

THE VISION OF NEP 2020
Integrating Bharatiya Knowledge
System in Computer Science Textbooks

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Vidya Bharati Uchcha Shiksha Sansthan



**VIDYA BHARATI
UCHCHA SHIKSHA SANSTHAN**

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**The Vision of NEP 2020: Integrating Bharatiya Knowledge System in
Computer Science Textbooks**

Editor: Neelam Dabas

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FOREWORD

This book, *The Vision of NEP 2020: Integrating Bhartiya Knowledge System in Computer Science Textbooks*, is an outcome of sustained efforts of Vidya Bharti Uchcha Shiksha Sansthan and NIT Kurukshetra towards implementation of various recommendations of NEP 2020 in School Curriculum. With the announcement of National Education Policy 2020, government agencies and pioneer organizations working in the field of education have come into action to work on National Curriculum Framework and State Curriculum Frameworks. These endeavours are seeing huge participation from intellectuals and stakeholders in the academic fields to prepare content and design school textbooks based on the mandate of NEP 2020. This research volume is a germane contribution in this direction and provides a strategic plan towards development of syllabi and new textbooks in Computer Science subject to be developed for all stages and classes.

In developing this volume, Vidya Bharti Uchcha Shiksha Sansthan has taken a pioneer initiative towards accomplishing the intent of NEP in re-connecting and re-establishing the foundations of age-old Indian Education System and connect it with global pedagogical developments. This work sheds powerful light on ways to assimilate the valued tenets of Bhartiya knowledge system in the computer science syllabi of schools. The document highlights the specific aspects of Indian education and heritage that must be included under the ambit of the curriculum along with focus on imparting 21st century skills to the learners. In covering this

facet, this book also presents an extensive list of reference books and primary texts that can be used to re-design computer science textbooks for different stages and classes in school. This judiciously written volume is an integral contribution to the countrywide efforts towards implementation of National Education Policy 2020. I am particularly pleased to provide an entry point to this volume and welcoming all policy makers, academics, scholars, authors and readers. Last but not the least, I would like to express our gratitude to all our partner institutions, collaborators and particularly IKS Division of MoE, AICTE, GoI for supporting us in this project.

Prof. Kailash Chandra Sharma

President, Vidya Bharati Uchcha Shiksha Sansthan

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The National Education Policy 2020 calls for intellectual brainstorming with an aim to conserve, develop, introduce, promote and disseminate the rich heritage of ancient knowledge paradigms of India. Vidya Bharati Uchcha Shiksha Sansthan (VBUSS) laid the groundwork for this book in its “Preparatory Workshops on Textbooks” organized in January-February 2022. The finalized roadmap called for reinvigoration of textbooks through a collaborative and cooperative effort involving organization of national/international workshops and conferences and inviting domain experts, academicians and practitioners. In this light a National Workshop on “Computer Science/I.T. in the light of NEP 2020 & Indian Knowledge Systems’ was organized on 25th & 26th May, 2022 as a collaborative effort of VBUSS, NIT Kurukshetra, School of Engineering (JNU) and Software Technology Park of India. We extend our sincere gratitude to all the partner institutions whose support was instrumental in the successful completion and fruitful deliberations at the workshop.

Further, we wish to express our sincere gratefulness towards Sh. K.N. Raghunandan Ji (Akhil Bharatiya Sangathan Mantri, VBUSS) Mananiya Prakash Chandra Ji (Vice-President, VBUSS) and Sh. Govind Mahant Ji (Sangathan Mantri of Vidya Bharti Akhil Bhartiya Shiksha Sansthan) for their patronage, guidance, motivation and inspiration. Their vision and continuous engagement have made this idea a reality.

We would like to express our special appreciation and thanks to Prof. B.V. Ramana Reddy, Director NIT Kurukshetra who has been

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Lastly we would like to express our heartfelt thanks to Prof. Ruchir Gupta, Professor, School of Engineering, JNU, Dabbe Bharti, Research Scholar, JNU and all those participants whose valuable insights contributed to the making of this document.



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PREFACE

Education is the foundational construct in the development of every nation. Every civilization has progressed by educating its masses. Education is not limited to simple information transactions but requires a deeper holistic interface between the teacher and the student. It involves the development of a comprehensive education system. Such a system would be the primary keystone to realizing "human potential" and the development of a just society. One of the essential prerequisites of such a system would be an alignment with the nation's cultural identity, collective consciousness, and development ethos. Such a system cannot be a mechanical adoption of a technique derived from "slavish throes" designed to bind the mind and subdue the subconscious memory of a rich heritage. It must be the one that instils pride, reinvigorates the greatness within, and gives freedom to explore, create and innovate.

