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Inculcation of Ancient Indian Spirit of Inquiry and Scientific Temper of *Bhautikaśāstrīs*in Government Science Textbooks:An Exploration

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ABSTRACT

According to Jawaharlal Nehru (1946), scientific temper leading to the spirit of inquiry is a voyage toward truth, the divinity of living things, and cooperative growth, begetting higher levels of freedom and human evolution(p.515). Our ancient Indian physicists (*Bhautikaśāstrīs*), who crossed the borders of classical physics, and are beginning to be recognized on account of the surviving manuscripts, exemplify this approach. The National Council of Educational Research and Training (NCERT) evaluated textbooks in 2017 and found traditional Indian wisdom to be useful. The study's goals were to look at the content of the updated NCERT Science Textbooks in terms of incorporating ancient Indian physicists' scientific knowledge and spirit, to identify problems, and to offer suggestions for the proper implementation of the above in the Government Science Textbooks. The authors undertook a descriptive research methodology based on content analysis. In the most recent version of NCERT Science Textbooks, the topic of ancient Indian physics (*bhautikaśāstra*)knowledge is only available in the chapter "Stars and Solar System" in the Science Textbook for Class VIII. There is an opportunity to include the unique research and findings of ancient Indian scientists. With the purpose of communicating and embracing the UN's SDG4, the Union Cabinet of the Government of India leveraged the ancient Indian knowledge system's vision and wisdom to launch the New Education Policy in July 2020. In the forthcoming edition of the NCERT Textbooks, the Indian government has decided to include historical Indian knowledge pertinent to science and other courses.

Keywords: Spirit of inquiry, Ancient Indian *Bhautikaśāstrīs*, Humanism, Textbooks, Educational reforms, New Education Policy 2020, NCERT

INTRODUCTION

The 42nd Constitutional Amendment Act of 1976, which included Scientific Temper, Humanism, Reform and the Spirit of inquiry as fundamental obligations (The Constitution of India, 1976, Art. 51(A) (h)), established the framework for a new India, seeking unbounded freedom in its venture to reveal the true nature of the universe.

Scientific Temperament is a mental condition in which logic is applied to everything it does, thinks about, watches, or simply exists.

"The discipline of science deals with the sphere of trustworthy and constructive information, but the mentality that it should cultivate goes beyond that arena," India's former prime leader Pandit Jawaharlal Nehru writes in his 1946 book "Discovery of India."

While visiting locations outside the scope of scientific objective investigation, such as atop a hill where philosophy thrives and deep sensations overwhelm us, or when experiencing moments of wonder at the infinite beyond, the scientific viewpoint, and temperament are still required. Despite having led the world in recognizing and embracing scientific techniques and concepts, the western world is yet to attain a truly scientific attitude and temper. Even if India lags behind the modern conceptions of scientific advancement, ourtime-honoured notion of fearless quest of uncovering reality, and perceiving divinity in all beings, together with the concept of peaceful life and progress towards elevated phases of freedom, progress of mankind, and collaborative existence exemplify the actual spirit and temper of the scientists (pp.624-627).

Despite the fact that Indian citizens' forebears sought truth and documented their plead to the Supreme in *Bṛhadāraṇyaka* Upaniṣad:"Tamasomājyotirgamaya"or "Guide me from darkness to illumination" (1.3.28), the method they employed to achieve it was logical and showed the scientific disposition of thinking. The commentaries on the *Nyāyasūtras* of Gautama extol the author for his systematic research and methodological investigations to bring forth to the world his scientific philosophy. Proof, according to this perspective, is a decision based on facts and authorization (Ganeri,2001). Thus, this scientific system encompasses rational realism because it instructs that the reality exists independent of our awareness and interpretations of it, and that this claim can be supported by logical reasoning and self-evaluation on the experience of individuals, rather than delusional belief, conviction, instinct, or doctrinal references. The steps to arrive at an insight and formulate a theory according to Nyaya doctrine was to first identify a research problem (*Saṃśaya*).The next step was to formulate the purpose of research clarify the aim of the problem (*prayojana*).The objects of valid knowledge were ascertained. The review of literature was done by going through the previous doctrines and models and ideas(*dṛṣṭānta*). Theresults (nirṇaya) were formulated through debates (*jalpa*) and discourses (*vāda*), premise and syllogism.

