Aims and Objectives of Science

While starting to work on any mission it is essential to think before working towards the motives and purposes of understanding that mission. Consequently, the work on this machine is always planned in view of the various advantages anticipated to be drawn through it. The same holds good for the study of a particular subject. Without knowledge of aim, the educator is like a sailor who does not know his destination and the young learner is like rudderless vessel drifting ashore.

According to John Dewey, an aim is a foreseen and which give direction to certain activities or motivates human behaviour.

The aims of teaching Science:

- to provide the broader objectives of science that is process skill knowledge curiosity etc.
- to encourage and enable students to develop inquiring minds and curiosity about science and nature.
- to acquire knowledge, conceptual understanding, and skills to solve problems and make informed decisions in scientific contexts.
- to develop skills of scientific inquiry to design and carry out scientific investigations and evaluate scientific evidence to draw conclusions.
- to communicate scientific ideas, arguments, and practical experiences accurately in a variety of ways
- to think analytically, critically and creatively to solve problems, judge arguments and make decisions in scientific and other contexts.
- to appreciate the benefits and limitations of science and its application in technological developments
- to understand the nature of science and the interdependence of science, technology, and society including the benefits, limitations, and implications imposed by social, economic, political, environmental, cultural and ethical factors.
- to demonstrate attitudes and develop values of honesty and respect for themselves, others, and their shared environment.

The advantages that can be drawn for purposes that can be served by the study of that subject generally become the aim of its study. In order to proceed for the realization of aim or broader purpose, these are usually divided into some definite functional and workable units named as objectives. These objectives may be termed as short-term goals that may be achieved within the specific limited resources and time by a subject teacher. They can be easily evaluated to the expected behavioural changes or learning outcomes. In this way, objectives are the ways and means of achieving the aim in a more practical way.
An objective is an intent communicated by a statement describing a proposed change in the learner a statement of what the learner is to like when he has successfully completed a learning experience. It is a description of a pattern of behaviour or performance we want the learner or student to be able to demonstrate.

UNESCO Planning Commission (1964), the teaching of science objectives should be worked on the problems of science education in India and suggested ways to improve it.

According to Kothari Commission (1964- 66), the science education is in bad shape, and it becomes worse if we fail to reckon with the exclusion of knowledge to meet his immediate feet the recommended upgrading School curricula by research in curriculum development the division of the textbook and teaching-learning material.

Difference between Objectives and Aims:

Aims	Objectives
• Aims include objectives. • It can be acquired after a long period. • These are subjective. • These are theoretical and indirect. • These are changeable.	• Many objectives help to reach their aim. • It can be achieved in a short time. • These are objective. • These are direct and concerned with the teaching-learning process. • These are unchangeable.

Objectives of general Science teaching at a Primary Stage:

- To provide practical knowledge of the subject matter content.

- to provide the latest knowledge to develop scientific knowledge scientific appreciation and scientific temper among the students.
- to encourage them to learn about nature to develop the love for nature and to try to conserve the natural resources and prevent pollution.
- to develop the scientific attitude and to use it for the development works to have open-mindedness two objective decision-making critical thinking a desire for accurate knowledge who developed the skill of experimentation.

Objectives of teaching at a Secondary Stage:

- To work according to the students' science method and developed scientific views.
- To impart the knowledge to the students about the world, the importance of Science and its effects on society and its environment and give them the knowledge of the role of the environment so that learners can utilize the correct methods of the uses of the environment.
- To usesssss scientific method i.e., problem, hypothesis, experiment, a conclusion in decision making.
- To develop the competency to apply his knowledge to the solution of the problems around him he or she understands the technological processes so that he or she can use it in his or her surroundings.
- He or she should develop desirable scientific attitudes and values like cooperation, team, spirit, fellow feeling, leadership, courage, truthfulness, honesty, and sincerity.

