



# THE NCF-SE IN CLASSROOM INSTRUCTION

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How can practicing school science teachers integrate the abstract and broad aims of education described in the NEP 2020 with what they teach in class? What role does the NCF-SE have in guiding teachers in their design of instructional and assessment strategies?

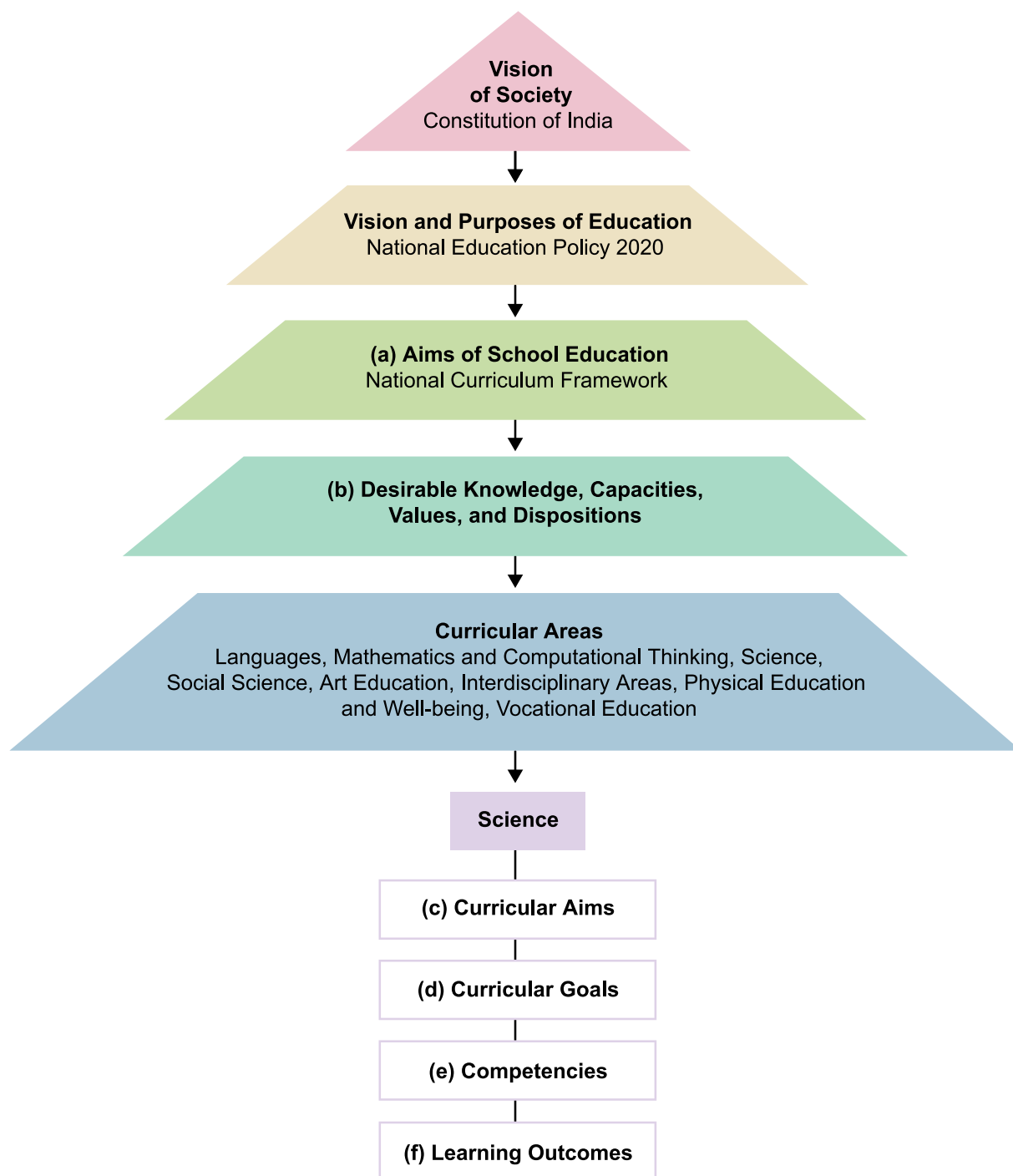
**D**rawing from the vision of society in the Constitution of India, the NEP 2020 states that the vision and purpose of: "...the education system is to develop good human beings capable of rational thought and action, possessing compassion and empathy, courage and resilience, scientific temper, and creative imagination, with sound ethical moorings and values. It aims at producing engaged, productive, and contributing citizens for building an equitable, inclusive, and plural society as envisaged by our Constitution".<sup>1</sup> While extremely relevant, this vision of education may appear quite abstract to school science teachers in the context of their classroom instruction. It may raise questions like: How can the topics included in the school science syllabus help fulfil this purpose? How can this vision guide a science teacher's approach to classroom instruction?