India enjoys an unparalleled ocean of ancient knowledge. Such is the power and utility of that unending reservoir that it still reaches out across aeons and plays an essential role in moulding the consciousness and conscience of the nation that is "*Bharat*". It plays out daily in our daily lives without us realizing its significance or role. It needs to be rediscovered in our cuisines, rituals, festivals, culinary practices, morals, norms, and social behaviour, which integrate "living" with "sustainability". This precious gift of "*Bhartiyata*" needs to be cherished, nurtured and preserved for the present and future generations. One of the golden ways of achieving this would be to revitalize our modern education system through

the *prāṇśakti* (life force) of the Bharatiya Knowledge System (BKS). Curricula in the higher education system require moving beyond conventional categories of thought. The global headwinds and the march towards an "*Aatmanirbhar Bharat*" necessitate recourse to "learning" and adopting problem-solving and critical skills development approaches. The necessary inspiration may be drawn from the interface of education and learning. It is unique to the central tenets and Ethos of the traditional Indian education system. It revolves around the three elements, namely "*Guru*", "*Shishya*", and "*Shiksha*" are attained through "*Deeksha*".

There is a need for intellectual brainstorming to identify, conserve, develop, introduce, promote and disseminate the traditional Indian knowledge paradigms. It entails understanding the relevance of the Bharatiya Knowledge System (BKS). The inculcation of these ancient treasures in the modern education system from the primary level onwards will give an added impetus to the spiritual and social progress of the students. It would involve re-working and redesigning the curriculum and enhancing the pedagogical tools and existing educational methodologies for implementing NEP 2020. It is only achievable through collaborations and coordination to promote interdisciplinary research involving modern disciplines. Of the myriad ways such an outcome may be attained, one perspective involves discovering and developing the societal application of BKS in Computer Science and Information Technology. We aim to incorporate historical perspective and pride in our heritage and create contemporary insights for global applications. It may be achieved by developing progressive thematic approaches based on BKS to enrich Computer Science/Information Technology textbooks prescribed in the school curriculum. As an illustration, principles forming the foundational construct of Computer programming can be distilled from ancient texts such as Panini's *Aṣṭādhyāyī* and introduced to the students. Or the peculiar form of framing of *sutra*

(s) or beautiful metrical compositions to encode information can be utilized to demonstrate to the students the experiential nature of our education system. As a necessary corollary, there would be a need to develop in them a conceptual understanding of the grammatical structure of Sanskrit, its procedural fluency, and its application for evolving new perspectives in information technology. In this context, this initiative attempts to explore the traditional Indian knowledge system and identify elements and principles which may be adopted and integrated by the educational practitioners for enhancing the content, pedagogy and relevance of computer science textbooks as per the mandate of NEP 2020.



Chapter–1

NATIONAL EDUCATION POLICY 2020: HIGHLIGHTS¹

Introduction

Education is fundamental for achieving full human potential, developing an equitable and just society, and promoting national development. Providing universal access to quality education is the key to India's continued ascent, and leadership. Universal high-quality education is the best way forward for developing and maximizing our country's rich talents and resources for the good of the individual, the society, the country, and the world.

The world is undergoing rapid changes in the knowledge landscape. With various dramatic scientific and technological advances, such as the rise of big data, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly involving mathematics, computer science, and data science, in conjunction with multidisciplinary abilities across the sciences, social sciences, and humanities, will be increasingly in greater demand.

Education thus, must move towards less content, and more towards learning about how to think critically and solve problems, how to be creative and multidisciplinary, and how to innovate, adapt, and absorb new material in novel and changing fields. Pedagogy must evolve to make education more experiential, holistic, integrated,

1. This chapter consists of extracts from NEP 2020 relevant to science curriculum

inquiry-driven, discovery-oriented, learner-centred, discussion-based, flexible, and, of course, enjoyable. The curriculum must include basic arts, crafts, humanities, games, sports and fitness, languages, literature, culture, and values, in addition to science and mathematics, to develop all aspects and capabilities of learners; and make education more well-rounded, useful, and fulfilling to the learner.

National Education Policy 2020 is the first education policy of the 21st century and aims to address the many growing developmental imperatives of our country. This Policy proposes the revision and revamping of all aspects of the education structure, including its regulation and governance, to create a new system that is aligned with the aspirational goals of 21st century education, including SDG4, while building upon India's traditions and value systems.

The rich heritage of ancient and eternal Indian knowledge and thought has been a guiding light for this Policy. The pursuit of knowledge (*Jnan*), wisdom (*Pragyaa*), and truth (*Satya*) was always considered in Indian thought and philosophy as the highest human goal. The aim of education in ancient India was not just the acquisition of knowledge as preparation for life in this world, or life beyond schooling, but for the complete realization and liberation of the self.

The Indian education system produced great scholars such as Charaka, Susruta, Aryabhata, Varahamihira, Bhaskaracharya, Brahmagupta, Chanakya, Chakrapani Datta, Madhava, Panini, Patanjali, Nagarjuna, Gautama, Pingala, Sankardev, Maitreyi, Gargi and Thiruvalluvar, among numerous others, who made seminal contributions to world knowledge in diverse fields such as mathematics, astronomy, metallurgy, medical science and surgery, civil engineering, architecture, shipbuilding and navigation, yoga, fine arts, chess, and more. Indian culture and philosophy have had a strong influence on the world. These rich legacies to world heritage must not only be nurtured and preserved for posterity but also researched, enhanced, and put to new uses through our education system.