Instructional Objectives:

- Teachers accept the general objectives in the form of desired goals but his or her goals are not clear and not helpful in teaching for removing these demerits classify the human behaviour in 1948 which are related to student’s behavioural change.
- A teacher must make some definite and specific objectives of a particular lesson, unit or subunit of the subject like science before the teaching-learning process for attending within a specified classroom period and resources and in hand through these so specific classroom teaching-learning objectives known as instructional objectives.
- A teacher tries to bring desired changes in the behaviour of students so the term instructional objectives are defined as a group of statements formulated by the teacher

for describing what the students are expected to do all will be able to do once the process of classroom instruction is over.

- In fact, instructional outcomes are the teaching-learning product in the form of behavioural changes in the students that a teacher expects as a result of his or her instruction related with a particular lesson, unit or subunit of the subject.
- instructional objectives are the descriptions of the student's terminal behaviour expected out of the ongoing classroom instruction.

Relationship of instructional objectives with general Aims and Objectives:

- In comparison to the general aim and objectives of teaching biological science instructional objectives are quite narrow and specific.
- Both are definite, precise, functional and tangible.
- Both are predetermined.
- They must be predictable.
- They are therefore termed as teaching-learning objectives for behavioural objectives the main purpose of these objectives is to provide statements of skills, concepts or behaviour students are expected to demonstrate after going through instruction.
- They are more specific and defined than the general circles but less specific and much wider than the classroom instructional objectives.
- Their attainment is quite possible within the educational structure and means.

Bloom's Taxonomy of educational objectives:

Bloom's Taxonomy is a system of hierarchical models (arranged in a rank, with some elements at the bottom and some at the top) used to categorize learning objectives into varying levels of complexity (Bloom, 1956). You might have heard the word "taxonomy" in biology class before, because it is most used to denote the classification of living things from kingdom to species. In the same way, this taxonomy classifies organisms, Bloom's Taxonomy classifies learning objectives for students, from recalling facts to producing new and original work.

Bloom's Taxonomy comprises three learning domains: cognitive, affective, and psychomotor. Within each domain, learning can take place at several levels ranging from simple to complex.

Development of the Taxonomy

Benjamin Bloom was an educational psychologist and the chair of the committee of educators at the University of Chicago.

In the mid-1950s, Benjamin Bloom worked in collaboration with Max Englehart, Edward Furst, Walter Hill, and David Krathwohl to devise a system that classified levels of cognitive functioning and provided a sense of structure for the various mental processes we experience (Armstrong, 2010). Through conducting a series of studies that focused on student achievement, the team was able to isolate certain factors both inside and outside the school environment that affect how children learn. One such factor was the lack of variation in teaching. In other words, teachers were not meeting each individual student's needs and instead relied upon one universal curriculum. To address this, Bloom and his colleagues postulated that if teachers were to provide individualized educational plans, students would learn significantly better. This hypothesis inspired the development of Bloom's Mastery Learning procedure in which teachers would organize specific skills and concepts into week-long units.

The completion of each unit would be followed by an assessment through which the student would reflect upon what they learned. The assessment would identify areas in which the student needs additional support, and they would then be given corrective activities to further sharpen their mastery of the concept (Bloom, 1971).This theory that students would be able to master subjects when teachers relied upon suitable learning conditions and clear learning objectives was guided by Bloom's Taxonomy.

The Original Taxonomy (1956)

Bloom's Taxonomy was originally published in 1956 in a paper titled *Taxonomy of Educational Objectives* (Bloom, 1956).

The taxonomy provides different levels of learning objectives, divided by complexity. Only after a student masters one level of learning goals, through formative assessments, corrective activities, and other enrichment exercises, can they move onto the next level (Guskey, 2005).

Cognitive Domain (1956)

Concerned with thinking and intellect.