The first school of the newly conceived intricate atomic thought was conceived by *Bhautikaśāstrī Kaṇāda*.This school of scientific AvantGardeposited that all matter was made of atoms which were indestructible, and cannot be seen with the naked eye. On the other hand, they become discernible when they agglomerate to form a combination of double atoms (dyads) or triple atoms(*tryanuka*), and so on. This insight laid the foundation of revealing the nature of the universe. The foundation of this theory was imbibed in his declaration: *nityaṃparimaṇḍalam*(KVs_7.1.20).The existing(bhava) matter(*padārthas*)are substances (*dravya*), and can be distinguished, general, active or are the ones which have quality(*guna*). *Kaṇāda*and the successive *Bhautikaśāstrīs* further averred that the existence or absence of the awareness of the scopious material or its components specifically the atoms has already been elucidated by the timeless being (KVs_7.1.8).

The *Bhautikaśāstrīs* of this school also clarified the fundamentals of mechanics, and understood the relationship between force and work (KVs_5.1.2), as well as the concept of antimatter (KVs_5.2.18). These physicists agreed that "The force's first impulse *nodanā* or the impulse causes the arrow to produce initial kinetic energy (karma), which causes the

arrow to gain momentum. The arrow climbs as its momentum increases (projectile).The arrow's *samsakara* or *vega* (velocity) decreases as it flies higher, and when it is no longer present, gravity causes it to fall down (KVs_5.1.18).

According to Chatterjee (1980), around 600 A.D. the notions of elasticity, sound transmission as wave propagation, and also the laws of floatation were established by *Bhautikaśāstrī Prasastapāda*(p.112). The Sama Veda delves into music theory and acoustics. Around 500 years before Newton, *Bhāskarcāhārya* (author of SiddhantaShiromani) conceived the concept of gravity. The Agastya Samhita sutras describe how to make an electrolytic cell and how to utilize it, while the *Bhautikaśāstrīs* of *Kaṇāda's* school discuss how to use a magnetic compass. SankaraMisra discovered capillarity in the 15th century A.D., while the Vedic astronomical computations paved the stage for breakthroughs in operations during the Siddhantic Era (500 A.D.). The succession of *Bhautikaśāstrīs* from Aryabhatiya were astronomers who determined the overall average and factual locations of heavenly objects, rectified the triple challenge of time, evolved hypothesis for the epileptic and the eccentric planet movement, their conjunction and positions. The Kerala School of Astronomers, who existed from the 14th through the 17th century, took this to a new degree of precision. Roger Billard was able to confirm the correctness of the observations using a computational examination of various astronomical treatises and accumulated data (Sen,1980, p.87). This proves in no uncertain terms that the ancient Indian
Bhautikaśāstrīs (physicists) possessed the scientific temperament needed to explore and theorize in depth about the universe and its physical reality.

After being decimated by invading foreign soldiers, the literature that has survived can attest to the Indians' ancient scientific prowess. The spirit of enquiry, egalitarianism, argumentation, objectivity, exploration, punctilious persistence, analytical conversations, ubiquity, rationality and coherence are the essential attributes that emerge from them. The wisdom and foresight of the ancient Indian *Bhautikavijñānīs* (physicists) were acknowledged by our intellectuals and social & political leaders as exhibiting the true temper and spirit of scientists with the concept of professionalism, which was highly integrated into the Scientific Policy Resolutions and various Educational practicesand policies of the nation since Independence, and which articulates the nation's perspective of disseminating the scientific passion embedded in the country's ancient heritage.

Textbooks can be viewed as sociological products that have been systematized to be fit for a certain age range and are recommended to homogenize and spread a specific point of view (Apple, 1990). Science textbooks play a significant role in guiding teachers away from a didactic approach and toward constructivist and collaborative teaching techniques. Krishna Kumar (1986), the former Head and Dean of the Central Institute of Education, of Delhi University avers that the digitalization process has failed to make a substantial headway in undermining the concept of state textbook culture, usually published by the National Council of Educational Research and Training for a uniform central curriculum and board examinations. The textbooks thus remain the only means of curriculum transaction (p.1309). A periodic evaluation of the content and the standard of government-mandated scientific textbooks has been a key governmental goal in India (Kumar, 1988). NCERT is an Indian

government organization that advises and aids national and state governments on educational policy and programmes.

