Course: Teaching Strategies in Science Education (6437)

Semester: Spring, 2021

ASSIGNMENT No. 1

Q.1 Elaborate the scientific method of inquiry. How the knowledge of nature of science help in implementation of scientific method?

Science teaching is a complex activity that lies at the heart of the vision of science education presented in the Standards. The teaching standards provide criteria for making judgments about progress toward the vision; they describe what teachers of science at all grade levels should understand and be able to do.

To highlight the importance of teachers in science education, these standards are presented first. However, to attain the vision of science education described in the Standards, change is needed in the entire system. Teachers are central to education, but they must not be placed in the position of being solely responsible for reform. Teachers will need to work within a collegial, organizational, and policy context that is supportive of good science teaching. In addition, students must accept and share responsibility for their own learning.

The standards for science teaching are grounded in five assumptions.

- The vision of science education described by the Standards requires changes throughout the entire system.
- What students learn is greatly influenced by how they are taught.
- The actions of teachers are deeply influenced by their perceptions of science as an enterprise and as a subject to be taught and learned.
- Student understanding is actively constructed through individual and social processes.
- Actions of teachers are deeply influenced by their understanding of and relationships with students.

The educational system must act to sustain effective teaching. The routines, rewards, structures, and expectations of the system must endorse the vision of science teaching portrayed by the Standards. Teachers must be provided with resources, time, and opportunities to make change as described in the program and system standards. They must work within a framework that encourages their efforts.

The changes required in the educational system to support quality science teaching are major ones. Each component of the system will change at a different pace, and most changes will be incremental. Nonetheless, changes in teaching must begin before all of the systemic problems are solved.

As knowledge regarding human development and learning has grown at a rapid pace, the opportunity to shape more effective educational practices has also increased. Taking advantage of these advances, however, requires integrating insights across multiple fields—from the biological and neurosciences to psychology, sociology, developmental and learning sciences—and connecting them to knowledge of successful approaches that is emerging in education. This article seeks to contribute to this process by drawing out the implications for school and classroom practices of an emerging consensus about the science of learning and development (SoLD), outlined in a recent synthesis of the research.

Using these articles as a foundation, we synthesize evidence from the learning sciences and several branches of educational research about well-vetted strategies that support the kinds of relationships and learning opportunities needed to promote children's well-being, healthy development, and transferable learning. In addition, we review research regarding practices that can help educators respond to individual variability, address adversity, and support resilience, such that schools can enable all children to learn and to find positive pathways to adulthood.

This work is situated in a relational developmental systems framework that looks at the "mutually influential relations between individuals and contexts". This framework makes it clear how children's development and learning are shaped by interactions among the environmental factors, relationships, and learning opportunities they experience, both in and out of school, along with physical, psychological, cognitive, social, and emotional processes that influence one another—both biologically and functionally—as they enable or undermine learning. Although our society and our schools often compartmentalize these developmental processes and treat them as distinct from one another—and treat the child as distinct from the many contexts she experiences—the sciences of learning and development demonstrate how tightly interrelated they are and how they jointly produce the outcomes for which educators are responsible.

Key insights from the science of learning and development are that the brain and the development of intelligences and capacities are malleable, and the "development of the brain is an experience-dependent process", which activates neural pathways that permit new kinds of thinking and performance. As a function of experiences, the brain and human capacities grow over the course of the entire developmental continuum and across the developmental spectrum (physical, cognitive, affective) in interactive ways. What happens in one domain influences what happens in others? For example, emotions can trigger or block learning. Emotions and social contexts shape neural connections which contribute to attention, concentration, and memory, to knowledge transfer and application. Understanding how developmental processes unfold over time and interact in different contexts can contribute to more supportive designs for learning environments.

Furthermore, general trends in development are modified by interactions between unique aspects of the child and his/her family, community, and classroom contexts. As a result, children have individual needs and trajectories that require differentiated instruction and supports to enable optimal growth in competence, confidence, and motivation.