Principles of NEP 2020

The 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.

The fundamental principles relevant to computer education that will guide both the education system at large, as well as the individual institutions within it are:

- Multidisciplinarity and a **holistic education** across the sciences, social sciences, arts, humanities, and sports for a multidisciplinary world in order to ensure the unity and integrity of all knowledge;
- **Creativity and critical thinking** to encourage logical decision-making and innovation;
- **Extensive use of technology** in teaching and learning, removing language barriers, increasing access for *Divyang* students, and educational planning and management;
- **Synergy in curriculum across all levels of education** from early childhood care and education to school education to higher education;
- **A rootedness and pride in India**, and its rich, diverse, ancient and modern culture and knowledge systems and traditions;

The Vision of NEP 2020

The National Education Policy envisions an education system rooted in Indian ethos that contributes directly to transforming India, that is Bharat, sustainably into an equitable and vibrant knowledge

society, by providing high-quality education to all, and thereby making India a global knowledge superpower.

SCHOOL EDUCATION

This policy envisages that the extant 10+2 structure in school education will be modified with a new pedagogical and curricular restructuring of 5+3+3+4 covering ages 3-18.

Early Childhood Care and Education

Para 1.1 of NEP 2020 states that Universal provisioning of quality early childhood development, care, and education must thus be achieved as soon as possible.

Foundational Literacy and Numeracy: An Urgent & Necessary Prerequisite to Learning

As per para 2.1 of NEP 2020 the ability to read and write, and perform basic operations with numbers, is a necessary foundation and an indispensable prerequisite for all future schooling and lifelong learning. Para 2.4 of NEP 2020 asserts that on the curricular side, there will be an increased focus on foundational literacy and numeracy - and generally, on reading, writing, speaking, counting, arithmetic, and mathematical thinking - throughout the preparatory and middle school curriculum, with a robust system of continuous formative/adaptive assessment to track and thereby individualize and ensure each student's learning. Specific hours daily - and regular events over the year-on activities involving these subjects will be dedicated to encourage and enthuse students. Teacher education and the early grade curriculum will be redesigned to have a renewed emphasis on foundational literacy and numeracy. Para 2.6 also recommends that A national repository of high-quality resources on foundational literacy and numeracy will be made available on the Digital Infrastructure for Knowledge Sharing (DIKSHA).

Technological interventions to serve as aids to teachers and to help bridge any language barriers that may exist between teachers and students, will be piloted and implemented.

Para 2.8 states that enjoyable and inspirational books for students at all levels will be developed, including through high-quality translation (technology assisted as needed) in all local and Indian languages, and will be made available extensively in both school and local public libraries.

Curtailling Dropout Rates and Ensuring Universal Access to Education at All Levels

As per NEP 2020 para 3.1, One of the primary goals of the schooling system must be to ensure that children are enrolled in and are attending school.

Curriculum and Pedagogy in Schools

Restructuring school curriculum and pedagogy in a new 5+3+3+4 design

As per para 4.1 of NEP 2020, the curricular and pedagogical structure of school education will be reconfigured to make it responsive and relevant to the developmental needs and interests of learners at different stages of their development, corresponding to the age ranges of 3-8, 8-11, 11-14, and 14-18 years, respectively. The curricular and pedagogical structure and the curricular framework for school education will therefore be guided by a 5+3+3+4 design, consisting of the Foundational Stage (in two parts, that is, 3 years of Anganwadi/pre-school + 2 years in primary school in Grades 1-2; both together covering ages 3-8), Preparatory Stage (Grades 3-5, covering ages 8-11), Middle Stage (Grades 6-8, covering ages 11-14), and Secondary Stage (Grades 9-12 in two phases, i.e., 9 and 10 in the first and 11 and 12 in the second, covering ages 14-18).

Para 4.2 also states that the Middle Stage will comprise three years of education, building on the pedagogical and curricular style of the Preparatory Stage, but with the introduction of subject teachers for learning and discussion of the more abstract concepts in each subject that students will be ready for at this stage across the sciences, mathematics, arts, social sciences, and humanities. Experiential learning within each subject, and explorations of relations among different subjects, will be encouraged and emphasized despite the introduction of more specialized subjects and subject teachers. The Secondary Stage will comprise of four years of multidisciplinary study, building on the subject-oriented pedagogical and curricular style of the Middle Stage, but with greater depth, greater critical thinking, greater attention to life aspirations, and greater flexibility and student choice of subjects.

Holistic development of learners

Para 4.4 asserts that the key overall thrust of curriculum and pedagogy reform across all stages will be to move the education system towards real understanding and towards learning how to learn - and away from the culture of rote learning as is largely present today.

Reduce curriculum content to enhance essential learning and critical thinking

Para 4.5 articulates that Curriculum content will be reduced in each subject to its core essentials, to make space for critical thinking and more holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning.