Looking at the validity criteria for the Science Curriculum in the successive National Curriculum Frameworks of India, we can see that the concept of historical validity, along with cognitive, content, process, and environmental validity, are becoming increasingly essential. Ratification directs those historical threads to be woven throughout the curriculum so as to enable the neophytes grasp the social factors that influence science's advancement and flowering, as well as the evolution of scientific ideas chronologically (National Curriculum Frame work, 2005, p.48).

RATIONALE OF THE STUDY

Ancient Indian knowledge and awareness were included into the teaching materials for the academic year 2018–19 as part of NCERT's textbook assessment, which occurred in 2017, ten years after the last one. This was a move forward in personifying science education, implementing elements of science's nature, and transferring the importance of the inherent temperament and views of the *Bhautikavijñānīs* of ancient India and collaborate with the educationists in order to enthuse and inspire the students in order to inculcate the values of inquisitiveness, innovation, creativity, and national pride in our country's younger generation.

The degree of incorporation of the expertise of the *Bhautikavijñānīs* of Ancient India in the Science Books throughout subject areas was evaluated in a thematic study of the current NCERT Text Books for classes 6 to 10. This study becomes even more significant in terms of the Indian government's official statement in July 2020 of an education system regulation that helps to enhance the theory of continuous learning, an encompassing and impartial educational organization, and a dynamic knowledge - based economy in alignment with the UN's 4th Sustainable Development Goal. Previous flagship schemes include the *Sarva Shiksha Abhiyan* (2001), which aimed to universalize primary education, the *Rashtriya Madhyamik Shiksha Abhiyan* (2009), which aimed to improve secondary education quality and access followed by the the Right to Education Act, which provides the right of compulsory and free education for children. (2009). As per the National Curriculum Framework, historic India was known for its quality residential, transdisciplinary regional and global establishments of higher education and research, such as Telhara (in District Nalanda, Bihar), Nalanda (in Magadha), Vallabhi (in Saurashtra, Gujarat), Vikramshila and so on (2020, p.1). It further elucidated (2020) that renowned ancient Indian visionaries revolutionized, and heralded the concept of scientific temperament while researching on varied subjects like medicine, agriculture, astronomy, engineering, pure sciences, architecture, surgery, e yoga, ethics, and many other fields (p.1). Historic India's cultural legacy has had a substantial impact on the rest of the globe. We must not only preserve and protect these rich global legacies for future generations, but also promulgate further research in these areas, to enable its application in times to come.

In conformity with such an approach, the Ministry of Education of India had put forth the policy of modifying the Government school NCERT Textbooks Books in the upcoming

term to include the insight and knowledge of prominent *Bhautikavijñānīs*, other scientists and scholars.

OBJECTIVES OF THE STUDY

The main research goals have been outlined:

(i)With a view of implementing the scientific knowledge and disposition of *Bhautikavijñānīs*of ancient India, the process of examination of the curriculum of the updated NCERT Science Books for grades VI to X (December 2017) vis a visthe earliest republished volumes of the different books. (ii) Using the aforementioned components, finding the gaps in the above-mentioned textbooks as regards the *bhautikaśāstra*.
(iii)Make suggestions for successfully incorporating the above-mentioned components into NCERT's Science Textbooks for grades VI through X.

METHODOLOGY AND PROCEDURE

The authors undertook a content analysis-based descriptive research project. Content analysis is a common systematized approach for statistically analyzing the written data. This strategy can be used for textbook content, interview transcripts, social media transactions, speeches, internet data, and other sources. In this study, human coded analysis was used. Bernard Berelsonpopularizedthis method of the analysis of the printed text by quantifying it as an objective assessment of communication's perceived content (1952, p.18). Content analysis, as defined by Kimberley Neuendorf in 2002, is a synthesis of scientifically based quantitative message analysis (p.10). The content of all academic books provided the framework for generating results pertinent to the methodology of the study, following Nachimas and Nachimas' approach from 1976. The analysis covers scientific books published by the Indian government for schools following the Central Board of Secondary Education program, which is a well-known National Board of Education system in India.

The examples were taken from the latest revised and first reprints of the National Council of Educational Research and Training's Science Textbooks. The books that were scrutinized were for pupils in the upper primary (grades VI through VIII) and secondary school (grades IX and X). For this study, every text, picture, and activity on every page of the NCERT textbooks was considered.

