the environment. Learning is seen as a change in knowledge state.

Knowledge is acquired through mental activity that entails internal coding and structuring by the learner. Learning is about what learners KNOW and HOW they acquired that knowledge rather than what they can do. Cognitivists indicate that environmental conditions influence learning.

Role of the teacher
Help the student to organize information.
Help the students sort out interfering information.
Help student relate information to new contexts.
Encourage active involvement of learners in the learning process.
Help learners create mnemonic devices.
Structure content in a hierarchical and logical manner to provide a build-up of experiences

Role of the learner
Learners are active participants in the learning process.
They must be able to process, store and retrieve the needed information.

- Teaching is seen as the act of imparting instructions or guiding learners to acquire knowledge, skill, and attitude on the part of the learner.
- Learning occurs when there is the acquisition of new knowledge, information, skill and value that can be concretely represented by observable modifications in behaviour and attitude of a learner.
- There are principles and maxims that govern effective teaching.
- Learning leads to adjustment, must be transferable among others.
- The various learning theories have different expectations for both teachers and learners.

- What are some of the experiences you went through at the basic/secondary/tertiary level(s) depict any of the principles of teaching?
- How have my experiences in this training session prepared me to be a better classroom practitioner? Which specific examples can I draw from the course to support my position?
- What is your position on the assumption that teachers are born?

Discussion

- How will the theories of learning discussed inform your teaching?
- Describe how any of the principles of teaching affect your classroom practices.

UNIT 2: INSTRUCTIONAL STRATEGIES

Do you recall some of the activities your teachers took you through when you were students? As a student, you may have noticed that your teachers did different activities at different times during lessons or different teachers used different approaches in their classes. Sometimes you got into groups to work on an assignment. Other times the teacher just explained concepts to you verbally. These are all different ways your teachers helped students to achieve the objectives of a lesson.

These various approaches teachers use to deliver the content are collectively called **instructional strategies**. In this unit, we shall discuss selected instructional strategies that can be used in the teaching and learning of science.

Learning outcome(s)

By the end of the unit, the participant will be able to:

1. Demonstrate understanding of the various instructional strategies
2. Identify conditions necessary for the use of specific instructional strategy.
3. Demonstrate the ability to enact specific instructional strategy.
4. Analyse the strengths and weaknesses of various instructional strategies.

The unit is divided into the following sessions:
Session 1: Lecture method
Session 2: Discussion
Session 3: Demonstration
Session 4: Field trip
Session 5: Problem-based Learning
Session 6: Predict-Observe-Explain

SESSION 1: LECTURE/VERBAL EXPOSITION METHOD

The word *lecture* comes from the Latin word *lectus* which means "to read." Lecture therefore means "that which is read." It was not until the 16th century that the word was used to describe oral instruction given by a teacher in front of an audience of learners. In this session, we will discuss the lecture method as a teaching strategy.

Learning outcome(s):

By the end of this session, the participant will be able to:

1. Explain the lecture method as a teaching strategy.
2. Evaluate the advantages and disadvantages of lecture method.
3. Identify strategies to enhance the lecture method
4. Discuss the conditions necessary for the use of lecture method.

Now read on.....

Lecturing is a teaching method that involves, an oral presentation given by an instructor to students. In a lecture, an authoritative figure (in a classroom setting that will be the teacher) stands at the front of a room and delivers a speech to a crowd of listeners. The underlying assumption of the lecture method is that knowledge is an object that can be transferred to the learner from the teacher.

Now, you might feel that this method sounds pretty one-sided. If you think so, you'd be one of the many people who believe the lecture method is a poor way of teaching. Before we get into the cons, though, let's explore why the lecture method has been used for as long as it has, and what value educators have found in its ways.

Advantages of the Lecture Method

As with every approach, there some advantages associated with the lecture method. Below are some of the advantages of the lecture method.

- **Teacher control:** Because the lecture is delivered by the teacher, s/he has full reign of the direction of the lesson and the tone of the classroom. The teacher shapes the course and can remain highly consistent when it comes to what kind of information is delivered, and how it is delivered.

- **New material:** Lectures are literally just long-winded explanations of information, deemed important by the teacher. In situations where it is difficult for students to come up with information no problem will arise since the teacher is the one brings the information to be learnt. As such, students can absorb large quantities of new material.

- **Effortless:** The lecture method makes the learning process mostly effortless on the part of the students, who need only to pay attention during the lecture and take notes where they see fit. Because so little input is required from students, it is the clearest, straightforward, and uncomplicated way to expose students to large quantities of information. Students just need to know how to take good notes.

Disadvantages of the Lecture Method

The lecture method comes with its own disadvantages. Some of which are below.

- **One-way flow of information:** In the lecture method, teachers dictate information flow to students. Students have little to no opportunity to provide their own personal input, or protest the information being delivered.

- **Passive students:** Not only do people see the lecture method as a biased, one-way road, but they also see it as a wholly passive experience for students. Not being actively engaged in a discussion over certain material can make the material itself seem worthless to a student.

- **Produce lazy students:** The lecture method can produce lazy students who will not go beyond the information the teacher has providing.

Guidelines for Effective Lecture Approach

Due to the inherent weaknesses identified with the use of the lecture method, educators have proposed ways through which teachers can improve on the lecture approach. Some of such strategies will be discussed below:

- Acquire mastery over content: As a teacher one of the ways you can use to improve the quality of the lecture method is to have mastery of the content you are going to deliver. Since you serve as the main source of information in the lecture approach, you should make it a point to be abreast with current information as well as show mastery over the content you are delivering.

- Select supplementary strategies to make lecture interesting and stimulating: Since the lecture method produces passive learners, it is very crucial that the teacher supplements the lecture with other techniques. This will enable the students to benefit from the other supplementary approaches as well as the positives of the lecture.

- Ask questions to keep students alert: Although a typical lecture may not involve any form of questioning, in the classroom the teacher may want to interspersed his or her lecture with questions. This will keep students alert and active and help eliminate the passiveness of the method.

- Use effective communication skills (verbal and nonverbal): as the main source of information in this approach, the teacher should use effective communication skills. The tone of his voice should be at the appropriate level so that every student will hear. Again, the teacher should use nonverbal gestures, cues and prompts to emphasize points as well as serve as guidance to the students.

- Plan and make conscious effort to explain difficult concepts: Lecture as a teaching approach is not just about dictating notes. The teacher should make it a point to explain concepts to the students.

- Provide audio-visual aids: Since the teacher will be talking predominantly in a lecture, it is appropriate if he/she uses audio-visual materials to help explain concepts. This will remove the abstractness of the concepts being explained.

SESSION 2: DISCUSSION METHOD

One major criticism against lecture is the passiveness of students. To mitigate against student passiveness and increase classroom engagement, educators proposed the discussion method of teaching. In this session, we will examine the discussion as a teaching strategy.

Learning outcome(s): By the end of this session, participants will be able to:

1. Describe discussion as a teaching method
2. Evaluate the advantages and disadvantages of discussion method.
3. Describe the conditions necessary for the use of discussion method

Now read on.....
Discussion method is a teaching approach where students share ideas on a question or problem among the whole class or in groups. It can be seen as exchange of ideas between the teacher and the students. Discussion could come in primarily two forms: whole class and small groups. The whole class discussion is where the teacher leads the entire class through the discussion period. The small groups discussion deals with the students being put into groups. In this form, the teacher may ask each group to discuss the issue on board among the members after which a uniformed response will be provided.

A successful discussion does not just happen—it demands that the instructor is well prepared. To help you prepare for a class discussion, common concerns and problems are listed below with suggestions for how to deal with each.

Guidelines for effective discussion:

- **Define the objectives of the discussion group**: You can relieve anxiety by letting students know that you do not expect everyone to speak every time. Emphasize that they are not expected to "perform," but rather, share their opinions and observations. It is important that you acknowledge student fears and nervousness. Stress that the goal of a discussion group is to enhance student understanding of a chosen topic or concept.

- **Explain the discussion format to the class**: Let students know if you require them to bring prepared material to class or whether you will focus on a number of previously handed-out questions or a particular theme. Change discussion formats frequently to ensure that students do not lose interest.

- **Define terms and state assumptions:** Discussion participants must agree on definitions of terms and assumptions so that everyone is starting from the same point. The instructor should watch for terms that may need definition and assumptions that may be implicit, but not stated.

- **Prior preparation:** Ask students ahead of time (in a previous class) to prepare one or two questions about their reading. If it is in class generated discussion, then allow time for students to come up with their ideas.

- **Break the class into smaller groups** (if you are undertaking small group discussion): Some students find small groups less threatening and, therefore, are more likely to enter into the discussion. In order to make this method effective, assign role to students in the groups. Be

sensitive to group dynamics (eg: ability levels, gender) when forming groups. Groups can be formed by teacher or students can be asked to form their groups.

- **Ask for responses in writing:** One excellent way to get discussions going is to ask students to respond to the question in writing. Quiet students will often speak up if they have the words before them. This strategy also demands that students think concisely.

- **Control excessive talkers**: Don't let one or two students monopolize the discussion. Solicit responses from the "nontalkers." Be alert to nonverbal cues indicating that they have something to say, and then call on them. Although you want to prevent few students hijacking the discussion, be careful that expressive students are not made to feel penalized. You don't want to destroy initiative, creativity, or confidence; you want to ensure that contributions come from all or most members of the class.

- **Concluding the Discussion:** Good discussions end with a summary so that students know the important points that have been covered. In addition to showing students why the discussion is important to their learning, a summary provides an opportunity to fill in points not covered, and to praise the class for the quality of their responses.

Advantages of Discussion Method of Teaching

There are various benefits associated with the use of discussion as an instructional approach. Below are some of the advantages associated with discussion.

1. **Emphasis on Learning instead of Teaching:** Discussion Method emphasises pupil-activity in the form of discussion, rather than simply telling and lecturing by the teacher. Thus, this method is more effective.

2. **Participation by Everybody:** In this method, everybody participates in the discussion, and therefore thinks and expresses himself. This is a sure way of learning.

3. **Development of democratic way of thinking:** Everybody cooperates in the discussion, and the ideas and opinions of everybody are respected. Thus, there is a development of democratic way of thinking and arriving at decision.

4. **Training in Reflective Thinking:** Students, during the course of discussion, get training in reflective thinking, which leads to deeper understanding of the historical problem under discussion.

5. **Training in self-expression:** During discussion, everybody is required to express his ideas and opinions in a clear and concise manner. This provides ample opportunities to the students for training in self-expression.

6. **Spirit of Tolerance is inculcated:** Students learn to discuss and differ with other members of the group. They learn to tolerate the views of others even if they are unpleasant and contradictory to each other's' views. Thus, respect for the viewpoints of others is developed.

7. Learning is made Interesting: More effective learning is possible when the students discuss, criticise and share ideas on a particular problem. Active participation by the students in the discussion makes learning full of interest for the students. This also ensures better and effective learning.

Disadvantages of Discussion Method

1. Some topics cannot be taught by Discussion Method. This is because for effective discussion students will need to have prior knowledge and information on the topic

2. This method cannot be used for teaching small children.

3. The students may not follow the rules of discussion.

4. Some students may not take part while others may try to dominate.

5. The teacher may not be able to guide and provide true leadership in the discussion.

SESSION 3: DEMONSTRATION METHOD

Science is made up of concepts that are abstract and complex. The product of science is made more real when the process of science is added. This calls for a conscious effort to exhibit the underlying processes of scientific principles to students. In this session, we are going to discuss the demonstration method of teaching.

Learning outcome(s): By the end of this session, you will be able to:

1. Describe the demonstration method of teaching.
2. Discuss the advantages and disadvantages of demonstration method.
3. Demonstrate understanding of when to apply the demonstration method of teaching in your classroom.

Now read on.....

The word ‘demonstration’ means to give demos or to perform a particular activity or concept. Demonstration method is a teaching strategy whereby the teacher exhibits or perform a procedure in front of the students to explain or show a concept or teach a skill. Demonstration often occurs when students have a hard time connecting theories to actual practice or when students are unable to understand applications of theories.

When to employ teacher demonstration method

There are situations that demand that demonstrations should be used. Some of them are enumerated below:

1. Demonstrations are necessary when the activity to be carried is dangerous and thus cannot be left to the students to do it on their own.
2. When the equipment to be used are costly.

3. When equipment to be used are sensitive such that any mishandling could lead to it been damaged.
4. When the equipment to be used are scanty and inadequate in number.
5. When you need to show a procedure or process to students.

Steps of Demonstration method

- Identify and assemble the needed equipment.
- Ensure that all equipment/tools are in working condition.
- Inform learners about the objectives of the demonstration.
- Ensure that every student has a good view of the demonstration.
- Explain the role of every equipment to the students.
- Demonstrate the entire procedure at a normal pace.
- Break long and complex procedures into parts.
- Explain each step to students.
- Obtain feedback from students after each step.
- Re-emphasize the vital and important steps at the end of the demonstration.
- Conclude and summarize.

Advantages of demonstration method

The use of demonstration method comes with many incentives. Among them are that it :

- helps in involving various senses to make learning permanent
- gives students the opportunity to see how certain activities are performed.
- develops interest in the learners and motivates them for their active participation
- helps in achieving psychomotor objectives
- makes complex skill easy to understand

Disadvantages of demonstration method

1.Not suitable for large class size.
2.Students are not so actively involved in the teaching and learning process.
3.Some students may not pay attention.