A central implication for educators is that this integrated and dynamic developmental system is optimally supported when all aspects of the educational environment support all of the dimensions of children's development. This calls for a deeply integrated approach to practice that supports the whole child in schools and classrooms that function coherently and consistently to build strong relationships and learning communities; support social, emotional, and cognitive development; and provide a system of supports as needed for healthy development, productive relationships, and academic progress. This holistic approach must necessarily connect

with family and community contexts: developing strong, respectful partnerships to understand and build on children's experiences and, as needed, to strengthen any aspects of the developmental system where there are challenges to children's health and well-being.

System of supports that enable healthy development, respond to student needs, and address learning barriers. These include a multi-tiered system of academic, health, and social supports that provide personalized resources within and beyond the classroom to address and prevent developmental detours, including conditions of trauma and adversity.

As we describe these components and their implications for educational practice, we both describe optimal practices for all children in schools and specific interventions that are needed when children have experienced adversities that require redress and when schools have been structured in ways that do not yet permit developmentally supportive experiences at all times and in all the contexts of school life. Where we describe specific programmatic interventions, we do so with the goal of informing a whole school approach that will eventually incorporate these elements into the regular features of educational settings.

The research presented in this article builds on the literature presented in the earlier syntheses on learning and development and maps the key findings to other research on school and teaching practices that have well-developed evidence associated with these goals. We tap reviews of research, meta-analyses, and handbook chapters that have synthesized evidence, as well as individual studies that represent a broader body of evidence represented in other research.

As part of a supportive environment:

- A caring, culturally responsive learning community, where students are well-known and valued and can learn in physical and emotional safety;
- Structures that allow for continuity in relationships, consistency in practices, and predictability in routines that reduce anxiety and support engaged learning;
- Relational trust and respect between and among staff, students, and parents.

As part of productive instructional strategies:

- Meaningful work that builds on students' prior knowledge and experiences and actively engages them in rich, engaging tasks that help them achieve conceptual understanding and transferable knowledge and skills;
- Inquiry as a major learning strategy, thoughtfully interwoven with explicit instruction and well-scaffolded opportunities to practice and apply learning;
- Well-designed collaborative learning opportunities that encourage students to question, explain, and elaborate their thoughts and co-construct solutions;
- Ongoing diagnostic assessments and opportunities to receive timely and helpful feedback, develop and exhibit competence, and revise work to improve;

- Opportunities to develop metacognitive skills through planning and management of complex tasks, self- and peer- assessment, and reflection on learning.

As part of social and emotional learning opportunities:

- Explicit instruction in social, emotional, and cognitive skills, such as intrapersonal awareness, interpersonal skills, conflict resolution, and good decision making;
- Infusion of opportunities to learn and use social-emotional skills, habits, mindsets throughout all aspects of the school's work in and outside of the classroom;
- Educative and restorative approaches to classroom management and discipline, so that children learn responsibility for themselves and their community.

As part of a system of supports:

- Access to integrated services (including physical and mental health and social service supports) that enable children's healthy development;
- Extended learning opportunities that nurture positive relationships, support enrichment and mastery learning, and close achievement gaps;
- Multi-tiered systems of support to address learning barriers both in and out of the classroom based on a shared developmental framework uniting a capable and stable staff with families and support providers.

Q.2 Make a plan for effective instruction of physics to 10th grade students. Take the content of your choice.

"The key to making your students' learning experiences worthwhile is to focus your planning on major instructional goals, phrased in terms of desired student outcomes—the knowledge, skills, attitudes, values, and dispositions that you want to develop in your students. Goals, not content coverage or learning processes, provide the rationale for curriculum and instruction."