It is in response to such questions that the National Curriculum Framework for

School Education (NCF-SE) 2023 offers the Learning Standards Framework (see Fig. 1). This framework is aimed at guiding teachers in the process of designing and facilitating learning experiences that convert the abstract overall aims of education into concrete classroom practices.

## Learning standards for science at the middle stage

**(a) Curricular aims for school science:** According to the NCF-SE, the aim of science education at the school level is to: "...develop an understanding of the natural and physical world through systematic inquiry. Learning science also builds process skills such as observation, analysis, and inference. This in turn enables the meaningful participation of individuals in society and the world of work with scientific temper, critical and evidence-based thinking, asking relevant questions, analysing practices and norms,



**Fig. 1. Components of the Learning Standards Framework in the NCF-SE.** (a) **Aims of school education:** Shaped by the vision for education in the NEP 2020, this section of the NCF-SE suggests that school education must support rational thought and independent thinking, health and well-being, democratic and community participation, economic participation, and cultural participation. These five aims are expressed as educational vision statements that give broad direction to all deliberate efforts (including curriculum development, institutional arrangements, funding and financing, and people's capacities) in school education. (b) **Knowledge, capacities, values, and dispositions:** This section of the NCF-SE outlines relevant and appropriate knowledge, capacities, values, and dispositions that students must develop to meet the aims of school education. (c) **Curricular Aims:** This section of the NCF-SE connects the aims of school education to aims specific to each of eight curricular areas. (d) **Curricular goals:** This section of the NCF-SE shares statements that guide stage-specific (foundational, preparatory, middle, and secondary) curricular arrangements necessary to meet the curricular aims. (e) **Competencies:** This section of the NCF-SE shares a set of learning achievements that students are expected to attain towards meeting each curricular goal. (f) **Learning Outcomes:** While the competencies listed in the NCF-SE are intended to guide student achievements in the middle stage, learning outcomes are interim grade-wise markers of each competency. Teachers can use these to plan their content, pedagogy, and assessments. They can also use them to observe and track student learning as well as respond to their needs on a continual basis.

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and acting for necessary change".<sup>2</sup> This emphasizes the need for science to be introduced to school students not just as a body of factual knowledge, but also as the means to construct and use such knowledge. Elaborating on their use of this knowledge, the NCF-SE states that: "Good education in science, including the development of a mindset of inquiry and research in students, is critical in addressing the challenges that India and the world face today, such as climate change, improving healthcare, technological advancement and use for sustainable development, creation of just and equitable livelihoods, and living in harmony with nature. This would help students to gain an understanding of how science and scientific research can address the central challenges faced by our society".<sup>2</sup>

**(b) Curricular goals for science at the middle stage:** According to the NCF-SE, the science curriculum for Grades VI-VIII must allow students to:

- CG-1: Explore the world of matter and its constituents, properties, and behaviour.
- CG-2: Explore the physical world in scientific and mathematical terms.
- CG-3: Explore the living world in scientific terms.
- CG-4: Understand the components of health, hygiene, and wellbeing.
- CG-5: Understand the interface of Science, Technology, and Society.
- CG-6: Explore the nature and processes of science through

engaging with the evolution of scientific knowledge and conducting scientific inquiry.