SESSION 4: FIELD TRIP

Do you remember the first day you did a worksheet about animal sounds? I can bet that you do not remember. What about your first day at a zoo where you saw animals? Now, those are memories that will live forever. In teaching science, there are days students should be taken to places where scientific principles are being enacted in real life. This calls for a field trip to that facility. In this session, we are going to discuss field trip as a teaching strategy.

Learning outcome(s): By the end of this session, you should be able to:

1. Discuss field trip as a teaching strategy.

2. Demonstrate understanding of how field trip can be conducted.
3. Discuss the advantages and disadvantages of field trip.
4. Identify classroom situations that demand the use of field trip as the teaching strategy.

Now read on.....

A field trip is an educational visit to an area outside of the normal classroom where children can try new things, have different experiences, and learn valuable life and scientific lessons in real life situations. A field trip can be to countless locations where students can see new sights and have hands-on opportunities in a wide variety of experiences. A field trip may be to a location right around the corner or may require a bus ride to a different town. Regardless, the objective of a field trip is to learn, be exposed to a different environment, and be able to try new things.

Field trips are most often done in 3 steps: preparation, trip and follow-up activity.

Preparation: This applies to both the student and the teacher. Teachers must take time to learn about the destination and the subject before the trip. The teacher will need to identify the place of visit. This should be done ahead of time and the place should be able to teach the necessary concepts the teacher is interested in teaching the students. The teacher will then need to inform the students about the objectives of the visit before they embark on it. It is imperative that the teacher discusses with the students what the place of visit will provide and the things the students will see. A critical aspect of the preparation for field trip, especially for trips outside the school, is the seeking of permission from the management of the place of visit. Permission should also be sought from the authorities of the school as well as the district directorate of education. Again, parental consent should be sought. The teacher must also visit the place of interest ahead of time in order to familiarize himself with the dictates of the place.

Trip: In order for the students to benefit from the trip, the teacher should notify the students about the materials they may need to carry along. A critical aspect of the trip is the teacher having a list of students that are embarking on the trip and making copies to the authorities of the school. This will ensure that an inventory of all those participating in the trip is kept. Encourage students to ask questions as well as take notes during the visit. Make sure every student has the required protective gear if it will be needed. Ensure students obey all rules and regulations of place of visit. The teacher should be in charge of the safety and care of the students under him. Under no circumstance should he shed this responsibility. At the end of the visit the teacher should make sure all the students that embarked on the trip have returned safely.

Follow-up activity: There should be discussion in the classroom about the trip. The teacher should explain scientific concepts seen at the place of visit to students. A play back of recorded video can be done in the class so that students will be able to relate what they saw and the scientific concepts being explained. The teacher should always remember to show appreciation to the management of the place of visit.

Advantages of field trip

1. **Provision of real-world experience:** One of the biggest advantages to field trips is that they allow students to have a real-world experience. This experience should clearly illustrate and enhance information taught by the curriculum.

2. **New Learning Environment**: Field trips allow students to learn outside of the classroom.
3. **Team Building:** Many field trips combine educational content with team-building activities, such as working together to clean a stream that has been polluted. To encourage this team spirit, it is often a good idea to go on a field trip early in the school year to help create a bond between the students.

Disadvantages of field trip

1. **Planning:** Field trips take an incredible amount of planning. You must figure out transportation issues, chaperons (including background checks), food and alternate plans in the event of bad weather (if the trip is to a location outdoors). You must make sure that every child has a signed permission form, that you have obtained emergency contact and information available on each student (including allergies), and that all fees have been paid in advance.

2. **Liability:** Field trips bring up a wide array of legal issues, most regarding liability. If a student gets injured on a nature hike, is the school liable for medical fees? What about the park or the forest ranger leading the hike? Parents may be nervous about the safety of their children. Other liabilities include exposure issues. For example, even a "children's" theatre performance may contain themes or scenes that some parents might object to.

3. **Affordability:** Although field trips are sometimes subsidized by the school, there is often an expense associated with the activity that is the responsibility of the student's family. The reality is that there are families that can barely afford to send a healthy lunch to school with their children, never mind pay for a field trip. This can be an awkward and uncomfortable situation for both student and teacher.

4. **Transportation Cost**: With the rising price of gasoline, transporting students to a field trip destination can be costly for the school. This generally reduces the amount of field trips that are available to students throughout the year

5. **Medical Risks**: Field trips can be stressful for teachers, and one of the reasons is the medical risk. Medical kits must be carried for all of the special needs within a classroom, including diabetic students and students with allergies. Also, there must be someone along that is trained to administer medication.

SESSION 5: PROBLEM-BASED LEARNING (PBL)

In the real world, people encounter problems and they are required to solve them. To prepare learners for the future, it is prudent to expose to them problems they will encounter in the real world whiles they are in school. This will serve as a template to usher them into the real world. In our efforts to bring students close to problems they may face in the future, proponents have argued that students should be taught with problem-based approaches. In this session, will take a look at the problem-based learning approach.

Learning Outcome(s): After studying this session, you will be able to:
a. Demonstrate understanding of PBL as a teaching and learning strategy.
b. Enumerate factors that make the PBL a unique method for teaching.

c. Evaluate the strengths and weaknesses of PBL
d. Demonstrate how PBL can be enacted in the classroom.

Now read on…

Problem-based learning (PBL) is a student-centred instructional approach in which students collaborate to solve problems and reflect on their experiences. The approach challenges students to learn through engagement in a real problem. It focuses on learning rather than teaching. The process uses the power of real problem solving to engage students and enhance their learning and motivation.

Uniqueness of the PBL Approach

Problem-based learning approach is unique because:

1. Learning takes place within the contexts of authentic tasks, issues and problems that are aligned with real-world concerns.
2. Students and teachers become co-learners, co-planners, co-producers, and co- evaluators as they design, implement, and continually refine their curricula.
3. It stimulates students to take responsibility for their own learning, since there are few lectures.
4. It fosters collaboration among students and stresses the development of problem-solving skills.
5. It promotes effective reasoning and self-directed learning leading to the development of motivation for life-long learning.
6. Students improve their communication skills.
7. Students will be able to defend positions on an issue with evidence and sound argument.

Steps in Problem-Solving

There are various approaches to organize problem-based learning for students. We will discuss the four-phase approach to problem-based learning. The four phases include engagement, investigation, resolution and debriefing.

Engagement – This is where the teacher brings out the problem to be solved. Students become interested in problem situation and begin posing questions that lead to investigation. The problem ought to be real and contextually situated.

Investigation – Students explore to find solution to the problem. Students are allowed to frame their own approach to find solution to the problem. Students should work in groups to solve the problem.

Resolution – Having explored and searched for information to solve the problem, students decide with regard to a solution and decide how best to represent their solution.

Debriefing – This is where students share their solution to the problem to whole class. Students step outside problem to reflect and generalize both content and process.

Strengths of PBL

There are various desirable student learning outcomes that are derived from the use of problem-based learning as a teaching and learning strategy. Among them are:

Intentional learning : Problem-based learning leads to purposeful construction of knowledge. Goal-setting is an important component as the learner establishes a personal agenda for acquiring knowledge and understanding information.

Relational understanding: This is the ability to know what to do and why. Problem-based learning develops the ability of students to know what to do and the reasons for taking such actions leading to the elimination of instrumental learning.

Critical thinking: Students become critical thinkers and problem solvers when they undergo PBL.

Creative thinking: Creative abilities of students are enhanced during PBL. Each group will have to produce solutions that are uniquely theirs.

Effective collaboration: Students are made to work in groups in which successful solution of the problem will depend effective collaboration. Students therefore learn how to collaborate to execute the assignment.

Weaknesses of PBL

Student unpreparedness: Prior learning experiences do not prepare students well for PBL. Some students may feel disengaged as a result of not being ready to use this style of learning.

Time consuming: PBL requires more time and takes away study time from other subjects.

Lack of cooperation among students: Sometimes group dynamics issues compromise the effectiveness of PBL.

Less content knowledge may be learned: Due to the investigative nature of this approach, students may spend a lot of time searching for appropriate information. This means that not much content areas can be learnt since the PBL used a lot of instructional time.

SESSION 6: PREDICT-OBSERVE-EXPLAIN

Science seeks to develop the curiosity of students. However, teachers have assumed that students will develop curiosity without them being taught explicitly. This is not the best way to foster the development of curiosity. The teacher should make conscious efforts with explicit teaching strategies before learners can develop curiosity. In this session, we will be discussing a teaching approach that can facilitate the development of curiosity among learners.

Learning outcome(s): By the end of this session, participants will be able to:

a. Demonstrate understanding of POE as a teaching and learning strategy.
b. Demonstrate how POE can be enacted in the classroom

Now read on….

Predict-observe-explain (POE) is a teaching strategy used to develop curiosity in students. It is used to uncover students' predictions, and their reasons behind the predictions. In POE, students are allowed to predict the outcome of a procedure after which they observe the procedure. It is made up of three stages. Predict stage, observation stage and explanation stage

How to enact POE

Predict: This is where the teacher introduces the concept to be learnt and asks students to make predictions about the concept. Here, the teacher may present materials and ask students to predict the outcome. The teacher may also change an aspect of a process and ask students to hazard a guess on the outcome. Teacher may ask students to record their predictions. Students can be asked to give reasons for their predictions.

Observe: At this stage, the teacher performs the activity and ask students to observe. The teacher should allow students to record their observations and share with the class.

Explain: This is where students are invited to explain what happened during the observation. They should explain why that observation occurred. Students can compare their earlier prediction to the observation made to identify discrepancies. The teacher can help clear students' misconceptions.

Advantages of POE

- It helps in finding out students' initial ideas about concepts.
- It builds students' curiosity.
- It initiates discussion.
- Motivates students to want to explore the concept

Disadvantages of POE

- Younger students may find it difficult writing their predictions.
- When responses are provided orally, some students will be influenced by the responses of their colleagues.
- Some students may have difficulty explaining their reasoning.
- It is not suitable for topics that are not "hands-on" or in which it is difficult to get immediate results.
- Some students are turned off if observations do not confirm their predictions.

Key ideas

Key ideas

- There are various instructional approaches teachers can use in the teaching and learning of science.
- Some of these approaches tend to be more teacher-centred while others are student-centred.
- Selection of a teaching approach is dependent on the learning outcomes to be attained as well as the nature of the concepts to be taught.
- Each approach has its strengths and weaknesses.

Reflection

Reflection

• Why should the teacher have knowledge and skills in variety of teaching approaches? • How does the knowledge of teaching approaches affect teaching and learning of science?
Discussion • If a teacher seeks to develop critical thinking in his students, which approach will be best suited and why? • Why are educationists moving away from teacher-centric strategies to student-centred ones?

UNIT 3: CLASSROOM MANAGEMENT AND PRACTICES FOR EFFECTIVE TEACHING

The classroom is an aggregation of students from different backgrounds with unique social characteristics. The teacher nevertheless has to ensure that the classroom is conducive for effective teaching and learning to occur. How do you ensure that your classroom is conducive for teaching and learning? This unit takes a look at how best the teacher can maximize his instructional time through good conduct on his part as well as from his students. The unit is divided into the following sessions:

Session 1: Principles of classroom management
Session 2: Purpose of classroom management
Session 3: Classroom management strategies
Session 4: Questioning techniques
Session 5: Student engagement strategies
Session 6: Use of the chalk/whiteboard and teaching and learning materials

Learning Outcomes:
By the end of this unit, you will be able to:

a. Explain principles of classroom management.

b. Indicate three purposes of managing the classroom.

c. Describe three strategies to manage your classroom.

d. Enumerate appropriate strategies to engage your students.

e. Demonstrate understanding of how to use the board and teaching and learning materials in the classroom.

SESSION 1: PRINCIPLES OF CLASSROOM MANAGEMENT

Classroom management refers to all procedures and strategies used by a teacher to maintain discipline in the classroom to ensure a conducive environment that can facilitate student learning. In this session, we are going to discuss the principles that govern effective classroom management.

Learning Outcome: By the end of this session, you will be able to explain the three principles of classroom management.

Now read on….

For successful teaching, the teacher needs to know how to effectively manage such an environment to foster effective teaching and promote meaningful learning. In order for the teacher to successfully manage the classroom, there are three principles which should be followed. These are the willingness of the teacher to accept responsibility for classroom management; long-term, solution-oriented

approaches to problems rather than short term responses; and the teacher should check to see if symptomatic behaviour is caused by underlying personal problems.

Let us discuss these principles.

Willingness of the teacher to accept responsibility for classroom management

The classroom is under the control of the teacher. It is her office any time she goes there to teach. Therefore, she should take responsibility for everything that happens there. The first step towards having a conducive classroom environment is the teacher taking ultimate responsibility for whatever goes on in the classroom. The teacher should therefore seek to create an environment that can facilitate her teaching. Allowing class captains/representatives to take charge of the management of the class is not a good sign of effective leadership.

Long-term, solution-oriented approaches to problems rather than short term responses

This principle seeks to indicate that it is better to use long term solutions to disruptive behaviours as compared to short term responses. Thus, teachers should strive for lasting solutions to problems instead of looking for quick fixes. It is therefore not appropriate to react to a classroom disruptive behaviour emotionally without thinking through your reactions.

Check to see if symptomatic behaviour is caused by underlying personal problems

When students exhibit classroom disruptive behaviours, teachers should look for the reasons behind the students' behaviour. Some students' disruptive behaviour may be caused by emotional, social, financial or health reasons. It is therefore imperative that teachers do not quickly tag students as 'bad' without finding out why the students behave that way. The teacher should check to see if the student suffers from impulsivity, lack awareness, has home problems, and has any sickness or genetic condition among others.