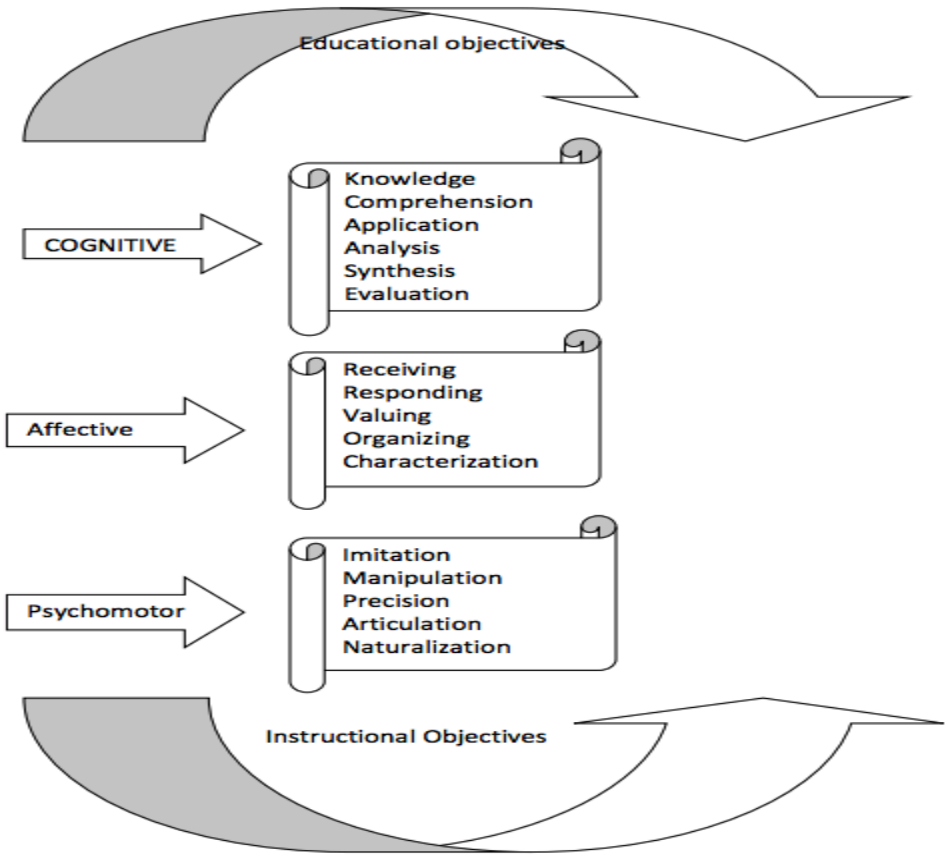
Education is a process of bringing desirable behavioural changes in the individuals. It helps the individuals to identify their capabilities and potential. Classroom instructions and activities are the gate way of this process. Hence a teacher who deals with any subject should clearly plan his objectives of a particular instruction. Pre determined learning outcome of an instruction can be called as instructional objectives. More clearly, Instructional objectives are the specific or immediate goal which is obtainable as a result of instruction or through classroom interaction. This is considered as the target of a teacher for a specific lesson or a topic. Learning/ teaching outcomes of a classroom is designed by the instructional objectives. Without formulating instructional objectives instruction become aimless or target less as well as wastage of time and effort of both teachers and students. Instructional objectives should be planned to develop different domains of the learner. Discussion on Blooms taxonomy is necessary to understand the different domains of the learner.

The word taxonomy derived from the Greek word 'taxis' which means systematic classification. Prof.Benjamin S Bloom and his associate, University of Chicago developed and classified the domains of educational objectives. Bloom (1956) presented his taxonomy related to cognitive domain giving emphasis to the hierarchy of cognitive process in attaining knowledge and development of thinking. Later Krathwhol (1964) introduced affective domain and Simpson (1966) developed psychomotor domain. They described the hierarchical development of the three domains of the learner though instruction. This classification objective is known as Blooms taxonomy of educational objectives.

1. Cognitive domain- Knowledge field
2. Affective domain- feeling field
3. Psychomotor domain-doing field

Every educational activity should be planned to develop all this domain of the learner. Hence these three domains are mutually interrelated and interdependent also.

Concept map of Blooms Taxonomy



Instructional Objectives in Cognitive Domain

The cognitive domain deals with the intellectual aspect of cognition. It concerned with sensation, perception and application of knowledge. The hierarchical development of cognitive domain is discussed below.

Knowledge

Acquisition of knowledge is the lowest level in the cognitive domain. It includes the ability of students to recall and remember the information learned in the classrooms. Recall and recognition are the specification of this instructional objective.

Comprehension

It is the second level of cognitive domain. It is the meaningful recall and recognition of the learned content. Here the learner could understand and explain what he learned in the classroom as his own language. Identifying relations, classification of objects, explanations, comparisons, translation etc are the specification of this level.