Experiential learning

Para 4.6 of NEP 2020 states that In all stages, experiential learning will be adopted, including hands-on learning, arts-integrated and sports-integrated education, story-telling-based pedagogy,

among others, as standard pedagogy within each subject, and with explorations of relations among different subjects. To close the gap in achievement of learning outcomes, classroom transactions will shift, towards competency-based learning and education. The assessment tools (including assessment “as”, “of”, and “for” learning) will also be aligned with the learning outcomes, capabilities, and dispositions as specified for each subject of a given class.

Empower students through flexibility in course choices

Para 4.9 claims that students will be given increased flexibility and choice of subjects to study, particularly in secondary school.

Multilingualism and the power of language

Wherever possible, the medium of instruction until at least Grade 5, but preferably till Grade 8 and beyond, will be the home language/mother tongue/local language/regional language. Thereafter, the home/local language shall continue to be taught as a language wherever possible. This will be followed by both public and private schools. High-quality textbooks, including in science, will be made available in home languages/mother tongue. All efforts will be made early on to ensure that any gaps that exist between the language spoken by the child and the medium of teaching are bridged. In cases where home language/mother tongue textbook material is not available, the language of transaction between teachers and students will still remain the home language/mother tongue wherever possible. Teachers will be encouraged to use a bilingual approach, including bilingual teaching-learning materials, with those students whose home language may be different from the medium of instruction. All languages will be taught with high quality to all students; a language does not need to be the medium of instruction for it to be taught and learned well. Para 4.12 states that extensive use of technology will be made for teaching and learning of different languages and to popularize language learning.

Para 4.17 frames that the importance, relevance, and beauty of the classical languages and literature of India cannot be overlooked. Sanskrit, while also an important modern language mentioned in the Eighth Schedule of the Constitution of India, possesses a classical literature that is greater in volume than that of Latin and Greek put together, containing vast treasures of mathematics, philosophy, grammar, music, politics, medicine, architecture, metallurgy, drama, poetry, storytelling, and more (known as ‘Sanskrit Knowledge Systems’), written by people of various religions as well as non-religious people, and by people from all walks of life and a wide range of socio-economic backgrounds over thousands of years. Sanskrit will thus be offered at all levels of school and higher education as an important, enriching option for students, including as an option in the three-language formula. It will be taught in ways that are interesting and experiential as well as contemporarily relevant, including through the use of Sanskrit Knowledge Systems, and in particular through phonetics and pronunciation. Sanskrit textbooks at the foundational and middle school level may be written in Simple Standard Sanskrit (SSS) to teach Sanskrit through Sanskrit (STS) and make its study truly enjoyable.

Curricular Integration of Essential Subjects, Skills, and Capacities

As per para 4.23, while students must have a large amount of flexibility in choosing their individual curricula, certain subjects, skills, and capacities should be learned by all students to become good, successful, innovative, adaptable, and productive human beings in today’s rapidly changing world. In addition to proficiency in languages, these skills include: scientific temper and evidence-based thinking; creativity and innovativeness; sense of aesthetics and art; oral and written communication; health and nutrition; physical education, fitness, wellness, and sports; collaboration and teamwork;

problem solving and logical reasoning; vocational exposure and skills; digital literacy, coding, and computational thinking; ethical and moral reasoning; knowledge and practice of human and Constitutional values; gender sensitivity; Fundamental Duties; citizenship skills and values; knowledge of India; environmental awareness including water and resource conservation, sanitation and hygiene; and current affairs and knowledge of critical issues facing local communities, States, the country, and the world.

Para 4.24 proclaims that concerted curricular and pedagogical initiatives, including the introduction of contemporary subjects such as Artificial Intelligence, Design Thinking, Holistic Health, Organic Living, Environmental Education, Global Citizenship Education (GCED), etc. at relevant stages will be undertaken to develop these various important skills in students at all levels. Para 4.25 claims that mathematics and mathematical thinking will be very important for India's future and India's leadership role in the numerous upcoming fields and professions that will involve artificial intelligence, machine learning, and data science, etc. Thus, mathematics and computational thinking will be given increased emphasis throughout the school years, starting with the foundational stage, through a variety of innovative methods, including the regular use of puzzles and games that make mathematical thinking more enjoyable and engaging. Activities involving coding will be introduced in Middle Stage.

Para 4.26 enunciates that every student will take a fun course, during Grades 6-8, that gives a survey and hands-on experience of a sampling of important vocational crafts, such as carpentry, electric work, metal work, gardening, pottery making, etc., as decided by States and local communities and as mapped by local skilling needs. A practice-based curriculum for Grades 6-8 will be appropriately designed by NCERT while framing the NCFSE 2020-21. All students will participate in a 10-day bagless period

sometime during Grades 6-8 where they intern with local vocational experts such as carpenters, gardeners, potters, artists, etc. Similar internship opportunities to learn vocational subjects may be made available to students throughout Grades 6-12, including holiday periods. Vocational courses through online mode will also be made available. Bagless days will be encouraged throughout the year for various types of enrichment activities involving arts, quizzes, sports, and vocational crafts. Children will be given periodic exposure to activities outside school through visits to places/monuments of historical, cultural and tourist importance, meeting local artists and craftsmen and visits higher educational institutions in their village/ Tehsil/District/State.