SESSION 2: PURPOSE OF CLASSROOM MANAGEMENT

Why do teachers need to manage their classrooms? This session will take a quick look at the purposes of managing the classroom. There are various purposes for managing the classroom. We will discuss few of such purposes.

Learning Outcome: By the end of this session, you will be able to enumerate three purposes for managing the classroom.

Now read on…..

- **To ensure that classroom teaching run smoothly despite the disruptive behaviour of some students**

Teachers need to manage the classroom so that no matter the nature of disruptive behaviour put up by some students, the teacher will be able to have a conducive environment to teach without being affected by those disruptive behaviours. This is very important since it is very difficult to eradicate disruptive

behaviours altogether. Thus, by managing the classroom you will be able to have a relatively conducive environment to teach.

- **To alert students of what is expected of them.**

Classroom management intimate to students their duties as well as attitude and behaviours expected from them. This helps to put students in check and create an environment where everyone knows his or her role.

- **To maximize the time for teaching and learning activities.**

If the classroom is not managed well then the teacher will have to use a lot of the instructional time to punish and/or shape students' behaviour. A properly managed classroom is ready for instruction as soon as the teacher enters the class. The teacher does not waste time on class control measures.

- **To minimize the effect of disruptive behaviour shown by students.**

In a good managed classroom, the effect of disruptive behaviours are highly minimized. Since each student is aware of his responsibility they are not affected by what others do. Students tend to be responsible and seek to fulfil their mandate as responsible learners.

- **To provide a conducive learning environment for students.**

The ultimate aim of managing the classroom is to have an atmosphere where teaching and learning can go on efficiently and effectively. In a managed classroom, the environment is serene, comfortable and devoid of fear. Teachers are able to teach successfully which leads to students maximizing their learning.

SESSION 3: CLASSROOM MANAGEMENT STRATEGIES

A variety of classroom management strategies can be used by the teacher to effectively manage the classroom. This session will discuss few of such strategies.

Learning Outcome: By the end of this session, you will be able to enumerate some strategies for managing the classroom.

Now read on….

Proactive planning

We have mentioned earlier that teaching is a planned activity. Planning does not only help you to teach the content efficiently but also helps in managing the classroom. If a teacher prepares well, he is able to select interesting and challenging activities to keep students engaged. When students are engaged, they will not put up disruptive behaviour. Mostly, the class becomes disorganized when students become bored.

Systematic arrangement of the classroom
A congested classroom is difficult to manage. Teachers should be able to move freely and reach any student without much difficulty. Arrange the classroom such that the teacher can keep an eye on students. Put students who are short or are hearing or visually impaired at the front.

Use preventive strategies
Identify precursors to student disruptive behaviours. Do not wait for students to misbehave before you react. You need to know your students and how they behave in certain conditions or within certain groups. If you know this then you do not allow certain students to sit with those they are likely to misbehave with. It will important to break up friends and groups in the class during teaching to ensure a conducive environment.

Fair treatment
Treat all students fairly. This increases respect for the teacher. Be consistent in dealing with students. Class and school rules should be reinforced consistently. Make sure that every student is given the stated punishment if they go wrong. Do not be partial in meting out disciplinary measures. If students are not treated equally and fairly, then the students will not be keen to follow the rules.

Have simple and understandable classroom rules
The teacher should establish classroom rules. These classroom rules should be simple and understandable. Classroom rules should be important for classroom management. Rules should communicate what is acceptable and unacceptable behaviour in the classroom. Each rule should come with its penalty if one falters.

Know the names of students
This is a very important tool to enhance classroom management. As a teacher, try as much as possible to know the names of your students. When students are aware that you know their names, they are careful how they behave in your presence. They become aware that you can identify them if they go wrong even when they are in a group.

Avoid confrontation
Do not confront students aggressively. Discipline is best administered in private. Even when you want to use it as deterrent to others the culprit will inform his colleagues what was done to him when he returns to the class after being punished.

SESSION 4: QUESTIONING TECHNIQUES

Questioning lies at the heart of good, interactive teaching. Questioning deals with the inquisition of information from another person. Here, we are looking at the teacher seeking information from the students. It should be noted that the students can also ask the teacher questions but the focus of this session is to look at how the teacher can ask questions in the class to facilitate effective teaching and learning.

Learning outcome(s): By the end of the session, the participant will be able to:

a. Demonstrate understanding of the importance of questioning in teaching and learning of science.
b. Describe strategies for effective questioning during teaching.

Read on……

Questions motivate and challenge students and gets them to actively participate in the lesson. They lead to the promotion of good communication skills and self confidence in the learning process. Skillful questioning contributes immensely to learning that is why teachers must master the skill of questioning.

When should teachers ask questions?

Teachers can ask questions at any point during the teaching process depending on the aim of the question.
At the beginning of the lesson, teachers may ask questions to; establish what students already know about the topic to be taught; review students' previous knowledge and make students develop interest in the lesson. This type of questioning is very important since the responses will set the stage for the development of the content. Again, if such questions are thought-provoking, they make lesson interesting and students' participation increases during the lesson.

In the course of the lesson, teachers may ask questions to monitor students' understanding of the lesson. This is very important because it prevents the 'whole show' syndrome at the end of the lesson. That is, if you do not solicit for students' understanding in the course of the lesson, some students will sit through the lesson and at the end inform you that they did not understand anything you have taught. Asking questions during the teaching process also make students alert. Students who will otherwise be passive and probably sleep will be alerted when they know you will be asking questions.
At the end of the lesson, questions are asked to summarize the lesson as well as evaluate the lesson. This type of questions should reflect the learning outcomes set for the day. It is these questions that will inform you whether the learning outcomes have been attained or not.

Guidelines for questioning

- The question should be asked to the whole class. Do not mention a name of a student before asking the question. Ask the question first to the whole class and then call students to respond.

- Good questions should be in the form of interrogative sentence or statement. Eg: What is…..? Who is….? How does…?, etc.

- Questions should not be ambiguous.The phrasing and clarity of words used in formulating a question greatly influence its effectiveness. A well-phrased question enables students to effectively understand the nature and scope of the question being posed. Rephrase the question if students fail to understand it.

- Avoid elliptical questions. Eg: Anaemia is caused by…..? as well as those that begin with "who can", "can you tell me"…etc. Elliptical questions generally tend to lead to chorus responses.

- Sequence questions for logical thought. Sequencing is asking questions in a patterned order with the purpose to elicit meaningful responses from the audience. First, ask students lower-order questions to create a psychologically safe environment. After a few simple questions to get students involved and interested, they move toward questions relating to material that is more analytical in nature.

- Avoid repetition of questions. If you make it a habit to repeat questions students will not pay attention assuming that you will always repeat the question. Again, you may unconsciously

interrupt students' thinking in their bid to produce the right response. Some students will need such silence in order to come up with appropriate response.

- Maintain friendly atmosphere when asking questions.The teacher should strive to ensure that each student feels valued. Students should be permitted to provide a full answer to the question without fear of penalty for an incorrect response. Create an environment in which learners feel encouraged to talk and learn. Do not erode students' sense of safety and self-worth. This is what some call as psychological safety.
- Distribute questions widely. Do not direct questions to only few students in the class. As much as possible, ensure that every student is given the opportunity to speak in your class.
- Balance open ended and closed ended questions. This is about asking both convergent and divergent questions from multiple knowledge domains and at varying cognitive levels. Thus, some questions should solicit for factual, one-word responses whiles others should be such that the responses may vary yet are appropriate.
- Increase 'wait time': The 'wait time' is the period of silence between the time a question is asked and when one or more students will be called to respond to that question. It has been found that when the wait time is increased a lot of students are able to respond to the question. This is because students use that period to reflect and process their thoughts in order to provide appropriate response to the question asked. Again, increased wait time also allows introvert students to muster courage to speak.

SESSION 5: STUDENT ENGAGEMENT STRATEGIES

Effective teaching is seen as an interactive process. Teachers and students must interact to ensure maximum understanding of concepts. In this session, we are going to discuss how best to ensure every student is involved in the teaching and learning process.

Learning outcome(s): By the end of this session, the participant will be able to:

a. Demonstrate the understanding of the importance of engaging students.

b. Distinguish between equality and equitable teaching.

c. Enact strategies to engage students in the classroom.

Read on….

Engagement has been defined as "the process whereby institutions make DELIBERATE attempts to involve and empower students in the process of shaping the learning experience" (HEFCE, 2008). Student engagement is the foundation of effective learning, effective teaching and quality progress (Carpenter et al. 2016). Pascarella and Terenzini (1991, 2005) argue that interactions with peers and teachers in a collaborative fashion significantly enhance students' learning leading to gains in content knowledge and cognitive skills. Student learning improves when they are "inquisitive, interested, or

inspired, and that learning tends to suffer when students are bored, dispassionate, disaffected, or otherwise disengaged" (Glossary of education reform, 2016).
Effective engagement leads to equitable teaching. Classroom equity deals with teaching every student in the classroom (Tanner, 2013). Equitable teaching moves away from treating all students the same to developing students based on their unique characteristics. Thus, remediation may be provided for the weaker students to help them reach their maximum potential.

Differences between equality and equitable teaching

Equality	**Equitable**
All students are the same.	**Individual differences exist among students.**
Students are treated as a group.	**Students are treated individually.**
Ends up improving already good students.	**Weak students are also improved.**
Only motivated students participate in class discussions.	**Every student is helped to be involved in class discussions.**
Some students are left behind	**No student is left behind.**

Strategies to actively engage students in the classroom
To ensure equitable teaching, conscious efforts should be made by the teacher to get every student on board. the following are some strategies that can be used to actively get every student involved in class activities.

Psychological safety in the classroom
The most important principle to get students actively engaged is to create an environment where they feel safe psychologically. Psychological safety is making students feel they will not be humiliated, intimidated or mocked in the classroom. Do not erode students' sense of safety and self-worth. The teacher should strive to ensure that each student feels valued and protected.
Students should be permitted to provide a full answer to the question without fear of penalty for an incorrect response.

Increase wait time

In the preceding session, we discussed wait time during questioning. Increasing wait time has been found to be effective in helping majority of students to respond. This is because students use that period to reflect and process their thoughts in order to provide appropriate response to the question asked. Again, increased wait time also allows introvert students to muster courage to speak. A simple strategy to help you increase wait time is to actively count mentally the following—"one thousand one . . . one thousand two . . .one thousand three . . . one thousand four . . . one thousand five"—before acknowledging potential student respondents is one simple way to track the amount of time that has transpired after asking a question.

Think-pair-share

Another strategy that can be used to get students involved in the teaching and learning process is the think-pair-share strategy. In this strategy, the teacher asks a question and allow students to **"think"** about what they know or have learned about the question. Students then **"pair"** up and discuss their responses. Students then "**share"** the thinking of the pair with their colleagues in a whole-class discussion. Students can bring points of disagreement that occurred to the whole class as well.

Let students write down their ideas.

Some students feel shy or intimidated to speak in class extemporaneously. The teacher can help such students by asking students to write down their responses to the question. Students can then be called to read out their response.

Multiple hands, multiple voices

The teacher can get students actively engaged in class activities by making sure that multiple hands are raised whenever you ask a question. The teacher should develop the strategy of calling different students to answer questions. Students can be told explicitly that you want more than one hand up when you ask a question. Students may be asked to rehearse with their colleagues what they will say if they are called.

Whip around

Let every student know that you would like to hear their opinions. Teacher should therefore listen to every student's opinion after asking a question. If a student says his ideas have been shared, let him share his in his own words. In a large class, you can ask only students on a row to share their ideas to a question. Rotate the rows during the course of the lesson

Muddiest points

Muddiest Point is a quick monitoring technique to find out most difficult or confusing parts of a lesson. It can be focused on specific parts of a lesson or the whole lesson. The use of muddiest points strategy prevents the whole show syndrome where students indicate that they do not understand everything the teacher has taught.

Sequencing and Balance

Sequencing is asking questions in a patterned order with the purpose to elicit meaningful responses from the audience. Balance is asking both convergent and divergent questions from multiple knowledge domains and at varying cognitive levels. First, the teacher should ask students lower-order questions to create a psychologically safe environment. After a few simple questions to get students involved and interested, they move toward questions relating to material that is more analytical in nature.

SESSION 6: USE OF THE CHALK/WHITEBOARD AND TEACHING AND LEARNING MATERIALS

A critical part of the classroom resources that is essential to the teaching and learning process is the board. Some boards are written on with chalk and others are written with marker. The writing material used on the bboard gives the name of the board. Thus, the bboard could be chalkboard (blackboard) or marker board (white board). aside the board, there are materials teachers use to facilitate the teaching and learning process. These materials are called teaching and learning materials. In this session, we will discuss how to effectively used the board and teaching and learning materials.

Learning outcome(s): By the end of the session, participants will be able to:

a. Outline the guidelines for effective use of the board
b. Describe various teaching and learning materials used in the teaching and learning of science.
c. Demonstrate the ability to select appropriate teaching and learning Materials for teaching a specific science concept.

Read on….

Chalkboards and whiteboards are vertical surfaces usually found in front of classrooms on which chalk/marker is used to write text, make illustrations or diagrams on it. In most cases, teachers inscribe verbal symbols on the board while teaching. Pictures, posters and charts can be placed on the boards too.

Guidelines for Effective Use of the Chalk/White board.