- CG-7: Communicate questions, observations, and conclusions related to science.
- CG-8: Understand and appreciate the contribution of India through history and the present times to the overall field of science, including the disciplines that constitute it.
- CG-9: Develop awareness of the most current discoveries, ideas, and frontiers in all areas of scientific knowledge in order to appreciate that science is ever evolving and that there are still many unanswered questions.<sup>2</sup>

**(c) Competencies for each curricular goal:**

The NCF-SE breaks down each curricular goal into a set of competencies to be achieved (see Table I). Together, they show teachers how to meet a related curricular goal. Science teachers can use them to map student progression in conceptual understanding and process capacities. Competencies are also helpful in laying out boundaries for conceptual discussion at each stage of learning.

**(d) Learning outcomes for each competency:**

Each competency in the learning standards for school science can be broken down into more granular milestones (see Table II).

These interim markers can be used to arrive at a progression of grade-specific learning outcomes (see Table III).

## Learning outcomes and classroom practice

The attainment of grade-specific learning outcomes is not restricted to mere reciprocation of factual knowledge. It involves the development of the process skills required to achieve a certain competency. It is from this perspective that learning outcomes can guide the classroom practice of science teachers in multiple ways:

- Learning outcomes can help a science teacher choose the focus of classroom instruction and scope of discussion for each year of middle school. Each learning outcome is also carefully constructed to help teachers choose appropriate pedagogical practices to achieve it. For example, the expectation that a learner is able to measure any change in the position of an object points to the need for an instructional strategy that gives students a hands-on experience of making such measurements themselves. Teachers can choose from a variety of context-specific pedagogical practices to achieve this outcome. For example, they could invite learners to measure the length of a running track in the school grounds, the distance covered by a marble rolled on the floor, or the number of steps needed to reach home from school. Similarly, for students to be able to measure time, teachers could ask students to

Curricular Goal (CG)	Desired Competencies
CG-2: Explore the physical world in scientific and mathematical terms.	C-2.1: Describes one-dimensional motion (uniform, non-uniform, horizontal, and vertical) using physical measurements (position, speed, and changes in speed) through mathematical and diagrammatic representations.
	C-2.2 Describes how electricity works through manipulating different elements in simple circuits and demonstrates the heating and magnetic effects of electricity.
	C-2.3 Describes the properties of a magnet (natural and artificial; Earth as a magnet).
	C-2.4 Demonstrates rectilinear propagation of light from different sources (natural, artificial, and reflecting surfaces), verifies the laws of reflection through manipulation of light sources and objects and the use of apparatus and artefacts (such as plane and curved mirrors, pinhole camera, kaleidoscope, and periscope).
	C-2.5 Observes and identifies celestial objects (stars, planets, natural and artificial satellites, constellations, and comets) in the night sky using a simple telescope and images/photographs, and explains their role in navigation, calendars, and other phenomena (phases of the moon, eclipse, and life on earth).

Table I. The set of competencies students need to develop to achieve CG-2.<sup>2</sup>

Desired Competency	Interim Markers of Achievement
C-2.1: Describes one-dimensional motion (uniform, non-uniform, horizontal, and vertical) using physical measurements (position, speed, and changes in speed) through mathematical and diagrammatic representations.	Identify and measure the physical quantities (position with respect to a reference and time) required to describe motion.
	Use appropriate instruments and units to measure these quantities (for example, measure change in the position and time of moving objects and use these to calculate speed).
	Trace the journey of the various units used to measure these quantities (for example, explore locally used units and progress from such units to the SI units used today).
	Collect data and represent it in various formats (for example, collect position-time data and represent it in pictorial format or a tabular column).
	Draw inferences from the data (for example, use it to infer if an object is at rest, how fast it is moving, if it is moving at a constant speed, whether it shows uniform or non-uniform motion, etc.).
	Use mathematical expressions to calculate, explain, and predict the motion of an object.
	Apply relevant concepts to make models of instruments to measure length or a fixed duration of time (like a sand clock or a seconds pendulum).

Table II. Potential interim markers in achieving C-2.1.