Application

In third level the learners are able to apply or use the knowledge which is acquired and comprehended during the first two levels. It is the ability to apply the acquired knowledge trough instruction in real life situations. Establishing new relationship, formulating hypothesis, predictions are the some specification of this level.

Analysis

Analysis is the meaningful breakdown of the materials into its various components and to identify the interrelationship between the elements and find out how they are organized and related. Specification of this level includes the analysis of elements, analysis of relationship, analysis of organizational principles.

Synthesis

Synthesis is the mental ability of the learner to integrate the acquired, comprehended, applied and analyzed knowledge in to a comprehensive whole. It involves the ability to give a new shape or structure to statements or procedures.

Evaluation

This is the highest level of cognitive domain. Students could evaluate an object, person, a theory or a principle if only he is par with all other lower hierarchy in the cognitive domain. It is the ability to judge a value of a material, aspects, methods, principles , theory, philosophy and so forth for a given purposes. At this level s/he could perform personal viewpoint about the information s/he synthesized.

Instructional Objectives in Affective Domain

Affective domain is related with the development of heart and mind of the child. It includes the areas of emotions, feelings, interest, attitude, appreciation and values. The teacher should be given emphasis to correlate the development of cognitive domain with affective domain. A person who studied the Gandhian principles, civic right and duties without developing his affective domain is worthless for the country as well as society. Hence the teacher should ensure the development of affective domain in his instructional objectives of the classroom instruction. Bloom and Krathwohl (1964) introduced the following hierarchy for affective domain.

Receiving

In the basic level the learner is sensitized to the existence of a certain phenomena and stimuli. s/he is willing to receive the information whole heartedly by exhibiting awareness on the stimuli and become conscious on particular person, principle, philosophy, incidents etc. For example students are interestingly listening to Gandhian principles.

Responding

Effective reception prepares the learner to respond seriously. As result of receiving some good message from the first hierarchy, the learner tries to respond to the situation positively. For example students show kindness towards elders and weaker people, hold honest behaviour in day to day life situations etc.

Valuing

By responding in good ways, the students set guidelines for their behavior. Accepting values, preference for values, commitment to values are the important behavioural changes in this level. For example students develop positive attitude towards non violent behavior, truthfulness, honesty etc.

Organization

Student builds a system of value at this level. Value conflict and value crisis are resolved. Through organizing different values students are able to develop their own code of conduct and standard of public life in the society. For example Pupil identifies the inseparability of the values like non violence, truthfulness and tolerance of Indian tradition. They show dislike towards corruption and violence in the country and think against to work.

Characterization

This is the highest level of internalization process. Values are imbibed and forms part of the life style of the individual. For example the non violence value becomes the philosophy of the individual. They will not be ready to compromise on their philosophy at any stage as well as, ready to work for justice even though they are alone their way.

Psychomotor domain deals with the action or performance level. This domain includes muscular action and neuromuscular coordination. Educational objectives of this domain aim to developing proficiency in performing certain acts. Simpson (1966) presented the psychomotor domain as follows.

Perception

Perception is the first level in psychomotor domain. It consist the process of becoming aware of objects, qualities or relation through sense organs.

Set

In this second hierarchy students make preparatory adjustment of readiness for a particular kind of action or experience. Mental as well as physical set for action is performed here.

Guided response

It is the overt behavioural act of a student under the guidance of the teacher. Students initially perform an act which is perceived and set through earlier levels. It includes imitation of teachers, elders, parents, and trial and

error activities in attaining writing, reading skill etc. For example; Student imitates the writing style of his teacher to write letter 'A' and repeat many times to learn how to write letter 'A'.

Mechanism

In this level student show progress in performing the act through imitation and trial and error. Student learned to write letter 'A' by imitating his teacher and through trial and error activity. Now s/he can write letter 'A' at his/her will. Here learned response has become habitual. It is a micro analysis in which each step in the mechanism is properly examined and drilled.

Complex Overt Response

In this level the student can perform a complex motor act which required a complex movement pattern. It this hierarchy students attain a high degree of skill and the act can be carried out smoothly and efficiently. In this level students could perform the act without any hesitation. Fine muscular coordination and great deal of ease in performing act are the peculiarity of this level. Here student able to write many word easily and simply within a short period of time, ability to run, walk, jump and talk easily are also comes under this category.