- Make sure the board is clean before starting the lesson.
- Divide the board into segments. Here, the teacher may use the larger columns for the main ideas or core points of the lesson and the smaller columns for suggestions and contributions that have not yet been accepted as being correct. In the event of the latter, the teacher should transfer the point to the larger column after the point has been discussed and accepted as being appropriate. Teachers may also have a column for new words that they want students to take note.
- Exhaust one segment before writing on the next segment.
- Write boldly and neatly on the board. The teacher should ensure that every student can see the writings on the board. Again, materials written on the board should be brief and simple so as to avoid crowding the board with writings.
- Avoid speaking while writing on the board. It is imperative that anytime you want to talk to students you turn to look at them. Some students will need to see the movement of your lips in order for them to learn how some words are pronounced. Again, it is plain rude to talk to someone with your back facing them.
- Do not clean the board with your fingers. To avoid this temptation, it is advisable to keep your duster in your other hand.
- Do not block students' view when you write on the board. The teacher should stand to the side of the points that have been put on the board so that the whole class can see whatever has been written on the board. This means that the teacher may need to get a pointer so that she can reach the point when she stands at the side.

Teaching and Learning Materials (TLMs) are support resources meant to help the teacher to clarify and reinforce learning. TLMs in broad terms, refer to a spectrum of educational materials that teachers use in the classroom to support specific learning objectives as set out in a lesson plan. These can be games, videos, flashcards and real objects.

Activity- based learning employs a variety of teaching and learning materials and focus on hands-on activities that focus on student interaction to learn new concepts. Not all TLMs are desirable and appropriate and therefore context specific learning materials are needed to enhance the teaching and learning process. TLMs have to improve teaching and learning process by appealing to the senses of

the students. They are able to motivate the students on what has been learnt and make them remember what has been taught.

Types of Teaching and Learning Materials

Fundamentally, there are two main TLMs. Those that can be projected on to a screen for view and those that are non-projected. The projected materials require a screen and a projector. For example, the overhead projector and the Liquid Crystal Display (LCD) projector connected to a computer. It could be film strips which are connected to an optical instrument that projects an enlarged image onto a screen.

The non-projected TLMs are those that are not projected together with an electronic device. For example, photographs, models, charts, specimens of real organisms. It should be noted that with the advent of technology, most of the materials listed under non-projected can be found on the internet and projected from a computer onto a screen. Most of the non-projected materials can be made by the teachers according to their requirement. Teachers could solicit the help of other people including students in preparing TLMs.

Benefits of Teaching and Learning Materials

The use of teaching and learning materials bring a lot of benefits to the teaching and learning process.

1. They reduce verbalism, i.e. the TLMs minimize teachers' use of words in teaching.
2. The TLMs increase students' retention of what has been learnt.
3. Using TLMs in a lesson motivate students to learn. For example, in teaching protein synthesis, it is so abstract that the use of TLM makes the students understand the concept better. Since the TLMs bring abstract concepts to life, the students get excited and motivated to learn it.
4. They reduce abstraction in teaching.

Criteria for Selecting TLMs

Producing a TLM and taking it to the classroom is one thing and using it effectively is another. Therefore, it is important to select TLMs carefully. Criteria that can guide you select TLMs must be based on the following:

1. **Suitability:** The TLM must be suitable for the intended purpose. The age and capability ought to help you determine the suitability.

2. **Appropriateness:** The TLM must be appropriate for intended learners. That is, it must be related to the students' prior knowledge and their intellectual capabilities.

3. **The TLM must be previewed, reviewed or examined before the teacher brings it to class:** This is to ensure that the material is working well or in good condition and can be used to what is intended to teach. Sometimes a teacher may send an equipment to be used in class and without trying it, and at the time is needed to be used, the teacher finds that it is not working.

4. **Attractiveness:** The TLM must be attractive to the students. The colours used must depict real state of what is being shown. When a drawing or diagram or chart is attractive students will draw nearer to look at it and learn from it. The drawing must have neatly drawn borders with

appropriate heading. The heading must be exactly what the drawing is depicting. For example, transverse section of a young dicotyledonous plant will be appropriate more than a drawing which just says Transverse section of a plant.

5. **Portability:** The TLMs must be easier to handle and to be carried from one point to the other. If the TLM is clumsy and not easy to handle, its use in the classroom become cumbersome. The teacher has to arrange and send students out to where the TLM is located.

6. **Accuracy and representativeness**: The TLM must be accurate and good representative of what it is meant for especially if it is a drawing, or an improvised material. It must show the central features of the real thing.

7. **Affordability:** The cost of the TLM must be low and not too expensive so that it can be bought. If it is going to be produced by the teacher, locally available cheap materials must be used. Note that not all expensive or cheap materials are suitable for a lesson. The teacher must strike the balance and buy what will serve the intended purpose.

8. **Time or Duration for Use:** If the material to be used can be fixed easily during the class or it should be fixed before the lesson. If it is a film or video clip you have to check to ensure that the time or duration for show will be within the available time for teaching. If not, then the teacher must arrange with a teacher who comes to the class after him to use part of that teacher's time or the teacher arranges the show after classes or any other time that will be suitable.

9. **Physical environment:** It is important to ensure that the physical environment is conducive for the use of the TLM. For example, if a video clip to be screened will be best seen in a darkened room, ensure that you provide that environment. If you need a sound system to facilitate the hearing of the clip, ensure that you make prior arrangement for that.

Key ideas

- The classroom is under the control of the teacher and s/he must follow appropriate Principles to effectively manage the classroom environment.
- Successful teaching and learning will depend on a conducive learning environment.
- Various strategies can be used to optimized the learning environment.
- Questions are critical components of the teaching and learning process and must be done well to ensure effective teaching and learning.
- Teachers must use different strategies to enable all students to be engaged in order for them to reach their potential.
- Teachers must use the board effectively and employ appropriate teaching and learning materials to successfully improve their students' learning.

Reflection

- Were you a vocal or quiet student in back at school? How did your teacher help you to become an integral member of the classroom?
- During your student days, what abstract topic did you find difficult? How will you teach it differently if you were to teach that topic?

Discussion

- If you have a shy and introvert student in your class, how will you ensure s/he gets involved in your lessons?
- How will you handle a student who likes making funny comments that bring laughter and chaos to your class?
- Students complain that science is abstract. How can you help your students to overcoming this perception through your teaching?

UNIT 4: TECHNOLOGY IN EDUCATION

The use of technology is now critical in the teaching and learning process. Teachers cannot afford not to use technology in teaching. However, the integration of technology in teaching comes in different shades and forms. Technology use in the classroom is context bound and is, or at least needs to be, dependent on subject matter, grade level, student background and teacher's technological expertise. In this unit, we are going to discuss how science teachers can effectively integrate technology in the teaching and learning process to maximize their students' learning. This unit is divided into the following sessions:

Session 1: Benefits of technology in science teaching
Session 2: Introduction to TPACK
Session 3: Integrating technology into science teaching
Session 4: Types of technological resources for science teaching

Learning outcome(s):

By the end of the unit, the participant will be able to

- Demonstrate understanding of the benefits technology bring to the teaching and learning of science
- Describe the fundamentals of the TPACK framework.
- Apply appropriate technology into the teaching of a science concept
- Identify different technological resources available for the teaching and learning of science.

SESSION 1: BENEFITS OF TECHNOLOGY IN SCIENCE TEACHING

There is a plethora of opportunities technology afford the teaching and learning of science. This session will take a brief look at ways in which technology can help the teaching and learning of science.

Learning outcome(s)
By the end of the session, you will be able to identify four benefits technology add to the teaching and learning of science.

Now read on….

The benefits and the potential of technology in education in general and science classrooms in particular cannot be overstated. Technology has been found to provide a means to good science instruction which can lead to better student understanding and achievement. Some of the ways through which technology is influencing science teaching are:

- **Technology can enhance the understanding of scientific concepts.**

There is enough evidence to support the fact that most students find scientific concepts difficult to grasp and understand. This is due to the microscopic nature of most science concepts. Technology,

however, can bring such microscopic ideas to light and students can see visual representations of such ideas. This helps to facilitate the understanding of such concepts.

- **Technology can make abstract concepts look 'real'.**

Abstract science concepts can be brought to life through the use of technology. Animations, simulations and models are capable of creating a real-life experience for students to observe concepts and processes that are otherwise too abstract to grasps.

- **Technology enhances investigative learning in science.**

Teachers are now able to give tasks to students and allow students to complete such tasks with the help of technology. The use of technology for exploratory and experimental purposes offers teachers a powerful means of stimulating active learning and it offers learners more responsibility and control. Students are able to get access to a wide range of information and they are capable of presenting the outcome of their investigations in forms that they deem fit with the help of technology.

- **Technology can extend learning opportunities**

The benefits of extending learning outside of the classroom into the field and the built environment include first-hand opportunities to engage with scientific concepts within a wider range of contexts. Many of these experiences involve data collection that can now be done by mobile computers that enable automated data collection and analysis in any location.

- **Technology can improve motivation and engagement**

The use of technology is found to be interesting and exciting to pupils than using other resources. Technology offers the opportunity to greatly enhance the quality of presentation, incorporating the use of movement, light, sound and colour rather than static text and images. This makes teaching and learning attractive and more authentic. Pupils are also observed to be more motivated to participate in science activity and discussion when using tools such as interactive whiteboards, modelling and simulations which permit active engagement and offer pupils a degree of control over their own learning.

- **Technology can foster collaborative learning**

Pupils carrying out research or practical activity using technology may work more independently of the teacher. To develop the concepts central to science teaching and to counter intuitive conceptions, pupils need to think for themselves. Peer collaboration between students working together on tasks, sharing their knowledge and expertise, and producing joint outcomes is becoming a prevalent model for the use of educational technology.

SESSION 2: INTRODUCTION TO TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK)

The mere introduction of technology into the classroom will not necessarily yield the needed results of students maximizing their learning. The teacher is required not only to have knowledge of specific technology but also the knowledge of the affordances and constraints of the technology, use adaptive strategies coupled with how to use these properties of technology to enhance comprehensive learning. In this session, you will be introduced to the knowledge construct required in order to be able to successfully integrate technology in your classroom.

Learning outcome(s)
By the end of the session, you will be able to:

a. Explain the various constructs of TPACK framework.
b. Describe an activity that falls under each of the constructs of TPACK framework.

Now read on…..
Technological Pedagogical Content Knowlede (TPACK) describes how teachers' understanding of technologies and pedagogical content knowledge interact to produce effective teaching with technology. The TPACK framework has seven constructs: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPACK). A brief description of the various constructs of the TPACK framework is provided below.

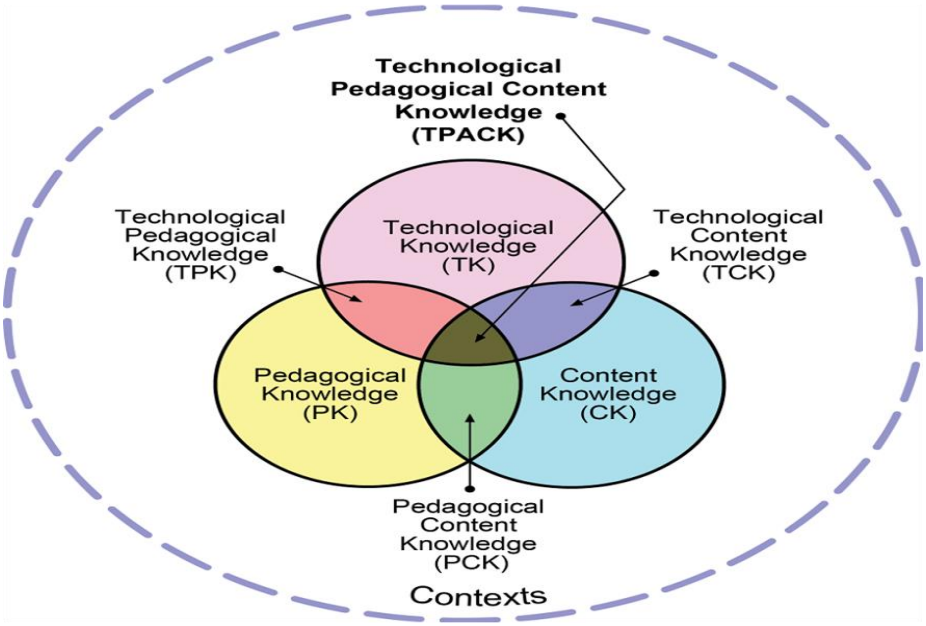


Figure 1: TPACK Framework (Mishra & Koehler, 2006)

Now let's describe each of the constructs that make up the TPACK framework in detail.

Technological Knowledge
Defining technology is notoriously difficult because it is always in a state of flux. Some authors define technological knowledge as knowledge of both old and new technologies such as black board, chalk, books, as well as internet and video conferencing. However, in this dispensation some technologies have become obsolete. Thus, it is important to define technology in terms of digital and emerging technologies. Technological knowledge is the ever-evolving knowledge base of how to use different digital and emerging technologies in different settings. This means TK has no finality about it but rather assumes a developmental posture which means that it will be evolving over a time of generative interactions with multiple technologies.

Pedagogical Knowledge

In order to teach effectively, a teacher must possess a repertoire of skills needed for teaching. Pedagogical knowledge encompasses knowledge of teaching approaches, theories and concepts underlying teaching. It includes knowledge of the nature of teaching and learning. Pedagogical knowledge includes the skills, beliefs and conceptions about teaching. It encompasses knowledge of how students learn, instructional planning and implementation, classroom management, and student assessment and thus encapsulates the conception of the overall purposes of education, values, goals and strategies of education as well as the processes and practice of teaching and learning. Teachers' understanding of the underlying philosophy and approaches to classroom management and organization constituted their pedagogical knowledge. Teachers with good pedagogical knowledge should be able to understand how students construct knowledge and learn as well as have appropriate and varying ways of assessing students. They should be able to meet the requirements and responsibilities of their job and end up fostering effective learning in students.