Para 4.27 determines that “Knowledge of India” will include knowledge from ancient India and its contributions to modern India and its successes and challenges, and a clear sense of India’s future aspirations with regard to education, health, environment, etc. These elements will be incorporated in an accurate and scientific manner throughout the school curriculum wherever relevant; in particular, Indian Knowledge Systems, including tribal knowledge and indigenous and traditional ways of learning, will be covered and included in mathematics, astronomy, philosophy, yoga, architecture, medicine, agriculture, engineering, linguistics, literature, sports, games, as well as in governance, polity, conservation. Specific courses in tribal ethno-medicinal practices, forest management, traditional (organic) crop cultivation, natural farming, etc. will also be made available.

Para 4.29 reveals that all curriculum and pedagogy, from the foundational stage onwards, will be redesigned to be strongly rooted in the Indian and local context and ethos in terms of culture, traditions, heritage, customs, language, philosophy, geography, ancient and contemporary knowledge, societal and scientific needs, indigenous and traditional ways of learning etc. – in order to ensure

that education is maximally relatable, relevant, interesting, and effective for our students. Stories, arts, games, sports, examples, problems, etc. will be chosen as much as possible to be rooted in the Indian and local geographic context. Ideas, abstractions, and creativity will indeed best flourish when learning is thus rooted.

National Curriculum Framework for School Education (NCFSE)

Para 4.30 states that the formulation of a new and comprehensive National Curricular Framework for School Education, NCFSE 2020-21, will be undertaken by the NCERT - based on the principles of this National Education Policy 2020, frontline curriculum needs.

Transforming Assessment for Student Development

Para 4.34 asserts that the aim of assessment in the culture of our schooling system will shift from one that is summative and primarily tests rote memorization skills to one that is more regular and formative, is more competency-based, promotes learning and development for our students, and tests higher-order skills, such as analysis, critical thinking, and conceptual clarity. The primary purpose of assessment will indeed be for learning; it will help the teacher and student, and the entire schooling system, continuously revise teaching-learning processes to optimize learning and development for all students. This will be the underlying principle for assessment at all levels of education. Para 4.35 expresses that AI-based software could be developed and used by students to help track their growth through their school years based on learning data and interactive questionnaires for parents, students, and teachers, in order to provide students with valuable information on their strengths, areas of interest, and needed areas of focus, and to thereby help them make optimal career choices.

Equitable and Inclusive Education: Learning for All

Para 6.15 states that capacities of teachers in the teaching of science, mathematics, language, and social studies will be developed including orientation to new pedagogical practices.

HIGHER EDUCATION

Quality Universities and Colleges: A New and Forward-looking Vision for India's Higher Education System

Para 9.1 specifies that Higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution - a democratic, just, socially-conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all. Higher education significantly contributes towards sustainable livelihoods and economic development of the nation. Para 9.1.1 describes that according to 21st century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. It must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and 21st century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education must enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to the society. It must prepare students for more meaningful and satisfying lives and work roles and enable economic independence. Para 9.1.2 states that for the purpose of developing holistic individuals, it is essential that an identified set of skills and values will be incorporated at each stage of learning, from pre-school to higher education.

Some of the major problems currently faced by the higher education system in India presents in para 9.2 are

- Less emphasis on the development of cognitive skills and learning outcomes;
- A rigid separation of disciplines, with early specialization and streaming of students into narrow areas of study;
- Limited access particularly in socio-economically disadvantaged areas, with few HEIs that teach in local languages
- Lesser emphasis on research at most universities and colleges, and lack of competitive peer-reviewed research funding across disciplines;

Towards a More Holistic and Multidisciplinary Education

Para 11.1 describes that India has a long tradition of holistic and multidisciplinary learning, from universities such as Takshashila and Nalanda, to the extensive literatures of India combining subjects across fields. Ancient Indian literary works such as Banabhatta's *Kadambari* described a good education as knowledge of the 64 Kalaas or arts; and among these 64 'arts' were not only subjects, such as singing and painting, but also 'scientific' fields, such as chemistry and mathematics, 'vocational' fields such as carpentry and clothes-making, 'professional' fields, such as medicine and engineering, as well as 'soft skills' such as communication, discussion, and debate. The very idea that all branches of creative human endeavour, including mathematics, science, vocational subjects, professional subjects, and soft skills should be considered 'arts', has distinctly Indian origins. This notion of a 'knowledge of many arts' or what in modern times is often called the 'liberal arts' (i.e., a liberal notion of the arts) must be brought back to Indian education, as it is exactly the kind of education that will be required for the 21st century.

As per para 11.2 NEP 2020, assessments of educational approaches in undergraduate education that integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) have consistently showed positive learning outcomes, including increased creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning. Research is also improved and enhanced through a holistic and multidisciplinary education approach.