Adaptation and Originating

This is the highest level. Here student are adapted with the ability of doing an act which is acquired through above steps. Now spontaneously s/he can perform the act with accuracy. More over s/he is able to originate a new pattern of action or style in doing the activity.

Dave (1969), from NCERT also contributed taxonomy for psychomotor domain which is discussed below.

Imitation

It is simply an imitation act of a student who energized through cognitive as well as affective domain development. It means that the student who learned how to write (cognitive domain), willing to write (affective domain) may imitate to write to get the ability to write (psychomotor domain).

Manipulation

This level student tries to do the imitated activity in various ways through repetition. Here students try many ways and styles to perform the activity and select appropriate one which is suitable and convenient to him/her.

Precision

In this level student attain speed, accuracy, proportion, exactness, neatness in a performing the act which is acquired through above two levels.

Articulation

Here the student able to handle many actions in unison. This includes coordination, sequence and harmony among acts.

Naturalization

This is the highest level in psychomotor domain. Here student attain the proficiency in performing the particular task. The action becomes automatic with least physic as well as mental energy.

The following criteria should be kept in mind by the teacher while setting and writing the instruction objectives.

1. Specification of the learner/Performer

   Specify the learner such as pupil, class, group etc

2. Learner performance

   Illustrate the learners' performance in classroom interaction, for example, students are able to understand, apply, identify, and justify etc. it also termed as action verb.

3. Learning content and condition

   Clearly mention the content of study, for example, the pupil able to justify the nonviolence principle of Gandhi

Besides the above, the teacher should set target of a minimum expected level performance of the learner in quantitatively and qualitatively. Exclusive inclusion of all the instructional objectives with adequate weightage should be taken care of.

Instructional Objectives and Specification

Instructional objectives can be defined as the specific or immediate outcome as result of an instruction. It could be design in such a manner that it shows what the students should be able to recall or perform after the completion of classroom courework. It describes the progressive changes in cognitive, affective and psychomotor domain in terms of Knowledge, comprehension, applications, skills, appreciation and so forth. But the problem arise in this case is that, how could a teacher understand whether the student gain any knowledge, able to apply the information he has received from the classroom interaction. It requires the presence of specification or specific objectives. Specifications are the observable and measurable changes in the behavior of the learner. It tells us what the pupil will do or how they behave if they realize an objective. Hence it is the behavioural changes showed by the students which can be observable and measurable by the teacher is called as behavioural objectives. For example, knowledge is an instructional objective; A teacher who taught the 8th class students the lesson of 'democracy'. How s/he could understand whether the student achieved the knowledge objective through his classroom interaction? Unless and until the student explain the concept of democracy or give example of any democratic country, teacher cannot understand whether s/he fulfill her/his instructional objectives. Here, the student activity of explain and give example are the specific objectives/behavioral objectives, by which a teacher can observe the attainment of instructional objectives by the students. This able the teacher quantitative as well as qualitative measurement of the same.

Q.3 Explain the phases of learning cycle, also identify appropriate technique for each phase.

1. Preparation: Arousing Interest

Adult learners need to be ready to engage in the learning process. Barriers are created when learners lack interest, don't see the benefit of learning, or have negative feelings about either the learning or the content.

The goal of the Preparation Phase is to give them positive feelings about the learning experience, and put them into an optimal state for learning. These are some ways to do this:

- Arouse the learners' curiosity by having them raise questions and pose problems for each other.
- Create a positive social environment incorporating collaborative activities
- Create a learning community by having everyone select and change learning partners throughout the program.
- Have learners define their main goals in attending the program and have them share them with other participants.
- Give each team a course objective and have them come up with as many benefits for that objective as they can.
- Remove learning barriers by having people write down their own barriers and, in teams, coming up with solutions for overcoming them.
- Provide positive suggestions by having a display of success stories of previous attendees.