RESEARCH POPULATION

The research population consisted of five science NCERT textbooks belonging to upper primary curriculum (classes six, seven and eight) and secondary curriculum (classes nine and ten). There were sixteen chapters in both the old and new edition of class six textbooks while the number of pages were one hundred and sixty-five in both the editions, all of which were analyzed. Class seven science NCERT textbook consisted of eighteen chapters in the old as well as new edition of while the number of pages in both the editions were two hundred and thirty, which were analyzed. There were eighteen chapters in both the old and new edition of class eight textbooks while the number of pages were two hundred and fifty-two in both the

editions, and they were all analyzed. There was a disparity in the number of pages in the old and new editions of the secondary science textbooks. The class nine textbook had fifteen chapters, and two hundred and eighteen pages in the older edition. The newer edition had two fifteen chapters, and two hundred and fifteen pages, which were all scrutinized. Similarly, the older and newer editions of the class ten NCERT science textbook had sixteen chapters each but there were two hundred and eighty-one pages in the older edition as compared to two hundred and eighty in the newer one, which were scrutinized.

TABLE 1: INCORPORATION OF DATA ASSOCIATED WITH ANCIENT INDIAN *BHAUTIKAVIJÑĀN* IN GOVERNMENT SCIENCE TEXTBOOKS

PUBLICATION MONTH AND YEAR/GRADE/ BOOK TITLE	**CHAPTER NUMBER/ CHAPTER'S NAME/ NO. OF PARAGRAPHS OR LINES/ PAGE NUMBERS/PAGE NO. OF DATA**	**DATA ASSOCIATED WITH ANCIENT INDIAN** ***BHAUTIKAŚĀSTRA***
November 2021/VIII/ Science: Text-book for class VIII	Chapter No.17/Stars and Solar System/One paragraph/215 to 238 /216	The research of astronomical bodies and the dynamics that govern them is called as astronomy. Our forefathers in ancient India spent considerable time exploring the cosmos. Their understanding of cosmology was far ahead of its time. The movement of the Sun, stars, moon, and planets through the sky made calenders and almanacks feasible. Because they used these on a regular basis, people were more aware of climate and rainfall patterns for optimum planting and crop selections, as well as establishing the dates of seasons and festivals.
November 2021/VIII/ Science: Text-book for class VIII	Chapter No.17/Stars and Solar System/One paragraph/215 to 238/216	The moon's stages have a significant impact on individuals' physical life. Nearly every single Indian festival revolves on the moon's stages. For instance, Diwali falls on a new moon day, whereas Budh Poornima and Guru Nanak's birthday fall on a full moon day, Maha Shivratri falls on the thirteenth midnight of the waning moon, and Eidul-Fitr falls on the day after the crescent moon appears.
November 2021/VIII/ Science: Text-book	Chapter No. 17/Stars and Solar	In all ancient civilisations, the numerous constellations have been associated with very interesting mythical narratives.

for class VIII	System, 215 to 238/222 /Three lines and one paragraph enclosed in cream coloured box	Ursa Major (Saptarshi): Ursa Major (Saptarshi): As illustrated in the picture below, Ursa Major (Sapt Saptarshi) has been associated with 7 well-known ancient Indian saints, or yogis.The Saptarshi, a group of seven sages, are said to maintain the Vedas' immortal wisdom and impart it to humanity in each new age, according to folklore.
November 2021/VIII/ Science: Text-book for class VIII	Chapter No. 17/Stars and Solar System, 215 to 238/227/two paragraphs enclosed in cream coloured box	Astronomy in Ancient India-According to the Rig Veda, which was written nearly 4000 years ago, astronomy was practiced in ancient India. In the discipline of astronomy, several Indian scientists have made notable contributions. One of the most well-known astronomers is Aryabhata. The book "Aryabhatiya" contains Aryabhata's astronomical work. In 499 CE, he wrote it at the age of 23. Aryabhata's estimation of the earth's diameter is close to what is currently known. Contrary to conventional perception, Aryabhata claimed that the Earth is a sphere that revolves on its own axis (immovable). His sidereal period estimate was 23 hours 56 minutes and 4.1 seconds, which is very close to the present value. He also said correctly that reflected sunlight illuminates the moon and planets. He described how astronomical and celestial eclipses work from a scientific viewpoint. A lunar eclipse occurs when the Earth's shadow falls on the moon. A solar eclipse occurs when the moon's shadow falls on the Earth. Aryabhata also calculated the Earth-Moon distance, which is still quite accurate today.