Para 11.3 describes that a holistic and multidisciplinary education would aim to develop all capacities of human beings -intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner. Such an education will help develop well-rounded individuals that possess critical 21st century capacities in fields across the arts, humanities, languages, sciences, social sciences, and professional, technical, and vocational fields; an ethic of social engagement; soft skills, such as communication, discussion and debate; and rigorous specialization in a chosen field or fields. Such a holistic education shall be, in the long term, the approach of all undergraduate programmes, including those in professional, technical, and vocational disciplines. Para 11.4 states that a holistic and multidisciplinary education, as described so beautifully in India's past, is indeed what is needed for the education of India to lead the country into the 21st century and the fourth industrial revolution. Even engineering institutions, such as IITs, will move towards more holistic and multidisciplinary education with more arts and humanities. Students of arts and humanities will aim to learn more science and all will make an effort to incorporate more vocational subjects and soft skills. As per para 11.5, Imaginative and flexible curricular structures will enable creative combinations of

disciplines for study, and would offer multiple entry and exit points, thus, removing currently prevalent rigid boundaries and creating new possibilities for life-long learning.

Para 11.7 asserts that Departments in Languages, Literature, Music, Philosophy, Indology, Art, Dance, Theatre, Education, Mathematics, Statistics, Pure and Applied Sciences, Sociology, Economics, Sports, Translation and Interpretation, and other such subjects needed for a multidisciplinary, stimulating Indian education and environment will be established and strengthened at all HEIs. Credits will be given in all Bachelor's Degree programmes for these subjects if they are done from such departments or through ODL mode when they are not offered in-class at the HEI.

Optimal Learning Environments and Support for Students

According to para 12.1, effective learning requires a comprehensive approach that involves appropriate curriculum, engaging pedagogy, continuous formative assessment, and adequate student support. The curriculum must be interesting and relevant, and updated regularly to align with the latest knowledge requirements and to meet specified learning outcomes. High-quality pedagogy is then necessary to successfully impart the curricular material to students; pedagogical practices determine the learning experiences that are provided to students, thus directly influencing learning outcomes. The assessment methods must be scientific, designed to continuously improve learning and test the application of knowledge. Last but not least, the development of capacities that promote student wellness such as fitness, good health, psycho-social well-being, and sound ethical grounding are also critical for high-quality learning.

Catalysing Quality Academic Research in All Fields through a new National Research Foundation

As per para 17.1, Knowledge creation and research are critical in growing and sustaining a large and vibrant economy, uplifting society,

and continuously inspiring a nation to achieve even greater heights. Para 17.2 states that a robust ecosystem of research is perhaps more important than ever with the rapid changes occurring in the world today, e.g., in the realm of climate change, population dynamics and management, biotechnology, an expanding digital marketplace, and the rise of machine learning and artificial intelligence. If India is to become a leader in these disparate areas, and truly achieve the potential of its vast talent pool to again become a leading knowledge society in the coming years and decades, the nation will require a significant expansion of its research capabilities and output across disciplines. Para 17.4 describes that The societal challenges that India needs to address today, such as access for all its citizens to clean drinking water and sanitation, quality education and healthcare, improved transportation, air quality, energy, and infrastructure, will require the implementation of approaches and solutions that are not only informed by top-notch science and technology but are also rooted in a deep understanding of the social sciences and humanities and the various socio-cultural and environmental dimensions of the nation. Facing and addressing these challenges will require high-quality interdisciplinary research across fields that must be done in India and cannot simply be imported; the ability to conduct one's own research also enables a country to much more easily import and adapt relevant research from abroad.

Para 17.5 states that in addition to their value in solutions to societal problems, any country's identity, upliftment, spiritual/intellectual satisfaction and creativity is also attained in a major way through its history, art, language, and culture. Research in the arts and humanities, along with innovations in the sciences and social sciences, are, therefore, extremely important for the progress and enlightened nature of a nation.

Para 17.7 describes that India has a long historical tradition of research and knowledge creation, in disciplines ranging from science

and mathematics to art and literature to phonetics and languages to medicine and agriculture. This needs to be further strengthened to make India lead research and innovation in the 21st century, as a strong and enlightened knowledge society and one of the three largest economies in the world. Para 17.8 explains that this Policy envisions a comprehensive approach to transforming the quality and quantity of research in India. This includes definitive shifts in school education to a more play and discovery-based style of learning with emphasis on the scientific method and critical thinking. This includes career counselling in schools towards identifying student interests and talents, promoting research in universities, the multidisciplinary nature of all HEIs and the emphasis on holistic education, the inclusion of research and internships in the undergraduate curriculum, faculty career management systems that give due weightage to research, and the governance and regulatory changes that encourage an environment of research and innovation. All of these aspects are extremely critical for developing a research mindset in the country.