2. Presentation: Encountering the New Knowledge or Skills

Unless adult learners are integrally involved in creating and adapting their own learning content, they don't learn. They need to initially encounter the new knowledge and skills in ways that are meaningful to them, and incorporating their own learning style, whether visual, auditory, intellectual, or kinesthetic.

The goal of the Presentation Phase is to help the learners encounter the new material in ways that are interesting, enjoyable, relevant, multisensory, and that appeal to all learning styles.

Here are some examples:

- Collaborative pretests and knowledge sharing
- Interactive presentations
- Variety to appeal to all learning styles
- Partner- and team-based learning projects
- Discovery exercises (personal, partnered, team-based)
- Real-world, contextual learning experiences
- Problem-solving exercises

Practice: Integrating the New Knowledge or Skills

Knowledge is not something a learner absorbs. It is something a learner creates, and it needs time for integration. Learners need to be given time to integrate the new knowledge and skills into their internal structure of self, meaning, beliefs, and skills.

The goal of the Practice Phase is to help learners integrate and incorporate the new knowledge or skill in a variety of ways:

- Hands-on trial/feedback/reflection/retrial

- Real-world simulations
- Learning games
- Action learning exercises
- Individual reflection and articulation
- Partner and team-based dialog
- Skill building practice activities

Performance: Applying the New Knowledge and Skills

Learners need to have the opportunity to immediately apply what they've learned. Without immediate application to the real world, only 5% of the newly learned knowledge and skills is retained. With immediate application—and the proper coaching and support—learners typically retain 90% of the new knowledge and skills.

The goal of the Performance Phase is to help learners apply and extend their new knowledge or skill to the real world. This phase ensures integration of learning into the job as well as continuous performance improvement. These are some approaches:

- Immediate real world application
- Creating and executing action plans
- Follow through reinforcement activities
- Post session reinforcement materials
- Ongoing coaching
- Performance evaluation and feedback
- Peer support activities

Conventional learning has tended to emphasize the Presentation Phase over all other phases in the learning cycle. When designing a training program, developers put 80% or more money, effort, and time into creating presentation materials.

At best though, the Presentation Phase accounts for only 20% of the learning. And unless preceded by a Preparation Phase and followed by Practice and Performance phases, it is almost completely useless.

The Presentation Phase exists only to initiate the learning process, not to be the center of it. People learn more from experience than they do from presentations and training materials. For most adult learners, learning is a matter of trial, feedback, reflection, and retrial. The presentations and training materials are there simply to initiate and support active learning experiences, nothing more.

Q.4 Develop criteria for writing performance learning outcomes. Also describe the role of taxonomy of educational objectives in writing learning outcomes.

One of the most widely used ways of organizing levels of expertise is according to Bloom's Taxonomy of Educational Objectives. (Bloom et al., 1994; Gronlund, 1991; Krathwohl et al., 1956.) Bloom's Taxonomy

(Tables 1-3) uses a multi-tiered scale to express the level of expertise required to achieve each measurable student outcome. Organizing measurable student outcomes in this way will allow us to select appropriate classroom assessment techniques for the course.

There are three taxonomies. Which of the three to use for a given measurable student outcome depends upon the original goal to which the measurable student outcome is connected. There are knowledge-based goals, skills-based goals, and affective goals (affective: values, attitudes, and interests); accordingly, there is a taxonomy for each. Within each taxonomy, levels of expertise are listed in order of increasing complexity. Measurable student outcomes that require the higher levels of expertise will require more sophisticated classroom assessment techniques.

The course goal in Figure 2--"student understands proper dental hygiene"--is an example of a knowledge-based goal. It is knowledge-based because it requires that the student learn certain facts and concepts. An example of a skills-based goal for this course might be "student flosses teeth properly." This is a skills-based goal because it requires that the student learn how to do something. Finally, an affective goal for this course might be "student cares about proper oral hygiene." This is an affective goal because it requires that the student's values, attitudes, or interests be affected by the course.

Table 1: Bloom's Taxonomy of Educational Objectives for Knowledge-Based Goals

Level of Expertise	Description of Level	Example of Measurable Student Outcome
1. Knowledge	Recall, or recognition of terms, ideas, procedure, theories, etc.	When is the first day of Spring?
2. Comprehension	Translate, interpret, extrapolate, but not see full implications or transfer to other situations, closer to literal translation.	What does the summer solstice represent?
3. Application	Apply abstractions, general principles, or methods to specific concrete situations.	What would Earth's seasons be like in specific regions with a different axis tilt?