The original version of the taxonomy, the cognitive domain, is the first and most common hierarchy of learning objectives (Bloom, 1956). It focuses on acquiring and applying knowledge and is widely used in the educational setting. This initial cognitive model relies on nouns, or more passive words, to illustrate the different educational benchmarks. Because it is hierarchical, the higher levels of the pyramid are dependent on having achieved the skills of the lower levels. The individual tiers of the cognitive model from bottom to top, with examples included, are as follows:

1. **Knowledge**: recalling information or knowledge is the foundation of the pyramid and a precondition for all future levels →
   Example: Name three common types of meat.

2. **Comprehension**: making sense out of information →
   Example: Summarize the defining characteristics of steak, pork, and chicken.

3. **Application**: using knowledge in a new but similar form →
   Example: Does eating meat help improve longevity?

4. **Analysis**: taking knowledge apart and exploring relationships →
   Example: Compare and contrast the different ways of serving meat and compare health benefits.

5. **Synthesis**: using information to create something new →
   Example: Convert an "unhealthy" recipe for meat into a "healthy" recipe by replacing certain ingredients. Argue for the health benefits of using the ingredients you chose as opposed to the original ones.

6. **Evaluation**: critically examining relevant and available information to make judgments →
   Example: Which kinds of meat are best for making a healthy meal and why?

Types of Knowledge

Although knowledge might be the most intuitive block of the cognitive model pyramid, this dimension is broken down into four different types of knowledge:

1. **Factual knowledge** refers to knowledge of terminology and specific details.

2. **Conceptual knowledge** describes knowledge of categories, principles, theories, and structures.

3. **Procedural knowledge** encompasses all forms of knowledge related to specific skills, algorithms, techniques, and methods.

4. **Metacognitive knowledge** defines knowledge related to thinking — knowledge about cognitive tasks and self-knowledge ("Revised Bloom's Taxonomy," n.d.).

However, this is not to say that this order reflects how concrete or abstract these forms of knowledge are (e.g., procedural knowledge is not always more abstract than conceptual knowledge).

Nevertheless, it is important to outline these different forms of knowledge to show how it is more dynamic than one may think and that there are multiple different types of knowledge that can be recalled before moving onto the comprehension phase.

And while the original 1956 taxonomy focused solely on a cognitive model of learning that can be applied in the classroom, an affective model of learning was published in 1964 and a psychomotor model in the 1970s.

The Affective Domain (1964)

Concerned with feelings and emotion

The affective model came as a second handbook (with the first being the cognitive model) and an extension of Bloom's original work (Krathwol et al., 1964).

This domain focuses on the ways in which we handle all things related to emotions, such as feelings, values, appreciation, enthusiasm, motivations, and attitudes (Clark, 2015).

From lowest to highest, with examples included, the five levels are:

1. **Receiving**: basic awareness →
   Example : Listening and remembering the names of your classmates when you meet them on the first day of school.

2. **Responding**: active participation and reacting to stimuli, with a focus on responding →
   Example : Participating in a class discussion.

3. **Valuing**: the value that is associated with a particular object or piece of information, ranging from basic acceptance to complex commitment; values are somehow related to prior knowledge and experience →
   Example : Valuing diversity and being sensitive to other people's backgrounds and beliefs.

4. **Organizing**: sorting values into priorities and creating a unique value system with an emphasis on comparing and relating previously identified values →
   Example : Accepting professional ethical standards.

5. **Characterizing**: building abstract knowledge based on knowledge acquired from the four previous tiers; value system is now in full effect and controls the way you behave →
   Example : Displaying a professional commitment to ethical standards in the workplace.

The Psychomotor Domain (Concerned with skilled behaviour)

The psychomotor domain of Bloom's Taxonomy refers to the ability to physically manipulate a tool or instrument. It includes physical movement, coordination, and use of the motor-skill areas. It focuses on the development of skills and the mastery of physical and manual tasks.

Mastery of these specific skills is marked by speed, precision, and distance. These psychomotor skills range from simple tasks, such as washing a car, to more complex tasks, such as operating intricate technological equipment.