Content Knowledge

Content Knowledge (CK) emphasizes knowledge of the subject matter that is to be taught or learnt. This is the knowledge about the concepts, frameworks, and processes in a given field. For teaching to be effective, it must begin with how a teacher understands what he to teach. Science teachers are expected to have mastery over the subject they teach. This includes both the 'process' and 'product' of science. Science teachers should be able to teach the concepts and theories of science as well as organize and supervise laboratory sessions, organize field trips, explain scientific observations to students and lead them to make valid and reliable conclusions.

Pedagogical Content Knowledge

Pedagogical Content Knowledge (PCK) indicates the manner in which the content can be represented and formulated to make it comprehensible to others. PCK goes beyond just pedagogy and content. It looks at how these two relate and interact for effective teaching. The relationship between pedagogy and content is a complicated one in which the boundaries between them are weak and porous. Thus, teachers' pedagogical and content knowledge are inextricably linked.

PCK encompasses knowledge of pedagogies and the planning processes that are appropriate and applicable to the teaching of a given content at any given time. For effective teaching to occur, knowledge of teaching and learning, assessment procedures, awareness of students' prior knowledge and content-related misconceptions are very essential. The awareness of these issues constitutes teachers' PCK. It deals with how to design specific subject matter and teach it effectively to suit learners of diverse abilities.

Technological Content Knowledge

Technological Content Knowledge (TCK) represents knowledge of subject matter representation with technology. It is the realization of how technology and content influence and affect each other. This is the ability to determine how the content a teacher wants to teach is affected by affordances of technology and vice versa. The availability of specific technology can help make the delivery of certain content easy to learn, concrete and real to students. It is the knowledge of how to utilize an emerging technology to represent specific concepts in a given content domain

Technological Pedagogical Knowledge

Technological Pedagogical Knowledge (TPK) refers to knowledge of using technology to implement different teaching methods. It is knowing how various technologies can be used in teaching and realizing that using technology may change how one teaches. TPK deals with the ability to realise how

technology affects the methods and strategies of teaching and how effective teaching and learning can be achieved with technology. It includes the realisation of the constraints and affordances that technology can bring to bear on pedagogical strategies, approaches and designs (Abbitt, 2011a). A teacher with TPK should be able to realise that the technology they want to use does affect their teaching approaches, methods and design. Basically, it is the realisation and conceptualisation of how teaching and learning can be affected or changed when particular technologies are used in a particular manner.

Technological Pedagogical Content Knowledge

TPCK depicts knowledge of using technology to implement teaching methods for different types of subject matter. TPCK treats technology, content and pedagogy in unison and blends these three constructs in a complex relationship. TPCK is the understanding that emerges from the interactions and interplays between and among technology, content and pedagogical knowledge that underlies meaningful teaching with technology. The complex relationships between the constructs provide a basis for understanding teacher knowledge that supports successful technology integration into classroom learning environments. The constructs are intertwined and interwoven and therefore it is not sufficient for pre-service teachers to just learn about technology, content or pedagogy alone and independently of each other. It is therefore critical that teachers understand the complex relationship among the constructs and the contexts in which they are formed and co-exist to constrain and co-create each other. This could enable teachers to use technology in student-centred approaches to foster inquiry learning in students instead of using it to support teacher transmission of knowledge.

These seven constructs constitute the TPACK framework. There is emphasis in the model on the interactions between and among the three core components of technology, pedagogy, and content. Effective teaching with technology requires TPACK (Abbitt, 2011b). TPACK helps us to conceptualise the movement away from relying on technological skills as the main ingredient needed for meaningful teaching with technology. It provides a framework for conceptualising instruction using effective technology integration that includes a consideration of appropriating the multiple uses of technology, in relation to content and effective pedagogy.

SESSION 3: INTEGRATING TECHNOLOGY INTO SCIENCE TEACHING

The use of technology in teaching is not a fad that teachers should just jump on. Teachers need to make sure that their teaching will be improved and the students' learning will be maximized when they use ICT. In this session, we are going to discuss how best teachers can integrate technology in their teaching.

Learning outcome(s):

By the end of this session, you will be able to:

- Demonstrate understanding of situations that affect the use of technology in teaching.
- Demonstrate ability to apply technology to teach a specific science concept

The use of technology to successfully enact science concepts can be achieved through systematically thinking about the ICT to be used and the affordances it provides as well as the benefits it will afford students. This can be done by asking the following questions:

- Does the ICT aid understanding of hard-to-see concepts?
- Does the ICT provide access to information not otherwise readily available because it is abstract, dangerous or in a remote location?
- Does it help pupils to think through scientific ideas or applications?

Answers to these questions will help the teacher select the appropriate ICT as well accrue the needed benefits from the ICT tool to be used. These questions have been formulated based on the affordances technology provide as well as the usefulness of ICT to the teaching and learning process.

Does the ICT aid understanding of hard-to-see concepts?
One of the advantages of ICT is that it has the ability to bring abstract concepts to life. Therefore, the teacher needs to ask himself whether this advantage is being achieved when he uses ICT. In science, the use of ICT should make difficult concepts clear and real. Sometimes ICT will help bring some particular features out more clearly. There is no point searching for images, videos and simulations that do not make learning easier for students, bring out understanding and make concepts clearer and more real.

Does the ICT provide access to information not otherwise readily available because it is abstract, dangerous or in a remote location?
For learning to be effective and the benefits of ICT properly accrued, the teacher should use ICT when students find it difficult to access information on concepts to be taught. Asking students to use ICT when information needed is readily available will not be a good practice. This is because ICT comes with a lot of cost so teachers need to make sure that any use of ICT is beneficial cost-wise. This does not in any way means that teachers should not use ICT in situations when some of the information are easily accessible to students. For instance, in teaching the features of different leaves, the teacher can project images of different leaves to the class as can be seen in the figure below. Although leaves are readily available, it is possible that not all the various leaves will be found in the locality of the students. Therefore, it will not be out of place for the teacher to rely on ICT to facilitate her teaching.

Does it help pupils to think through scientific ideas or applications?
The use of ICT should not just be an 'add-on' whereby the teacher teaches the concepts 'manually' and then uses some form of technology to strengthen what has been taught. Teachers should rather use ICT to facilitate students' conceptual understanding. Therefore, the use of ICT in the science classroom should be such that students' thought processes will be provoked which will lead to critical and creative thinking. Teachers therefore should make sure that the ICT they are going to use has the ability to make students think about the scientific concepts being discussed.

As a teacher you therefore need to think about these issues before you integrate technology into your teaching. It should be noted that the use of technology is dependent on the pedagogy one wants to use and at the same time the kind of technology available can also affect which pedagogy to use. Thus, pedagogy and technology are intricately linked and related such that they influence each other.

SESSION FOUR: TYPES OF TECHNOLOGICAL RESOURCES FOR SCIENCE TEACHING

There are various forms of technological resources available to science teachers to use. In this session, we will take a brief look at some of the technological resources teachers can use in the teaching and learning of science.

Learning outcome(s):

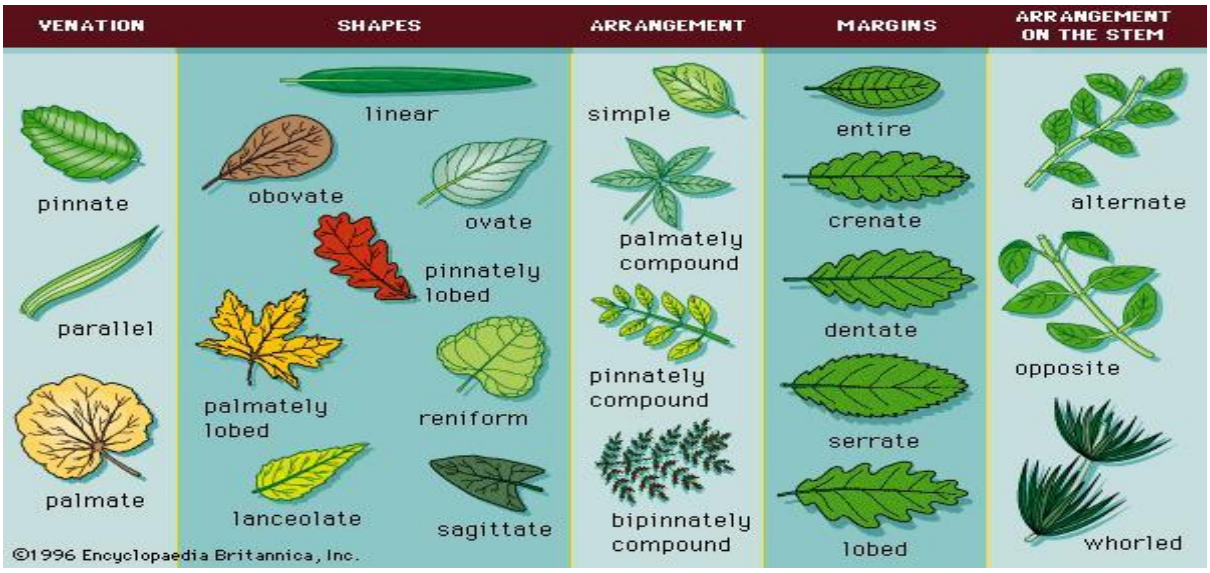
By the end of the session, you will be able to identify various technological resources that a science teacher can use.

Now read on…….

There are a lot of ICT tools available that teachers can use. However, in our part of the world we do not have access to most of the advanced ICT available. Nonetheless, there are still basic tools that teachers can use effectively to enhance the teaching and learning process. Teachers can use images (pictures, diagrams), videos, animations and simulations. Lets take them individually and discuss them.

Images

Images are the commonest technological devices science teachers can use. An image is a visual representation of something. There is plethora of images for various science concepts. With a computer and a projector, the teacher can make good use of images to foster teaching and learning process. Images come in different shapes, forms and colour. They are a pictorial or diagrammatical representation of the real thing. They help to bring out some of the parts actual realia may not be able to show. For instances in teaching the characteristics of leaves, it may be difficult to have et access to different leaves with different leaf venations, shapes and leaf arrangement. However, an image like the one blow can show all the various venations a teacher may want to teach.



Videos

Another technological resource available to be used in the science classroom is video recordings. Videos come in various forms. Teachers can download videos of concepts from the internet and play to their students. There are videos of real-life events as well as simulated videos all over the internet that teachers can make good use of. Teachers can also make their own videos and show to the students.

Simulations

Simulations are representation of a part of reality. By manipulating variables in these representations and studying the effects, students can gain an understanding of the reality. Simulations make it possible for students to study in reality things that otherwise would have been difficult to study due to safety or

cost. They serve as a bridge between reality and the student's mental model of reality. Thus they provide an approximation of reality that does not require the expense of real life or its risks. This application helps the learner to visualize abstract concepts. They are more or less realistic imitations. Due to its very nature, learners can experiment with hazardous chemicals on the computer without the fear of being hurt. Thus in this approach, students take risks as if they were confronted with real life situations without having to suffer the consequences of failure. Simulation reduces cost, saves time and reduces risks involved in experiments. Moreover, it gives the student a rare opportunity to experience happenings and situations that are not normally available or difficult to undertake in the classroom.

Animations

Animation is the process of giving the illusion of movement to drawings, models, or inanimate objects. It is a kind of visual digital display technology that simulates moving objects on-screen. Modern forms of computer animation evolved from more primitive computer graphics over the last few decades, as huge advances in computer technology led to much more sophisticated imaging methods. Animations can be 2D or 3D. These animations can show microscopic and abstract scientific concepts that cannot be seen with the naked eye. This will help students to 'see' such concepts that can facilitate student understanding.

The discussed resources are the most common technological resources that teachers can use to foster effective teaching and maximize their students' learning.

Key ideas

- The use of technology is now critical in the teaching and learning process.
- Teachers cannot afford not to use technology in teaching.
- The integration of technology in teaching should be influenced by the technology, content, pedagogy and the related constructs for it to be successful.
- Technology use in the classroom is context bound and is, or at least needs to be, dependent on subject matter, grade level, student background and teacher's technological expertise
- The use of technology should be done cautiously in order to achieve the best results.

Reflection

- What technology is readily available to you and how can you maximize it in your teaching?
- Should every lesson be infused with technology? Justify your answer

Discussion

- Discuss two conditions an ICT tool should meet before using it to teach science.
- How do you plan to make an abstract science concept concrete to your students?

UNIT 5: EDUCATIONAL OBJECTIVES

Education is a purposeful and planed activity which is under taken by the educator and the learner. There should therefore be a clear-cut target or ends in view. Without an end or target no purposeful activity will have that real force which directs it and makes it meaningful. Thus, there should be objectives for every educational activity.

For any educational programme to be effective the purposes and objectives are to be clearly stated so that it is easy to select the right subject matter, the experience and the right method to evaluate the student's performance and the teaching learning process. This unit therefore seeks to introduce students to the concepts of educational aims and objectives. The unit has been structured into the following sessions:

Session 1: Purposes of educational objectives
Session 2: Bloom's taxonomy
Session 3: Characteristics of specific objectives
Session 4: Components of specific objectives
Session 5: Writing learning objective

Learning outcome(s): After going through this unit, you will be able to:

- Demonstrate understanding of the purposes of educational objectives in the teaching and learning process.
- Discuss Bloom's taxonomy of learning outcomes
- Demonstrate the ability to explain the characteristics of specific learning objectives
- Discuss the components of specific objectives
- Write learning objectives for a selected science concept to be taught.