4. Analysis	Separation of a complex idea into its constituent parts and an understanding of organization and relationship between the parts. Includes realizing the distinction between hypothesis and fact as well as between relevant and extraneous variables.	Why are seasons reversed in the southern hemisphere?
5. Synthesis	Creative, mental construction of ideas and concepts from multiple sources to form complex ideas into a new, integrated, and meaningful pattern subject to given constraints.	If the longest day of the year is in June, why is the northern hemisphere hottest in August?
6. Evaluation	To make a judgment of ideas or methods using external evidence or self-selected criteria substantiated by observations or informed rationalizations.	What would be the important variables for predicting seasons on a newly discovered planet?

Table 2: Bloom's Taxonomy of Educational Objectives for Skills-Based Goals

Level of Expertise	**Description of Level**	**Example of Measurable Student Outcome**
Perception	Uses sensory cues to guide actions	Some of the colored samples you see will need dilution before you take their spectra. Using only observation, how will you decide which solutions might need to be diluted?
Set	Demonstrates a readiness to take action to perform the task or objective	Describe how you would go about taking the absorbance spectra of a sample of pigments?

Guided Response	Knows steps required to complete the task or objective	Determine the density of a group of sample metals with regular and irregular shapes.
Mechanism	Performs task or objective in a somewhat confident, proficient, and habitual manner	Using the procedure described below, determine the quantity of copper in your unknown ore. Report its mean value and standard deviation.
Complex Overt Response	Performs task or objective in a confident, proficient, and habitual manner	Use titration to determine the Ka for an unknown weak acid.
Adaptation	Performs task or objective as above, but can also modify actions to account for new or problematic situations	You are performing titrations on a series of unknown acids and find a variety of problems with the resulting curves, e.g., only 3.0 ml of base is required for one acid while 75.0 ml is required in another. What can you do to get valid data for all the unknown acids?
Organization	Creates new tasks or objectives incorporating learned ones	Recall your plating and etching experiences with an aluminum substrate. Choose a different metal substrate and design a process to plate, mask, and etch so that a pattern of 4 different metals is created.

Table 3: Bloom's Taxonomy of Educational Objectives for Affective Goals

Level of Expertise	**Description of Level**	**Example of Measurable Student Outcome**

Receiving	Demonstrates a willingness to participate in the activity	When I'm in class I am attentive to the instructor, take notes, etc. I do not read the newspaper instead.
Responding	Shows interest in the objects, phenomena, or activity by seeking it out or pursuing it for pleasure	I complete my homework and participate in class discussions.
Valuing	Internalizes an appreciation for (values) the objectives, phenomena, or activity	I seek out information in popular media related to my class.
Organization	Begins to compare different values, and resolves conflicts between them to form an internally consistent system of values	Some of the ideas I've learned in my class differ from my previous beliefs. How do I resolve this?
Characterization by a Value or Value Complex	Adopts a long-term value system that is "pervasive, consistent, and predictable"	I've decided to take my family on a vacation to visit some of the places I learned about in my class.

To determine the level of expertise required for each measurable student outcome, first decide which of these three broad categories (knowledge-based, skills-based, and affective) the corresponding course goal belongs to. Then, using the appropriate Bloom's Taxonomy, look over the descriptions of the various levels of expertise. Determine which description most closely matches that measurable student outcome. As can be seen from the examples given in the three Tables, there are different ways of representing measurable student outcomes, e.g., as statements about students (Figure 2), as questions to be asked of students (Tables 1 and 2), or as statements from the student's perspective (Table 3). You may find additional ways of representing measurable student outcomes; those listed in Figure 2 and in Tables 1-3 are just examples.