As with the cognitive domain, the psychomotor model does not come without modifications. This model was first published by Robert Armstrong and colleagues in 1970 and included five levels:

1) imitation; 2) manipulation; 3) precision; 4) articulation; 5) naturalization. These tiers represent different degrees of performing a skill from exposure to mastery.

The third and final domain of Bloom's Taxonomy is the psychomotor domain. The psychomotor model focuses on physical movement, coordination, and anything related to motor skills.
Two years later, Anita Harrow (1972) proposed a revised version with six levels:

1) reflex movements; 2) fundamental movements; 3) perceptual abilities; 4) physical abilities; 5) skilled movements; 6) non-discursive communication.

This model is concerned with developing physical fitness, dexterity, agility, and body control and focuses on varying degrees of coordination, from reflexes to highly expressive movements.

That same year, Elizabeth Simpson (1972) created a taxonomy that progressed from observation to invention.

The seven tiers, along with examples, are listed below:

1. **Perception** : basic awareness →
   Example : Estimating where a ball will land after it's thrown and guiding your movements to be in a position to catch it.

2. **Set** : readiness to act; the mental, physical, and emotional mindsets that make you act the way you do →
   Example : Desire to learn how to throw a perfect strike, recognizing one's current inability to do so.

3. **Guided Response** : the beginning stage of mastering a physical skill. It requires trial and error →

Example : Throwing a ball after observing a coach do so, while paying specific attention to the movements required.

4. **Mechanism** : the intermediate stage of mastering a skill. It involves converting learned responses into habitual reactions so that they can be performed with confidence and proficiency →
   Example : Successfully throwing a ball to the catcher.

5. **Complex Overt Response** : skillfully performing complex movements automatically and without hesitation →
   Example : Throwing a perfect strike to the catcher's glove.

6. **Adaptation** : skills are so developed that they can be modified depending on certain requirements →
   Example : Throwing a perfect strike to the catcher even if a batter is standing at the plate.

7. **Origination** : the ability to create new movements depending on the situation or problem. These movements are derived from an already developed skill set of physical movements →
   Example : Taking the skill set needed to throw the perfect fastball and learning how to throw a curveball.

The Revised Taxonomy (2001)

In 2001, the original cognitive model was modified by educational psychologists David Krathwol (with whom Bloom worked on the initial taxonomy) and Lorin Anderson (a previous student of Bloom) and published with the title *A Taxonomy for Teaching, Learning, and Assessment*. This revised taxonomy emphasizes a more dynamic approach to education instead of shoehorning educational objectives into fixed, unchanging spaces.

To reflect this active model of learning, the revised version utilizes verbs to describe the active process of learning and does away with the nouns used in the original version (Armstrong, 2001).

The figure below illustrates what words were changed and a slight adjustment to the hierarchy itself (evaluation and synthesis were swapped). The cognitive, affective, and psychomotor models make up Bloom's Taxonomy.

The taxonomy explains that (Shabatura, 2013):

1. Before you can understand a concept, you need to remember it;
2. To apply a concept, you need first to understand it;
3. To evaluate a process, you need first to analyze it;
4. To create something new, you need to have completed a thorough evaluation

This hierarchy takes students through a process of synthesizing information that allows them to think critically. Students start with a piece of information and are motivated to ask questions and seek out answers.

Not only does Bloom's Taxonomy help teachers understand the process of learning, but it also provides more concrete guidance on how to create effective learning objectives.

Bloom's Level	**Key Verbs (keywords)**	**Example Learning Objective**
Create	design, formulate, build, invent, create, compose, generate, derive,	By the end of this lesson, the student will be able to design an original homework problem dealing with the principle of conservation of energy.