TABLE 2: INCORPORATION OF FIGURES ASSOCIATED WITH ANCIENT INDIAN *BHAUTIKAVIJÑĀN* IN GOVERNMENT SCIENCE TEXTBOOK

Publication Month and Year/Grade/ Book Title	**Chapter Number/ Chapter's Name/ / page Numbers/Page No. containing the figure**	**FIGURES ASSOCIATED WITH ANCIENT INDIAN** ***BHAUTIKAŚĀSTRA***

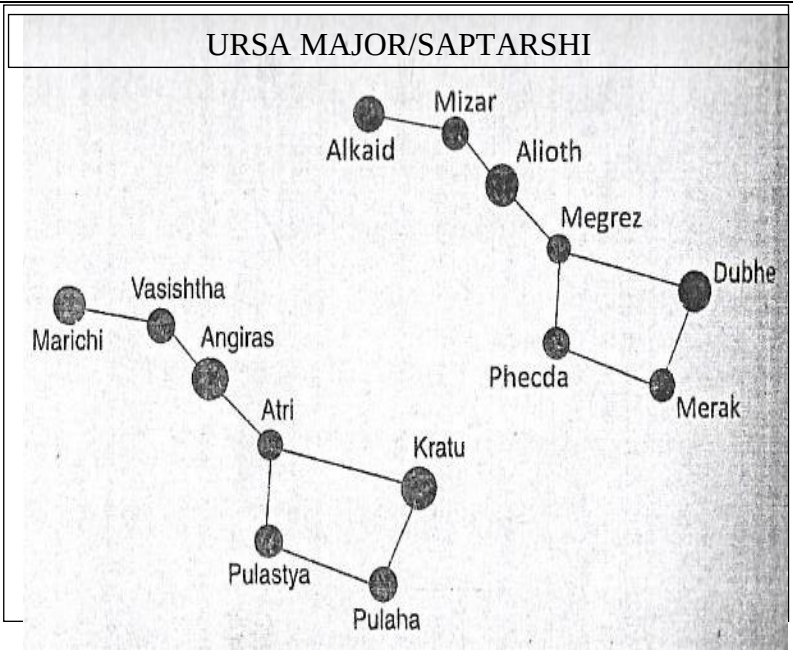
November 2021/VIII/ Science: Text-book for class VIII	Chapter No.17/Stars and Solar System/One paragraph/215 to 238/222	URSA MAJOR/SAPTARSHI 
November 2021/VIII/ Science: Text-book for class VIII	Chapter No.17/Stars and Solar System/One paragraph/215 to 238/227	RENOWNED *BHAUTIKAŚĀSTRI*(ASTRONOMER) OF ANCIENT INDIA 

TABLE 3: INCORPORATION OF QUESTIONS AND ACTIVITIES FOR EXTENDED LEARNING ASSOCIATED WITH ANCIENT INDIAN *BHAUTIKAŚĀSTRA* IN REVISED GOVERNMENT SCIENCE TEXTBOOKS

Publication Month and Year/Grade/	**Chapter Number/ Chapter's Name/ No. of**	**QUESTIONS AND ACTIVITIES FOR EXTENDED LEARNING ASSOCIATED WITH ANCIENT INDIAN *BHAUTIKAŚĀSTRA* IN GOVERNMENT SCIENCE**

Book Title	**paragraphs or lines/ page Numbers/Page No. of data/Ques. No.** **VALUE INCULCATION**	**TEXTBOOKS**
November 2021/VIII/ Science: Text-book for class VIII	Chapter No. 17/Stars and Solar System, 215 to 238/237/two paragraphs enclosed in cream coloured box/5 SCIENTIFIC DISPOSITION AND TEMPERAMENT	The rising Sun's location Uttarayan and Dakshinayan, This activity may last for several weeks. Choose a spot that provides a clear view of the eastern horizon. A landmark, such as a tree or an electric pole, might serve as a marker for the rising sun. It's enough to do it once a week. On any given day, keep track of where the sun rises. Rep the process once a week. What have you learned so far? You've probably noticed that sunrises occur at different times. After the summer solstice, the dawn point steadily moves southward (around June 21st). At that time, the Sun is supposed to be in Dakshinayan (going south). This will be the case until the winter solstice (around 22nd December). The sunrise's orientation shifts as it moves northward. According to folklore, the Sun is now in Uttarayan(going north). The Sun rises in the east from the equator just two days a year, on the days of the equinoxes (about March 21st and September 23rd). It rises to the north or south of the equator on all other days. As a result, orienting yourself using the rising sun is not a good idea. The Pole Star, which marks the North Pole, is a significantly better direction indicator.