SESSION 1: PURPOSES OF EDUCATIONAL OBJECTIVES

The result sought by the learner at the end of the educational program constitutes the educational objective. This implies that what the students should be able to do at the end of a learning period that they could not do beforehand constitutes the educational objective. Objectives are often worded in course documentation in a way that explains to learners what they should try to achieve as they learn.

Educational objectives are also called "learning objectives" as opposed to "teaching objectives". They define what the student, not the teacher, should be able to do. Educational objectives are important for a successful teaching and learning because without an end goal teaching will be haphazard. Thus, in this session, we will discuss the purposes of educational objectives.

Learning outcome(s): By the end of this session, you will be able to:

1. Demonstrate understanding of the purposes of educational objectives in the teaching and learning process.
2. Identify characteristics of effective educational objectives in teaching and learning of science

Now read on.....

The Purpose of Educational Objectives

There are several reasons for stating educational objectives. Some of the reasons will be discussed below.

1. Foster a common understanding or expectation among instructors, students and administrators regarding what an educational activity aims to accomplish.
   Educational objectives serve as an end to what is expected from teachers and what learners should be capable of doing at the end of any educational activity. With this, learners will be able to assess whether they have been provided with the right knowledge and experience. Teachers and administrators will also be able to identify if they provided the right experience. Thus, the educational objective serves as an avenue to ensure accountability on the part of all stakeholders in the educational program.

2. Define an activity's place or role within a broader program.
   Educational objectives help to identify the locus and the importance of specific experiences in the broader frame of the whole educational process. Objectives are set to capture the desired learning outcomes; thus, one will be able to ascertain the worth whileness being placed on a particular experience if such experience is captured by the objectives.

3. Guide students about where they should focus their learning efforts.
   Educational objectives are set to reflect and depict the most cherished knowledge, skills and attitudes. This implies that they serve as the goal post of the learning process. Students will therefore be able to decipher the expectations required of them and learn accordingly.

4. Establish standards against which an activity can be evaluated.
   Since the objectives are the expected outcomes, one is able to assess his performance based on the objectives. Thus, if the objectives are attained at the end of the educational period then we can assume that the program has been successful. Therefore, the objectives serve as the yardstick for evaluation in that we tend to evaluate to see if the objectives have been attained.

Characteristics of Effective Educational Objectives

Since educational objective plays unique role in the educational process, one must be aware of the nature of such objectives. The following are some of the characteristics an educational objective may possess.

1. Focus entirely on students. The students must be the target for which an effective educational objective aims towards. The teacher should think of his/her students before setting the objectives.
2. Emphasize core skills and content. The core skills and content enshrined in the syllabus must be emphasized.
3. Relate directly back to program goals. The objective must be in line with the program goal which is the ultimate and longtime target.
4. Define learning levels: In setting an effective educational objective, the learning levels of the students must be taken into consideration. There are different levels of maturation and so the teacher would have to know the level of his/her students before stating the objective.

5. Measurable within the confines of the course. Every course has what it seeks to achieve so the objective must measure what the course intends to achieve.
6. Specific. The objective must be specific by stating exactly what you want to achieve. It must be relevant. Thus, it should be free of any superfluous material but cover every point relating to the aims in view. Relevance is the essential quality of educational objectives. Objectives that have every quality except relevance are potentially dangerous Realistic. This means that it must be feasible or achievable.

7. Clearly and concisely written. The objective must be clear and unambiguously stated.

- Strive for higher order learning. The objective must seek to address higher thinking skills.

Due to the characteristics of educational objectives, some educational organisations design objectives which carefully match the SMART criteria. SMART literally means specific, measurable, achievable, realistic and time bound. Other educational organisations also design objectives to carefully match the BOMSA criteria. BOMSA means behavioural, observable, measurable, specific and achievable. These are provided to serve as a guide to teachers so that in setting objectives the various characteristics will be catered for. It is therefore expected that when teachers are writing educational objectives they should bear in mind these criteria.

SESSION 2: BLOOM'S TAXONOMY OF EDUCATIONAL OBJECTIVES

Bloom's taxonomy of educational objectives is a hierarchical ordering of learning outcomes that learners can attain. The hierarchical nature of the taxonomy means that learners need to move through the levels one step at a time by accomplishing the lowest level before attaining the higher levels. Students cannot proceed to a new level without achieving the previous one. The attainment of a higher level implies that the learner has attained the levels beneath the higher level that has been attained. The taxonomy helps teachers teach and students learn effectively and efficiently. This session will discuss the taxonomy.

Learning outcome(s): By the end of this session, you will be able to:

- Discuss Bloom's taxonomy of educational objectives
- Identify verbs that typify the various levels of the taxonomy.

Now read on.....

Benjamin Bloom (1956) identified three domains of educational objectives

a. Cognitive: intellectual skills
b. Affective: attitudes or communication skills
c. Psychomotor: practical skills

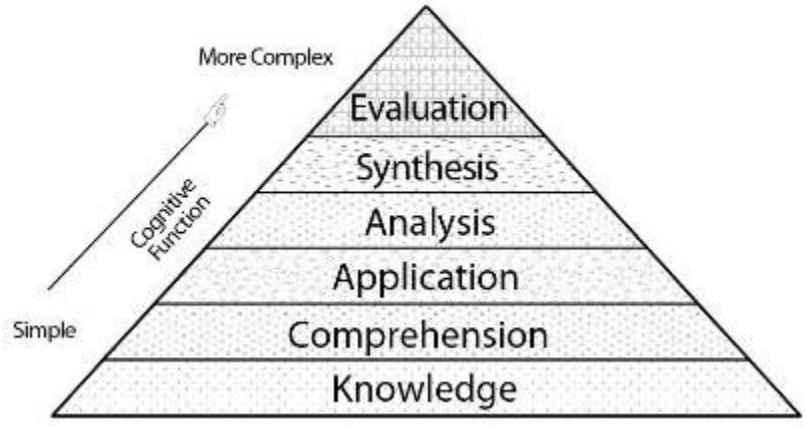
Each of these domains further consists of a hierarchy that denotes different levels of learning.

Cognitive Domain

The cognitive domain (Bloom, 1956) depicts the various levels of knowledge and thinking. The taxonomy is used to classify educational objectives into various complexities. They are hierarchical in nature because they are in increasing complexity and difficulty and the lower levels must be achieved before the higher levels. In other words, the attainment of the higher levels depict that one has mastered

the lower levels. There are six major categories starting from the simplest behaviour to the most complex. The categories can be thought of as degrees of difficulties. That means, the first one must be mastered before the next one can take place.

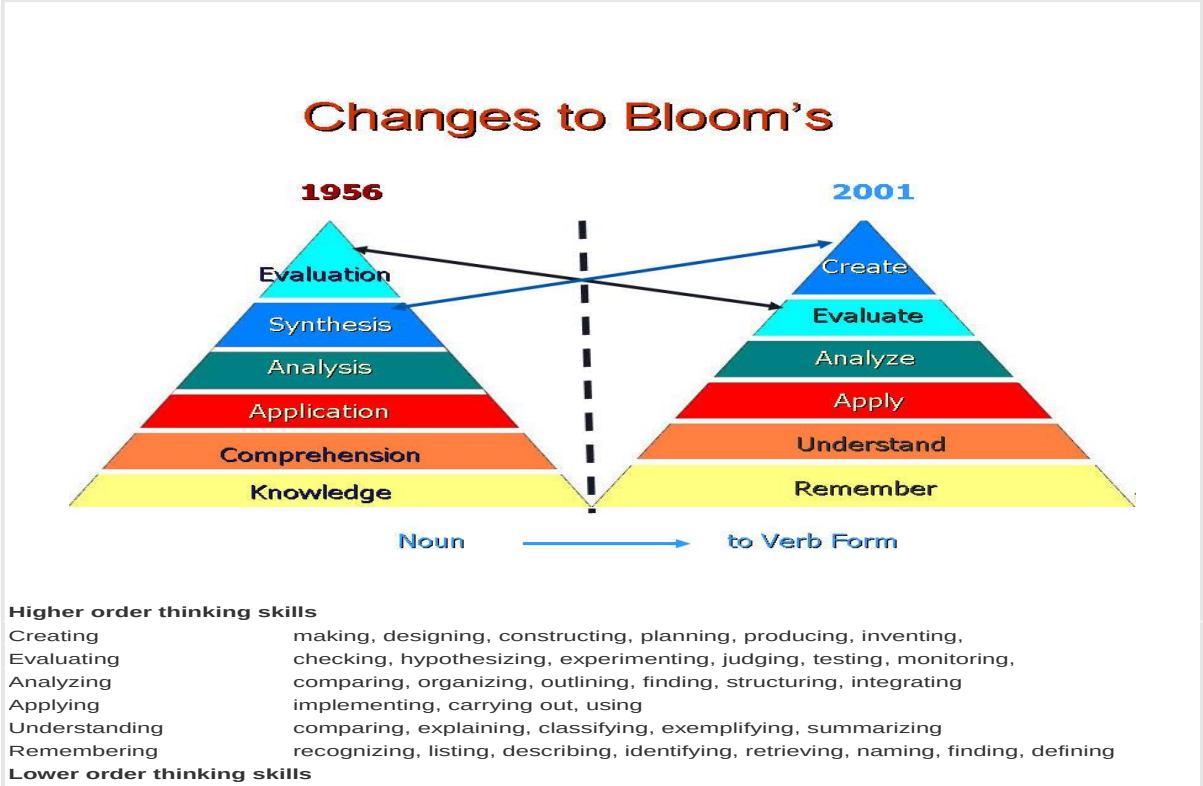
As a teacher, you are aware that objectives are stated using measurable verbs. The verb used in the objective goes a long way to portray the mastery level of learning the teacher wants the students to attain. Thus, some verbs depict low level of thinking whiles others demand higher cognitive abilities. Although these verbs depict learning levels, it should be noted that some verbs cut across more than one level and therefore the context within which the verb has been used will need to be determined in order to appropriately identify the level it is measuring.



ORIGINAL BLOOM's COGNITIVE TAXONOMY

Category	**Description**
Knowledge	Ability to recall previously learned material. Some verbs that depict knowledge level outcome are define, list, state, name, mention among others.
Comprehension	Ability to grasp meaning, explain, restate ideas. Some verbs that measure comprehension are convert, distinguish, estimate, explains, generalize, Infer, Interprets, summarize, translate.
Application	Ability to use learned material in new situations. Examples of verbs measuring application are demonstrate, illustrate, construct, show
Analysis	Ability to separate material into component parts and show relationships between parts. Example of verbs: compose, design, create, arrange, contrast, compare.
Synthesis	Ability to put together the separate ideas to form new whole, establish new relationships. Some verbs that assess synthesis are categorize, compose, create, design, explain, reconstruct, relate, summarizes, Write.
Evaluation	Ability to judge the worth of material against stated criteria. Example of verbs: justify, critique, compare, contrast etc.

This taxonomy was revised in 2001 by Anderson and Krathwohl to change the category names from nouns to verbs, and to switch the Evaluation and Synthesis levels in the hierarchy.



Affective Domain

The affective domain depicts the manner in which we deal with things emotionally, such as feelings, values, appreciation, enthusiasms, motivations, and attitudes (Krathwohl, Bloom, Masia, 1973). The five major categories are listed from the simplest behavior to the most complex:

AFFECTIVE TAXONOMY

Level	Definition	Example
Receiving	Being aware of or attending to something in the environment.	Individual reads a book passage about civil rights.
Responding	Showing some new behaviors as a result of experience.	Individual answers questions about the book, reads another book by the same author, another book about civil rights, etc.

Valuing	Showing some definite involvement or commitment.	The individual demonstrates this by voluntarily attending a lecture on civil rights.
Organization	Integrating a new value into one's general set of values, giving it some ranking among one's general priorities.	The individual arranges a civil rights rally.
Characterization by Value	Acting consistently with the new value.	The individual is firmly committed to the value, perhaps becoming a civil rights leader.

Psychomotor Domain

The psychomotor domain includes physical movement, coordination, and use of the motor-skill areas (Simpson, 1972). Development of these skills requires practice and is measured in terms of speed, precision, distance, procedures, or techniques in execution. The categories of the psychomotor domain have been developed by different authors. We will have a look at some selected categories.

Dave (1970) also developed different categories for the psychomotor domain. He identified five levels which are listed below:

1. Imitation – Observing and copying someone else.
2. Manipulation – Guided via instruction to perform a skill.
3. Precision – Accuracy, proportion and exactness exist in the skill performance without the presence of the original source.
4. Articulation – Two or more skills combined, sequenced, and performed consistently.
5. Naturalization – Two or more skills combined, sequenced, and performed consistently and with ease. The performance is automatic with little physical or mental exertion.

SESSION 3: CHARACTERISTICS OF SPECIFIC OBJECTIVES

Although educational objectives may have been provided for each content area within the subject, the teacher will need to break these down to specific learning objectives. In this session, our aim will be to look at the characteristics of the specific objectives.

Learning outcome(s): By the end of this session, you should be able to:

Explain the characteristics of specific learning objectives

Now read on.....

The specific learning objectives seek to set the tone for instruction. They depict the intended outcome expected for the specific content about to be discussed during a particular lesson. Thus, the specific objectives are written for particular lessons. There are several characteristics of specific objectives and we will look at a few of them.

- **Relevant:** The stated specific objective should be free of any superfluous material but cover every point relating to the aims in view. Relevance is the essential quality of educational objectives. Objectives that have every quality except relevance are potentially dangerous. Thus, the objective should target the salient knowledge, skill or attitude you want learners to demonstrate at the end of the instructional period.