Professional Education

As per para 20.6 of NEP 2020 India must also take the lead in preparing professionals in cutting-edge areas that are fast gaining prominence, such as Artificial Intelligence (AI), 3-D machining, big data analysis, and machine learning, in addition to genomic studies, biotechnology, nanotechnology, neuroscience, with important applications to health, environment, and sustainable living that will be woven into undergraduate education for enhancing the employability of the youth. Para 22.2 describes that the promotion of Indian arts and culture is important not only for the nation but also for the individual. Cultural awareness and expression are among the major competencies considered important to develop in children, in order to provide them with a sense of identity, belonging, as well

as an appreciation of other cultures and identities. It is through the development of a strong sense and knowledge of their own cultural history, arts, languages, and traditions that children can build a positive cultural identity and self-esteem. Thus, cultural awareness and expression are important contributors both to individual as well as societal well-being. Para 22.15 asserts that due to its vast and significant contributions and literature across genres and subjects, its cultural significance, and its scientific nature, rather than being restricted to single-stream Sanskrit Pathshalas and Universities, Sanskrit will be mainstreamed with strong offerings in school - including as one of the language options in the three-language formula - as well as in higher education. It will be taught not in isolation, but in interesting and innovative ways, and connected to other contemporary and relevant subjects such as mathematics, astronomy, philosophy, linguistics, dramatics, yoga, etc. Thus, in consonance with the rest of this policy, Sanskrit Universities too will move towards becoming large multidisciplinary institutions of higher learning. Departments of Sanskrit that conduct teaching and outstanding interdisciplinary research on Sanskrit and Sanskrit Knowledge Systems will be established/strengthened across the new multidisciplinary higher education system. Sanskrit will become a natural part of a holistic multidisciplinary higher education if a student so chooses. Sanskrit teachers in large numbers will be professionalized across the country in mission mode through the offering of 4-year integrated multidisciplinary B.Ed. dual degrees in education and Sanskrit.

Technology Use and Integration

Para 23.1 describes that India is a global leader in information and communication technology and in other cutting-edge domains, such as space. The Digital India Campaign is helping to transform the entire nation into a digitally empowered society and knowledge economy.

While education will play a critical role in this transformation, technology itself will play an important role in the improvement of educational processes and outcomes; thus, the relationship between technology and education at all levels is bi-directional. Para 23.2 states that given the explosive pace of technological development allied with the sheer creativity of tech-savvy teachers and entrepreneurs including student entrepreneurs, it is certain that technology will impact education in multiple ways, only some of which can be foreseen at the present time. New technologies involving artificial intelligence, machine learning, block chains, smart boards, handheld computing devices, adaptive computer testing for student development, and other forms of educational software and hardware will not just change what students learn in the classroom but how they learn, and thus these areas and beyond will require extensive research both on the technological as well as educational fronts.

Para 23.5 of NEP 2020 explains that the thrust of technological interventions will be for the purposes of improving teaching-learning and evaluation processes, supporting teacher preparation and professional development, enhancing educational access, and streamlining educational planning, management, and administration including processes related to admissions, attendance, assessments, etc. Para 23.6 acknowledges that a rich variety of educational software, for all the above purposes, will be developed and made available for students and teachers at all levels. All such software will be available in all major Indian languages and will be accessible to a wide range of users including students in remote areas and *Divyang* students. Teaching-learning e-content will continue to be developed by all States in all regional languages, as well as by the NCERT, CIET, CBSE, NIOS, and other bodies/institutions, and will be uploaded onto the DIKSHA platform.

Para 23.7 claims that Particular attention will need to be paid to emerging disruptive technologies that will necessarily transform

the education system. When the 1986/1992 National Policy on Education was formulated, it was difficult to predict the disruptive effect that the internet would have brought. Our present education system's inability to cope with these rapid and disruptive changes places us individually and nationally at a perilous disadvantage in an increasingly competitive world. For example, while computers have largely surpassed humans in leveraging factual and procedural knowledge, our education at all levels excessively burdens students with such knowledge at the expense of developing their higher-order competencies. Para 23.8 states that this policy has been formulated at a time when an unquestionably disruptive technology -Artificial Intelligence (AI) 3D/7D Virtual Reality - has emerged. As the cost of AI-based prediction falls, AI will be able to match or outperform and, therefore, be a valuable aid to even skilled professionals such as doctors in certain predictive tasks. AI's disruptive potential in the workplace is clear, and the education system must be poised to respond quickly. Para 23.9 declares that in response to MHRD's formal recognition of a new disruptive technology, the National Research Foundation will initiate or expand research efforts in the technology. In the context of AI, NRF may consider a three-pronged approach: (a) advancing core AI research, (b) developing and deploying application-based research, and (c) advancing international research efforts to address global challenges in areas such as healthcare, agriculture, and climate change using AI.

Para 23.10 describes that HEIs will play an active role not only in conducting research on disruptive technologies but also in creating initial versions of instructional materials and courses including online courses in cutting-edge domains and assessing their impact on specific areas such as professional education. Once the technology has attained a level of maturity, HEIs with thousands of students will be ideally placed to scale these teaching and skilling efforts, which will include targeted training for job readiness.