Grade	Grade-specific Learning Outcomes
VI	Describe the position of an object in relation to a reference and record changes in its position; learn how distances have been traditionally measured in the learner's context and the basis of these measurements; explore standard instruments and units to measure distance; handle and construct models of different instruments to measure length; and extend the discussion on distance to other quantities required to describe motion.
VII	Measure time; handle and construct instruments and units to measure time; collect the position-time data of different objects in motion and present it as a graph; calculate (average) speed and arrive at its mathematical formula.
VIII	Infer if the motion of an object is uniform or non-uniform by reducing time intervals; predict the position of the object mathematically; and use this knowledge appropriately in different contexts.

Table III. An example of the progression of grade-specific learning outcomes.

- measure the time it takes to walk from home to school.
- Learning outcomes can also guide teachers in designing assessments to determine what knowledge and process skills students have learned. For example, teachers could ask learners to design a strategy to measure the height of the school building. Responses to this task could be used to assess if the learner is able to extend the idea of measuring distances discussed in the classroom to real-world

contexts. Teachers could also design assessment tasks that provide information of students' attainment of more than one learning outcome (see **Box 1**). Extending the assessment of learning outcomes across each grade to the end of the middle stage would provide information on the attainment of a competency. Similarly, information regarding the attainment of a set of competencies would indicate if a certain curricular goal has been achieved.

To make effective use of the learning standards framework in their classroom practice, teachers need to have an overall idea of each topic (of 'motion' for example) in the middle school curriculum, capacities students need to develop at the end of this stage, and how the attainment of outcomes

**Box 1. An example of an assessment to measure the attainment of multiple learning outcomes related to motion:**

Consider giving students the following assessment task: *Who walks the fastest in your family? Support your answer with a valid argument.*

A student working on this task is expected to record the position-time data of different family members and calculate their speeds using the related mathematical expression. They are also expected to come up with a design to approach this task. While both these requirements may seem simple, students will need to demonstrate both factual knowledge of related concepts and certain process skills to achieve them. For example, they will need to determine the time it takes for each family member to walk a certain distance. Teachers can assess:

- How students fix the optimum distance for this exercise.
- How they mark the fixed distance (which would involve proper handling of instruments).
- How they arrive at a format to record their observations after finalizing the number of quantities to be measured and the number of trials.
- How they compare the calculated values of speed for each family member to determine which member walks the fastest.
- If they represent their conclusion in an understandable manner.

This could be further extended to ask students to determine if their family members showed uniform or non-uniform motion during the task. To do this, students would need to measure position-time data along the walking track they have marked for the task.

needs to progress across stages. For example, learning to collect and use data to infer changes in the motion of an object in the middle stage would help students learn how to represent this data graphically at later stages.

## Parting thoughts

The NCF-SE provides a structured approach for science teachers to design and facilitate classroom processes that help achieve the overall aims

of education. We have shared how this framework could be applied to 'Motion in one dimension' to ensure that students not only understand key concepts, but also develop the skills and knowledge necessary to apply them effectively. But this framework can be used to teach any other topic in science. Not only does it outline clearly defined curricular goals for science at the middle stage, it offers guidance on the process of organizing content across

grades in a logical sequence, integrating competencies, emphasizing their real-world applications, and aligning teaching strategies and assessments with overall learning standards. By establishing connections between the abstract larger aims of education and the granular learning outcomes for each topic in the middle school science curriculum, the NCF-SE also emphasizes the necessity of looking at aims and outcomes in continuity and simultaneity.

## Key takeaways

- The NCF-SE provides a framework that supports teachers in developing instructional strategies that break down complex scientific concepts into manageable learning goals. By connecting each step with broader educational objectives, teachers can create a classroom environment that fosters deep understanding and continuous learning.
- Using the example of 'motion in one dimension', the article illustrates how teachers can guide students from mastering basic measurements to more advanced skills like data analysis. This structured progression offers a clear step-by-step approach to help students grasp complex topics by aligning each learning stage with specific educational goals.
- Teachers are encouraged to design assessments that go beyond simple recall to focus on evaluating process skills like planning and data analysis. These assessments need to be thoughtfully crafted to ensure that students meet their grade-specific learning outcomes while also providing insights into their grasp of concepts and practical skills.



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