Bloom's Level	Key Verbs (keywords)	Example Learning Objective
	modify, develop.	
Evaluate	choose, support, relate, determine, defend, judge, grade, compare, contrast, argue, justify, support, convince, select, evaluate.	By the end of this lesson, the student will be able to determine whether using conservation of energy or conservation of momentum would be more appropriate for solving a dynamics problem.
Analyze	classify, break down, categorize,	By the end of this lesson, the student will be able to

Bloom's Level	Key Verbs (keywords)	Example Learning Objective
	analyze, diagram, illustrate, criticize, simplify, associate.	differentiate between potential and kinetic energy.
Apply	calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, perform, present.	By the end of this lesson, the student will be able to calculate the kinetic energy of a projectile.
Understand	describe, explain, paraphrase, restate, give original examples of, summarize, contrast,	*By the end of this lesson, the student will be able to* *describe Newton's three laws of motion in her/his own words*

Bloom's Level	Key Verbs (keywords)	Example Learning Objective
	interpret, discuss.	
Remember	list, recite, outline, define, name, match, quote, recall, identify, label, recognize.	By the end of this lesson, the student will be able to recite Newton's three laws of motion.

The revised version reminds teachers that learning is an active process, stressing the importance of including measurable verbs in the objectives.

And the clear structure of the taxonomy itself emphasizes the importance of keeping learning objectives clear and concise as opposed to vague and abstract. Bloom's Taxonomy even applies at the broader course level. That is, in addition to being applied to specific classroom units, Bloom's Taxonomy can be applied to an entire course to determine the learning goals of that course. Specifically, lower-level introductory courses, typically geared towards freshmen, will target Bloom's lower-order skills as students build foundational knowledge. However, that is not to say that this is the only level incorporated, but you might only move a couple of rungs up the ladder into the applying and analysing stages. On the other hand, upper-level classes don't emphasize remembering and understanding, as students in these courses have already mastered these skills.

As a result, these courses focus instead on higher-order learning objectives such as evaluating and creating. In this way, professors can reflect upon what type of course they are teaching and refer to Bloom's Taxonomy to determine what they want the overall learning objectives of the course to be. Having these clear and organized objectives allows teachers to plan and deliver appropriate instruction, design valid tasks and assessments, and ensure that such instruction and assessment aligns with the outlined objectives (Armstrong, 2010).

Critical Evaluation

Bloom's Taxonomy accomplishes the seemingly daunting task of taking the important and complex topic of thinking and giving it a concrete structure. The taxonomy continues to provide teachers and educators with a framework for guiding the way they set learning goals for students and how they design their curriculum. And by having specific questions or general assignments that align with Bloom's principles, students are encouraged to engage in higher-order thinking. However, even though it is still used today, this taxonomy does not come without its flaws. As mentioned before, the initial 1956 taxonomy presented learning as a static concept. Although this was ultimately addressed by the 2001 revised version that included active verbs to emphasize the dynamic nature of learning, Bloom's updated structure is still met with multiple criticisms. Many psychologists take issue with the pyramid nature of the taxonomy. The shape creates the false impression that these cognitive steps are discrete and must be performed independently of one another. However, most tasks require several cognitive skills to work in tandem with each other. In other words, a task will not be only an analysis or a comprehension task. Rather, they occur simultaneously as opposed to sequentially. The structure also makes it seem like some of these skills are more difficult and important than others. However, adopting this mindset causes less emphasis on knowledge and comprehension, which are as, if not more important, than the processes towards the top of the pyramid. Additionally, author Doug Lemov (2017) argues that this contributes to a national trend devaluing knowledge's importance. He goes even further to say that lower-income students who have less exposure to sources of information suffer from a knowledge gap in schools.

A third problem with the taxonomy is that the sheer order of elements is inaccurate. When we learn, we don't always start with remembering and then move on to comprehension and creating something new. Instead, we mostly learn by applying and creating. For example, you

don’t know how to write an essay until you do it. And you might not know how to speak Spanish until you do it (Berger, 2020).

The act of doing is where the learning lies, as opposed to moving through a regimented, linear process. Despite these several valid criticisms of Bloom’s Taxonomy, this model is still widely used today.