- **Unequivocal**: "Loaded" words (words that do not point to one particular point) should not be used, to avoid any possibility of misunderstanding. What do we mean when we say we want a student to "know" something? Do we want him to be able to recite, or to solve, or to construct? To say merely that we want him to "know" tells him too little or too much. The objective is unequivocal when you describe what the learner will have to do to demonstrate that he "knows", or "understands", or "can do". Therefore ,use verbs and words that show clearly what is expected of the learner.

- **Feasible**: It must be ensured that what the student is required to do can actually be done, within the time allowed and with the facilities to hand. The basic condition for feasibility: the minimum (practical, communication and intellectual skills) to qualify for the course. This is the prerequisite level.

- **Logical**: The objective must be internally consistent, plausible and scientifically appropriate.

- **Observable**: It is obvious that unless there is some means of observing progress towards an objective, it will be impossible to tell whether the objective has been achieved. There is therefore the need to ensure that the objectives stated are in behavioural form.

- **Measurable**: The objective must include an indication of acceptable level of performance on the part of the student. The existence of a creation for measurement will make it easier to choose or to construct a valid evaluation mechanism. That is why the objective must include an indication of acceptable level of performance on the part of the student. Therefore, the teacher should use verbs that can measured. For example, using verbs such as "know", "understand" will be problematic since it is not easy to measure whether someone has understood a point or not. But, when you use a verb such as "list", you will be able to assess if the person has been able to list the knowledge required.

SESSION 4: COMPONENTS OF SPECIFIC OBJECTIVES

The specific learning objective is critical for the teaching and learning of any concept. Therefore, teachers need to pat attention to them. For successful creation and usage of the specific learning objective, teachers should be abreast with its components. This session will describe the components of specific objective.

Learning outcome(s): By the end of this session, you should be able to:

Explain the components of specific objectives

Now read on…..

Heinich, Molenda, and Russell (1989) argued that there are four components of every objective. These components are the audience, behaviour, conditions and degree. These gave rise to the acronym (ABCD). Let's look at how each one stands for.

- ***Audience*** — who are the target of this objective, and what characteristics do they possess constitute the audience. The characteristics of the learner (age, level of development, aspirations, entry behaviour, etc) must be considered in the development of the objective.
- ***Behavior*** — what behavior is expected from the learner to demonstrate that he or she has learned the material. Words like "learn," "appreciate," and "know" are vague. Instead, use action verbs like "identify," "demonstrate," and "list". These action verbs actually portray what the learner is expected to achieve.
- ***Conditions*** — under what conditions will the learner be expected to demonstrate her knowledge. Are the learners going to learn in the laboratory, classroom or field? Will the learner be given graphs, illustrations, reference material, or must she perform from memory?
- ***Degree*** —the standard by which acceptable performance will be judged. This should talk about the degree or level of mastery of the performance or the subject matter by the students.

The implication is that every specific objective should have these components. The serves as a template through which the accurateness of the specific objective will be assessed.

SESSION 5: WRITING LEARNING OBJECTIVES

We have looked at the characteristics and components of the specific objective. As a teacher, you would need to know how to state these objectives in order to be effective in teaching. The focus of this session is to guide you to write specific learning objective for a chosen lesson.

Learning outcome(s): By the end of this session, you should be able to:

Write specific objective for a selected science topic.

Now read on.....

The writing of the specific objectives depends on the components we have discussed in session 5. In writing the objectives, care should be taken so that the various components will be met. The learning objectives should be written to cover the various levels of the Bloom's taxonomy. In teaching, we do not want our learners to acquire only the low level thinking skills but we also aim at helping learners to master higher order thinking skills. Therefore, teachers should ensure that their objectives cut across the various levels of the Bloom's taxonomy.

The ABCDs of Writing Objectives

Since we will deal so much on the components of the objectives as enumerated in the previous session, we would want to have a critical look at the components again. This will help us to have better understanding with the hope of aiding us to write appropriate objectives.

The ABCDs of writing objectives has been formulated as a guide to teachers in order for teachers to be able to formulate the best instructional objectives. Teachers should remember that only good instructional objectives will help them in their teaching. What then are the ABCDs of formulating good instructional objectives?

Audience (they are the learners)

It is always important to state the audience for which the learning outcomes are intended. You should therefore know who your learners are, their strengths and weaknesses and clearly and specifically state whose behaviour is going to change. For example, you must state if the learning outcomes are intended for JHS three pupils.

Behaviour to be Demonstrated

After every instruction, you expect that learners are expected to master a particular task. You should state clearly what behaviour should be mastered at the end of the instructional session. What you expect to observe from learners should be mentioned accurately in the statement of the objectives.

Conditions under which the behaviour will be observed

In stating objectives, you should include the conditions under which the mastery of task is to be observed. In this case, conditions are the settings or circumstances under which the behaviour will be observed. For example, you may state an objective this way, **"With the aid of a diagram showing the parts of the body**, the pupils will be able to write down the five sense organs". The bolded words are the conditions or settings that need to be mentioned.

Degree to which the learned skills are to be mastered

This is a measure of mastery. It measures the extent to which mastery will be judged. What degree of accuracy or proficiency must the learner display? The criteria by which mastery will be judged can be stated quantitatively or qualitatively. For example, we can state an instructional objective that "given a model of a human body, JHS 1 students should be able to identify at least 5 parts of the human body. "**At least 5 parts of the human body**" is the degree to which the behaviour will be observed.

In a typical classroom, the objectives are stated to cover the period of instruction. Thus, we normally precede objectives with the phrase: 'By the end of the lesson, the student will be able….. this will then be followed by the bulleted objectives as the case may be.
For example; By the end of the lesson

- JHS three students **(audience**) will be able to identify **(behaviour**) at least 3 **(degree**) parts of the flower using a chart **(condition**).

Key ideas

- Educational objectives are the intended outcomes of educational programmes expected to be seen in the learner.
- Educational objectives serves as the guideline to direct instructors, students and administrators.
- Learning outcomes have been categorized into a hierarchical structure to guide teachers and learners.
- It is crucial that educational objectives are relevant, feasible, logical among others.
- In writing learning objective, it is important that the various components are captured.

Reflection

- How do you ensure that your students attain higher levels of learning outcome?
- What affective attributes do you possess as a science student?

Discussion

- Why is it that teachers do not assess the affective domain?
- Why are the verbs used for writing objectives are required to be measurable?

UNIT 6: PLANNING FOR TEACHING AND LEARNING

The key to effective teaching is planning. A plan is a guide or map that helps to clarify the expectations in behaviour change of students after instructional activities. The purpose of a plan in science teaching is to articulate a programme of learning concerning how to make a group of students understand science materials and acquire scientific skills. This unit therefore seeks to introduce you to how you can successfully plan your lesson. The unit is structured into the following sessions:
Session 1: Lesson forecast and preliminaries
Session 2: Tabular lesson plan
Session 3: The back matter

Learning Outcome(s):
By the end of this unit, you will be able to:

- Develop scheme of work for the semester
- Develop a lesson plan for any science lesson.

Now read on……
Planning is a sequential decision-making process. Planning of a lesson involves decisions the teacher makes such selection of content to be taught, writing the statement of desired learning outcomes or objectives, selection of appropriate or best teaching method for the intended learning, selection of teaching-learning materials needed, plan the best way to introduce the subject or topic and plan appropriate closures of lesson. Let us look at how we can plan successfully as teachers.

SESSION 1: LESSON FORECAST AND PRELIMINARIES

We will start our planning with how to plan for the term as a teacher. Forecasting the various lessons that will be taught through the term is very important. This session will therefore take a look at how teachers can develop their lesson forecasts for the term.

Learning Outcome(s):
By the end of the session, you will be able to develop lesson forecast for the term.
Now read on….

The lesson forecast for the term is also called scheme of work or weekly forecast. This is a plan which organizes course content and the learning of important skills in the syllabus into a logical teaching order. This entails breaking the topics in the syllabus into smaller units and assigning duration of time within which each unit will be covered i.e. breaking up topics into teaching weeks.
It is prepared by the subject teacher for a group of learners with the objectives of describing the contents to be covered in each week as well as how the topics will be sequenced.

Scheme of work guide lesson planning, notifying the teacher on ‘what comes next’ and whether you are on target to finish the course within the time available.

Format for a weekly forecast or scheme of work

Teaching week	Week Ending	Topic	Sub-topic(s)	References	TLM	Remarks

The first column of the scheme of work deals with the teaching weeks for the term. The second column notifies you of the specific dates for the week. Having noted the week and the dates, you need to indicate the topic you will be teaching during that week. If the topic is broad and comes with sub-topic(s), then you will need to indicate those sub-topics. Since the scheme of work can be used by other teachers in the absence of the substantive teacher, it is necessary that the teacher developing the scheme of work indicates books and other academic materials he would refer to in order to prepare the lesson on the stated topic. The next item to be noted in the scheme of work is the teaching and learning materials the teacher would want to use when teaching the stated topic. This is very important especially if you may need to make arrangements for specific materials. Again, if your school does not have the material you will be able to solicit for some in a nearby school on time. The last column of the scheme of work is the remarks column. Most often than note, teachers fill this column at the end of the week to indicate if the plan was successfully implemented or there was some occurrences that hindered the successful implementation of the scheme. Now let us fill the table to serve as an example.

Scheme of work for year 1 Biology (2nd Term)

Teaching week	Week Ending	Topic	Sub-topic(s)	References	TLM	Remarks
1 2	3rd-7th April 10TH-14TH April	The cell as a unit of life. Movement of substances into and out of cells	The concept of cell Akaryotes and Prokayotes Mode of life of viruses and bacteria Eukaryotic cell structure and functions Transport across the cell surface membrane	Campbell, N.A.,& Reece, J. B. (2005). *Biology.* (7th ed.). San Francisco: Pearson Raven, P. H., & Johnson, G. B. (2002). *Biology.* (2nded.). New York:	Microscope, Red blood cells, Onion cells. Electron micrographs, *Zebrina*, perfume,	

			Physiological processes by which substances move into and out of the cell. Experiment on diffusion, osmosis and plasmolysis.	McGraw-Hill.		

SESSION 2: TABULAR LESSON PLAN

This session will look at how you can translate the scheme of work into specific lessons. In order to successfully teach, a teacher must have a lesson plan. In this session, we are going to look at how to prepare a lesson plan to facilitate teaching and learning in the biology classroom.

Learning Outcome(s):

By the end of the session, you will be able to:

- Formulate a lesson objective for a specific topic
- Identify a relevant previous knowledge for a science concept to be taught.
- Develop a lesson plan for a lesson to be taught.

Now read on….

A lesson plan is the day-to-day instructional design or guide that is developed by a teacher for specific lessons. It is an extremely useful tool that serves as a guide, resource and historical document reflecting the teacher's teaching philosophy as well as learning goals for her students. A lesson plan serves as a map or checklist that guides the teacher in knowing what we want to do next, the sequences of activities and objectives of the lesson for the students. Lesson plan helps to make teaching organized and more systematic. It induces confidence in the teacher as well as helps save instructional time. In the absence of the substantive teacher, a substitute teacher can use to teach just as the original teacher would have taught.

In developing the lesson plan, there are three main divisions: the rubrics, the table and the back matter. The rubric is made up of all the preliminaries that come before the actual teaching and learning procedures are presented. The rubrics consist of subject, topic, subtopic, class, number of students in the class, venue, time, duration, relevant previous knowledge, objectives, and advanced preparation. Let us know discuss these aspects of the lesson plan.

The 'subject' section is where you identify the subject area in which the lesson plan being developed. You then indicate the 'topic' the plan will cover. If you have broken down the topic into subtopics, then you write the subtopic you are going to teach at that section. The teacher must state the class in which he is going to teach as well as indicate the number of students in that class. The venue of the lesson, the time the lesson will occur and the duration for the lesson should be identified. If you are

teaching more than one class the same concepts, you can have one lesson plan for all the classes. In such a situation, the rubrics we have identified can be put in a table form.

Relevant Previous Knowledge (RPK)
This is the knowledge, skill or ideas which the students already know and which relates the new material to be learnt. It could be general knowledge acquired from everyday experiences or real life and may also come from other subjects in the curriculum. It could also come from a previous lesson especially when the topic to be taught is a continuation of the previous lesson. Note that any RPK stated must be relevant to the lesson.

How to state RPK:
Relevant previous knowledge is stated from the students' point of view.
Example: A relevant previous knowledge for the digestion can be: students eat food to get energy or students are aware that food contains nutrients.

Specific lesson objectives
The next thing to consider is the objectives for the lesson. The objectives provide operational definition of the kind of learning that should occur in the classroom. It is a statement of intent, describing what student should gain and be able to do after instructional experience. The objectives should be written in behavioural terms and should be observable as well as measurable. Thus, the objectives should be SMART: Specific, Measurable, Attainable, Relevant and Timely (Time bound).
A good specific lesson objective should have these components:

- **Verb/action word:** The action word depicts the observable behaviour of the student. The verb must be observable and measurable. Verbs such as 'know', 'understand', 'appreciate' are not measurable in the short term and should be avoided when writing lesson objectives.

- **Content:** The objective must indicate the content the teacher wants the students to learn.

- **Criteria:** Indicates the acceptable level of performance expected from students. It specifies how accurately the students should exhibit the behaviour.

- **Condition:** It describes the conditions under which the behaviour is to be performed. It specifies the circumstances, materials, and directions that the student is provided to perform the given task. It can also show the context within which the behaviour is to be performed.

Although some objectives may have all the four components, it must be noted that not all objectives may have all the four components. However, every objective must have the verb and the content.