FINDINGS

The chapter "Stars and Solar System" in the new edition of Government Science Textbook of Class VIII is entirely devoted to ancient Indian scientific knowledge. There are now two more figures which have been included in the chapter. In the first figure, Ursa Major (Saptarshi) is linked to seven ancient Indian sages who maintain immortal wisdom. The second illustration depicts Aryabhata, a renowned *bhautikaśāstrī* of ancient India. To stimulate the scientific spirit, a lengthy exercise has been provided in the same chapter. It is noted that the first reprint of the Government Science Book came out in December 2008. Since then other reprints came out in the years January 2010, November 2010, January 2012, November 2012, October 2013, December 2014, December 2015, February 2017, December 2017, December 2018, August 2019, January 2021 and latest was in November 2021. The incorporation of furtherancient Indian *bhautikaśāstra* was incorporated in December 2017 reprint. The ancient Indian scientific spirit and discoveries of *paramāṇu*(atoms), and their combinations put forward by *bhautikaśāstrīs* Kanad and Katyayamahad previously been

included in the “Atoms and Molecules” Chapter of the class IX. There has been no addition of further ancient Indian *bhautikaśāstra* in the subsequent reprints since December 2017.

RECOMMENDATIONS: PLUGGING THE GAPS

It is recommended that this practice of introducing ancient Indian *bhautikaśāstrīs* concepts and thoughts into subsequent chapters be continued. The Chapter of Sound, and the Floatation section of the Chapter of Gravitation of the Government Science Textbook of class nine can introduce Prashastapada's idea of the notion of sound and buoyancy respectively. Through the chapter "Gravitation," secondary class students of IX, may be exposed to *bhautikaśāstrī*’Bhāskarcāhārya’sexposition on gravitation. The rule on cell production from the Agastya Samhita may be included in Chapter 14 of the class eightcurriculum.Vaisheshika's magnetic compass should be introduced in the chapter on Fun with magnets of class six curriculum. Despite the fact that some information on the *bhautikaśāstri* Aryabhata has been provided, the names and contributions of other *bhautikaśāstris* like Brahmagupta,Varahamira, Bhāskarcāhārya and others should become well known to the Indian students, and there should be an acknowledgement of their breakthroughs in astronomical procedures and construction of sophisticated instruments. It is vital to introduce class IX pupils to the founder of Vaiśeṣika school, and other physicists of the same school of *bhautikaśāstra* in the realm of mechanics, and study of buoyancy from the sixth century B.C. to the sixth century A.D. The sound chapter of class nine can feature the concept of its propagation in the form of compressions and subsequent rarefactions as introduced by the *Mimamsakas*.

DISCUSSION

The nation's goal has been put forth through its educational systems and various educational policies. One of the major aims is to foster the scientific temperament of the ancient Indian *bhautikaśāstrīs* in its truest sense. It's important to mention that some of the concepts and inventions of the *bhautikaśāstrīs* of ancient India have been included in the recent updated Government Science Books, which will ignite the curiosity of our country's youth and inculcate the importance of research skills in them, and the consequent values of resilience, open mindedness, imaginativeness, meticulousness, mental acquisitiveness, and communicativeness. In order to facilitate the process of the students imbibing this mindset, and way of life we need to include it in our scientific books at all stages of education. Gravity, buoyancy, the electric cell, mechanical theories, astrophysical developments, magnetism, and other discoveries of Ancient Indian scientists may all be learned.

India's National Education Policy of 2020, introduced when the nation was confronting the first wave of the pandemic which decimated the entire country and the world, has unlatched trailblazing prospects in terms of resolutions in its policies concerning school education.

The introduction of this fresh ray of hope was meant to lift the nation's spirits, and the administration has already started implementing several aspects of the new national education programme.

The comprehensive and ingenious National Education policy 2020 is futuristic, and at the same time the infallible wisdom and scientific spirit of our ancient Indian scholars provides a firm underpinning to the policy. With the intention of creating minds imbued with the character of the *bhautikaśāstrīs*, the government is in the process of modifying its science books so as to not only preserve this classical knowledge tradition but to create future *bhautikaśāstrīs* who can usher in the camouflagedavant-garde and a new world order.

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