Bloom's Taxonomy is a convenient way to describe the degree to which we want our students to understand and use concepts, to demonstrate particular skills, and to have their values, attitudes, and interests affected. It is critical that we determine the levels of student expertise that we are expecting our students to achieve because this will determine which classroom assessment techniques are most appropriate for the course. Though the most common form of classroom assessment used in introductory college courses--multiple choice tests--might

be quite adequate for assessing knowledge and comprehension (levels 1 and 2, Table 1), this type of assessment often falls short when we want to assess our students knowledge at the higher levels of synthesis and evaluation (levels 5 and 6).4

Multiple-choice tests also rarely provide information about achievement of skills-based goals. Similarly, traditional course evaluations, a technique commonly used for affective assessment, do not generally provide useful information about changes in student values, attitudes, and interests.

Thus, commonly used assessment techniques, while perhaps providing a means for assigning grades, often do not provide us (or our students) with useful feedback for determining whether students are attaining our course goals. Usually, this is due to a combination of not having formalized goals to begin with, not having translated those goals into outcomes that are measurable, and not using assessment techniques capable of measuring expected student outcomes given the levels of expertise required to achieve them. Using the CIA model of course development, we can ensure that our curriculum, instructional methods, and classroom assessment techniques are properly aligned with course goals.

Q.5 Explain demonstration method; also write advantages and limitations of demonstration method for teaching of chemistry at secondary level.

Demonstration **method of teaching is a traditional classroom strategy** used in technical and training colleges and in teacher education.

Focus, Structure and Principles

Demonstration Strategy focus to achieve psychomotor and cognitive objectives. If we talk about its structure, it is given in three successive steps:

1. **Introduction:** In this step objectives of the lesson are stated. **The teacher may be called demonstrator**. He demonstrates the activity before the student that is to be developed.
2. **Development.** Students try to initiate the demonstrated activity. If there is any query the teacher tries to satisfy them by further demonstration and illustrations.
3. **Integration.** At this step, the teacher integrates all the activities and then these activities are rehearsed revised and evaluated.

Principles

This **teaching strategy** is based on the following principles

1. Learning by doing maxim is followed
2. Skills can be developed by limitation
3. The perception helps in imitation

Application

This strategy is applied mainly in technical or training institutes. In teacher education programs it is used to develop skills in the student teacher. At school level, a teacher applies it in teaching science, biology, nature study arts and crafts.

Advantages and Disadvantages of Demonstration Method of Teaching

Advantages of Demonstration Method

1. It helps in involving various sense to make learning permanent
2. Though, teacher behavior is autocratic, he invites **the cooperation of pupils in teaching learning process**
3. It develops interest in the learners and motivates them for their active participation
4. It helps in achieving psychomotor objectives
5. Any simple or complex sill becomes easy to understand

Disadvantages of Demonstration Method

1. It can be used only for skills subjects
2. Only the attention of the learners is invited towards the activity demonstrated. They are not free to discuss about it
3. Due to poor economic conditions of the government schools, **there is scarcity of audio-visual aids and equipment and the teachers are not so creative to produce handmade models for demonstration**
4. There is a general lack of sincerity and diligence among teachers who wish to complete the syllabus or syllabi at the earliest without putting sincere efforts

There are six steps of demonstration process.

(1) Planning and preparation

proper planning is required for good demonstration. For this following points should be kept in mind.

- Through the preparation of subject matter.
- lesson planning
- collection of material related to the demonstration.
- rehearsal of demonstration.

In order to ensure the success of demonstration, the teacher should prepare lesson minutely and very seriously.

(2) Introducing the lesson

The teacher should motivate students and prepare them mentally for the demonstration.

The teacher should introduce the lesson to students keeping in mind the following things.

- individual differences
- Environment
- Experiences

The lesson can also be started with some simple and interesting experiments. Very common event or some internal story.

The experiment should be able to hold the attention of students.

(3) Presentation of subject matter

– In demonstration presentation of subject matter is very important.

– The principle of reflecting thinking should be kept in mind.

– The teacher should teach the student in such a way that their previous knowledge can be attached to their new knowledge.

(4) Demonstration

-The performance in the demonstration table should be ideal for the student.

-The demonstration should be neat and clean.

(5) Teaching Aids

-The teacher can use various teaching aids like models, blackboard, graphs etc.during demonstration.

(6) Evaluation

-In this last step, evaluation of the whole demonstration should be done, so that it can be made more effective.