How to state objectives: You first indicate the preamble and then followed by the objectives.
Example

By the end of the lesson, the student will be able to:
a. Identify epithelial tissues under the light microscope in the laboratory.
b. Define osmosis.

In example (a) above, all the four components were met. In that example, the verb is 'identify', the content is 'epithelial tissues', criteria is 'under the light microscope', and the condition is 'in the

laboratory'. In example (b) however, only two components formed the objective. Here, we have only the verb and the content.

Advanced Preparation

This includes all activities or preparations the teacher makes prior to the main lesson.

For instances if the teacher developed a diagram of the heart on cardboard, then that is an advanced preparation that should be captured in the lesson plan. Since by the time the lesson will be conducted the advanced preparation would have occurred, that section is written in the past tense. For example, an advanced preparation for the topic 'digestion' could be:

Teacher prepared a chart on the digestive system of a human being.

Reference: The teacher must indicate the source of his information. Therefore he should write the reference material he used to prepare the lesson. The reference should be properly written.

The tabular plan

After the rubrics, the next sections of the lesson plan will be written in a tabular form. The table helps to align the information being provided and helps systematic and logical presentation of information. The first row indicates the heading for the various columns in the table. The heading for the first column is 'stage, step, content item and estimated time'. Let us take this heading and discuss them.

Stage, step, content item (estimated time)	Teaching-learning materials	Teaching/learning strategy		MAIN IDEAS
		Teacher Activity	Student Activity	
INTRODUCTION				
CONTENT DEVELOPMENT				
APPLICATION				
CLOSURE (Summary and Evaluation)				

STAGE: This indicates the part of the lesson you are developing. There are four main stages in the lesson plan. These are the introduction, content development, application and closure. Let us expand these four stages.

- **Introduction**

This is the stage the students or learners are prepared to get them thinking and ready for a lesson. It pertains to preparing and motivating learners to the lesson content by linking it to the previous knowledge of the student, by arousing curiosity of the learners and by making an appeal to their senses. This prepares the learner's mind to receive new knowledge. This step though so important must be brief. At this stage, the stated relevant previous knowledge (RPK) is activated in order to link it to the

new lesson you are coming to teach. There are various approaches through which the teacher can use to introduce his or her lesson. Teachers should therefore use their ingenuity and make their introduction very interesting and captivating.

- **Content development**

The 'actual' lesson begins and both teacher and students' activities are stated. Teachers should make use of different teaching methods and aids to make his lesson effective. Teachers should draw as much as possible from the students making use of judicious questions. It is here that the core points or main ideas are stated. The content of the lesson should be developed in steps based on the stated objectives.

- **Application**

In this stage of the lesson, the knowledge gained is applied to real or novel situations. This stage aims at helping students to transfer knowledge gained in the classroom to real world situations. No lesson in science may be considered complete if learned rules, principles, and formula are not applied to life situations.

- **Closure – Summary and Evaluation**

The teacher brings the lesson to an end at this stage. This stage encompasses two main activities: summary and evaluation. The teacher summarizes the lesson and ascertain whether his students have understood and the objectives of the lesson have been achieved. Here, the teacher evaluates the lesson based on the stated objectives. All stated objectives must be evaluated. This is used for assessing the effectiveness of the lesson by asking students questions on the contents of the lesson based on the objectives stated at the onset. It should be noted that evaluation can also be done at the end of each step of the content development. If that is done, then at the closure the teacher could just summarize since she undertook formative evaluation in the course of teaching.

STEP: Some stages may be too long so the teacher will need to break such stages into steps. The most common stage that is normally sequenced into steps is the content development.

CONTENT ITEM: This looks at what the teacher is doing at that particular stage or step. So the teacher should explicitly indicate the specific focus of the step she is performing.

ESTIMATED TIME: In order to be systematic and not go beyond your allotted time, the teacher must indicate the estimated time he would use for each activity during the lesson.

TEACHING-LEARNING MATERIALS

The next column is titled 'teaching-leaning materials'. This is where the teacher indicates the various teaching and learning materials she will use. In doing this, the teacher must indicate the teaching-learning material at the stage or step of the lesson where the material will be sued. Thus, there should be an alignment between the material and the stage/step it will be used.

TEACHING AND LEARNING STRATEGY

This is where the instructional activities to be performed to elicit student learning will be employed. Since the classroom discourse is between the teacher and the students, this section has two subdivisions'; teacher activity' and 'student activity'. Under the 'teacher activity', the teacher should indicate the instructional technique he will use to deliver specific content. The teacher should vary his instructional strategies to enhance student conception and maintain students' interest. Again, the teacher should use student-centred instructional strategies to foster student engagement in the teaching

and learning process. The teacher will then have to indicate a corresponding activity for students under the 'student activity'. The teacher indicates how he wants students to react to the instructional approach he is going to use.

MAIN IDEAS

The last column in the table is the main ideas column. This is the section where the content the teacher wants the learners to understand are written. The teacher should note that every concept that he is going to teach should appear under this column. Again, whatsoever comes here should be part of the chalk board summary.

SESSION 3: THE BACK MATTER

This session looks at the last part of the lesson plan. The session will also combine all the discussions on the lesson plan and put the issues together to form one plan.

Objective:

By the end of this session, you will be able to

a. Identify the constituents of the back matter.
b. Draw a lesson plan for a science lesson.

Now read on….

After the table comes what we call the back matter. This is made up of the assignment, references and remarks.

ASSIGNMENT: The teacher should give students assignment to enhance learning as well as promote retention of the materials learnt in class. The assignment should be able to help student apply what they have learnt in class. Again, the assignment should help students to further learn about the content discussed in class. The assignment should not be another evaluation of the lesson taught.

REFERENCES: When assignments are given, the teacher should indicate the reference material students can consult to help them complete the assignment. Reference provided should be readily available to the students. It is very important that the solution or answers to the assignment questions are not explicitly found in the reference material.

REMARKS: The last part of this section is the 'remarks'. The 'remarks' part seeks to note whatever happened during the course of instruction. So, the 'remarks' section is mostly filled after teaching. You indicate if the lesson was successfully taught or there will be remediation.

Now let us combine all the issues we have discussed in the previous session and this session to form the outline for a lesson plan.

LESSON PLAN FORMAT TO BE USED FOR ONE CLASS

SUBJECT
TOPIC
SUBTOPIC
CLASS
NO. IN CLASS
DATE
VENUE
TIME
DURATION

OBJECTIVES
RELEVANT PREVIOUS KNOWLEDGE
REFERENCE
ADVANCED PREPARATION

Stage,step, content item (estimated time)	Teaching-learning materials	Teaching/learningstrategy		MAIN IDEAS
		Teacher Activity	Student Activity	
INTRODUCTION				
CONTENT DEVELOPMENT				
APPLICATION				
CLOSURE (Summary and Evaluation)				

ASSIGNMENT:
REFERENCE:
REMARKS:
If you are teaching the same concepts to more than one class, then the format will be as found below.

LESSON PLAN FORMAT TO BE USED FOR MORE THAN ONE CLASS
SUBJECT
TOPIC
SUBTOPIC

CLASS	DATE	TIME	DURATION	NUMBER OF STUDENTS IN CLASS	VENUE
2 SCI 1	9-4-17	12:00-12:40pm	40mins	45	Classroom
2 SCI 2	11-4-17	8:00-8:40am	40mins	46	Science Lab
2 SCI 3	11-4-17	1:00-1:40pm	40mins	44	Classroom

OBJECTIVES
RELEVANT PREVIOUS KNOWLEDGE
ADVANCED PREPARATION

Stage, step, content item		Teaching/learning strategy	MAIN IDEAS

(estimated time)	Teaching-learning materials	Teacher Activity	Student Activity	
INTRODUCTION				
CONTENT DEVELOPMENT				
APPLICATION				
CLOSURE (Summary and Evaluation)				

ASSIGNMENT:
REFERENCE:
REMARKS:

Now let us have an example of a 30 minutes lesson plan for a topic in Science.
SUBJECT: Science
TOPIC: The cell as a unit of life
SUBTOPIC: Concept of cell
CLASS: 1 Science 1
NO. IN CLASS: 50
DATE: 3-5-17
VENUE: Science Lab
TIME: 8:30-9:00am
DURATION: 30minutes
OBJECTIVES
By the end of the lesson, the student will be able to:

a. Define the cell
b. State the cell theory

RELEVANT PREVIOUS KNOWLEDGE
Students are aware that the basic structural unit of a building is a block.
REFERENCE
Campbell, N.A.,& Reece, J. B. (2005). *Biology.* (7thed.). San Francisco: Pearson

ADVANCED PREPARATION
Teacher prepared microscopes and slides for the lesson.

Stage,step, content item (estimated time)	Teaching-learning materials	Teaching/learningstrategy		MAIN IDEAS
		Teacher Activity	Student Activity	
<u>INTRODUCTION</u> <u>Review of students relevant previous knowledge</u> <u>(2mins)</u>		Teacher uses question to review students' relevant previous knowledge and introduce the lesson. Question: What is the basic unit of a building?	Students' respond to teacher's question. Expected response: A block	
<u>CONTENT DEVELOPMENT</u> Step 1: Definition of a cell (10mins) Step 2: The cell theory (10mins)	Microscope, slides of onion cell, red blood cell.	Teacher mounts slides on the microscopes and allow students to observe and brainstorm to come up with the definition of a cell. Teacher uses lecture method to bring out the cell theory.	Students observe the cells under the microscope and brainstorm to come up with the meaning of a cell. Students listen and pay attention to teacher's explanations.	<u>Definition of a cell</u> A cell is a membrane-bounded unit that contains DNA and cytoplasm and constitutethe basic unit of life in all living organisms. <u>Cell theory</u> The cell theory is made up of basic principles: All living things are made up of one or more cells. The smallest living unit of structure and function of all organisms is the cell. All cells arise from pre-existingcells.
<u>APPLICATION</u> (3mins)		Teacher uses question to allow students apply what	Students respond to teacher's question.	

		they have learnt. Question: What causes infants to grow to become adults?	Expected response: The cells of the infants divide and multiple and this leads to growth.	
<u>CLOSURE (Summary and Evaluation) (5mins)</u>		Teacher summarizes the lesson and uses questions to evaluate the lesson. Questions: What is a cell? State the cell theory?	Students listen to the summary and answer teacher's questions. Expected responses: A cell is a membrane-bounded unit that contains DNA and cytoplasm and constitute the basic unit of life in all living organisms. The cell theory states that: All cells arise from pre-existing cells. The smallest living unit of structure and function of all organisms is the cell. All living things are made up of one or more cells.	

ASSIGNMENT: Identify two organisms that are made up of one cell and two organisms that are made up of more than one cell.

REFERENCE: Raven, P. H., & Johnson, G. B. (2002). *Biology*. (2nd ed.). New York: McGraw-Hill.

REMARKS:

Key ideas

- Successful planning facilitates the teaching and learning process.
- Forecasting your instruction throughout the semester helps to determine materials you will need during the lesson.
- Lesson plans help teachers to teach systematically.

Reflection

- There has been agitations from teachers about the need to develop lesson plans. What is your view on this after going through this unit?

Discussion

- Develop a 30-minutes lesson plan on the topic digestion in humans.
- Develop a scheme of work for the semester.

BIBLIOGRAPHY

Abell, S. K., Appleton, K., &Hanuscin, D. L. (2010). *Designing and teaching the elementary science methods course*. New York: Taylor & Francis.

Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education (JRTE), 43*(4), 281-300.

Akpan, O. E. (1992). *Toward creative science teaching and learning in the West African Schools*. Cape Coast: Catholic Mission Press.

Ebel, R. L., &Friesby, D. A. (1995). *Measurement and assessment in teaching*. Upper Saddle River, NJ: Prentice Hall.

Erinosho, S. Y. (2008). *Teaching science in secondary schools: A methodological handbook*. Lagos: African Culture International Centre.

Gibson, J.J. (1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin Company.

Guilbert J. *Educational handbook for health personnel*. 6th ed. (1987) revised 1998. Geneva: World Health Organization; Page No. – 1.30 to 108.

Green, H., Facer, K., Rudd, T., Dillon, P., & Humphreys, P. (2005). Personalisation and digital technologies. . Retrieved 20/10/2011, from http://archive.futurelab.org.uk/resources/publications-reports-articles/opening-education-reports

Gronlund, N. E. (1985). *Stating objectives for classroom instruction* (3rd ed.). New York: Macmillan Publishing Company.

Hixon, E., & Buckenmeyer, J. (2009). Revisiting technology integration in schools: Implications for professional development. *Computers in the Schools,, 26*(2), 130-146.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054.

Nilson, L.B. (2010). *Teaching at its best: A research-based resource for college instructors (2nd ed).* San Francisco: Jossey-Bass.

Patidar, A. B. (2013). *Communication and nursing education*. Delhi: Pearson

Tamakloe, F. K., Amedahe, F. K., & Atta, E. T. (2006). *Principles and methods of teaching* (2nd ed.). Accra: Ghana University Press.

Tanner, K. D. (2013). Structure Matters: Twenty-one teaching strategies to promote student engagement and cultivate classroom equity. *CBE-Life Sciences Education,* 12, 322-331.

Trowbridge, L., Bybee, R.W., & Powell, J.C (2004). *Teaching secondary school science: Strategies for developing scientific literacy*. Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

Prensky, M. (2001). Digital natives, digital immigrants. *On the horizon, 9*(5), 1-6.

White, R. T., & Gunstone, R. F. (1992). *Probing Understanding*. Great Britain: Falmer Press.