Disruptive technologies will make certain jobs redundant, and hence approaches to skilling and deskilling that are both efficient and ensure quality will be of increasing importance to create and sustain employment. Para 23.11 states that Universities will aim to offer Ph.D. and Masters programmes in core areas such as Machine Learning as well as multidisciplinary fields “AI + X” and professional areas like health care, agriculture, and law. They may also develop and disseminate courses in these areas via platforms, such as SWAYAM. For rapid adoption, HEIs may blend these online courses with traditional teaching in undergraduate and vocational programmes. HEIs may also offer targeted training in low-expertise tasks for supporting the AI value chain such as data annotation, image classification, and speech transcription. Efforts to teach languages to school students will be dovetailed with efforts to enhance Natural Language Processing for India’s diverse languages.

As per para 23.12, As disruptive technologies emerge, schooling and continuing education will assist in raising the general populace’s awareness of their potential disruptive effects and will also address related issues. This awareness is necessary to have informed public consent on matters related to these technologies. In school, the study of current affairs and ethical issues will include a discussion on disruptive technologies such as those identified by NETF/MHRD. Appropriate instructional and discussion materials will also be prepared for continuing education. Para 23.13 explains that data is a key fuel for AI-based technologies, and it is critical to raise awareness on issues of privacy, laws, and standards associated with data handling and data protection, etc. It is also necessary to highlight ethical issues surrounding the development and deployment of AI-based technologies. Education will play a key role in these awareness raising efforts. Other disruptive technologies that are expected to change the way we live, and, therefore, change the way we educate students, include those relating to clean and renewable energy, water

conservation, sustainable farming, environmental preservation, and other green initiatives; these will also receive prioritized attention in education.

Online and Digital Education: Ensuring Equitable Use of Technology

As per para 24.4 of NEP 2020, Given the emergence of digital technologies and the emerging importance of leveraging technology for teaching-learning at all levels from school to higher education, this Policy recommends the following key initiatives:

- Pilot studies for online education: Appropriate agencies, such as the NETE, CIET, NIOS, IGNOU, IITs, NITs, etc. will be identified to conduct a series of pilot studies, in parallel, to evaluate the benefits of integrating education with online education while mitigating the downsides
- Digital infrastructure: There is a need to invest in creation of open, interoperable, evolvable, public digital infrastructure in the education sector that can be used by multiple platforms and point solutions, to solve for India's scale, diversity, complexity and device penetration.
- Online teaching platform and tools: Appropriate existing e-learning platforms such as SWAYAM, DIKSHA, will be extended to provide teachers with a structured, user-friendly, rich set of assistive tools for monitoring progress of learners.
- Content creation, digital repository, and dissemination: A digital repository of content including creation of coursework, Learning Games & Simulations, Augmented Reality and Virtual Reality will be developed, with a clear public system for ratings by users on effectiveness and quality. For fun based learning student-appropriate tools like apps, gamification of Indian art and culture, in multiple

languages, with clear operating instructions, will also be created. A reliable backup mechanism for disseminating e-content to students will be provided.

- Addressing the digital divide: Given the fact that there still persists a substantial section of the population whose digital access is highly limited, the existing mass media, such as television, radio, and community radio will be extensively used for telecast and broadcasts.
- Virtual Labs: Existing e-learning platforms such as DIKSHA, SWAYAM and SWAYAMPURABHA will also be leveraged for creating virtual labs so that all students have equal access to quality practical and hands-on experiment-based learning experiences. The possibility of providing adequate access to SEDG students and teachers through suitable digital devices, such as tablets with pre-loaded content, will be considered and developed.
- Training and incentives for teachers: Teachers will undergo rigorous training in learner-centric pedagogy and on how to become high-quality online content creators themselves using online teaching platforms and tools.
- Online assessment and examinations: Appropriate bodies, such as the proposed National Assessment Centre or PARAKH, School Boards, NTA, and other identified bodies will design and implement assessment frameworks encompassing design of competencies, portfolio, rubrics, standardized assessments, and assessment analytics.
- Blended models of learning: While promoting digital learning and education, the importance of face-to-face in-person learning is fully recognized. Accordingly, different effective models of blended learning will be identified for appropriate replication for different subjects.

- Laying down standards: As research on online/digital education emerges, NETF and other appropriate bodies shall set up standards of content, technology, and pedagogy for online/digital teaching-learning.



**EXTRACTS OF 331st REPORT:
REFORMS IN CONTENT AND DESIGN OF
SCHOOL TEXT BOOKS¹**

Department-Related Parliamentary Standing Committee on Education, Women, Children, Youth and Sports has presented the “Three Hundred and Thirty First Report of the Committee on “Reforms in Content and Design of School Text books”. The report focuses on:

- Removing references to un-historical facts and distortions about our national heroes from the text books;
- Ensuring equal or proportionate references to all periods of Indian History;
- Highlighting the role of great historic women achievers.

The relevant highlights of the report are given below

- The report elaborates upon National Curriculum Framework that will provide roadmap for the development of new generation of textbooks providing more space to experiential learning for bringing in students the conceptual clarity and motivate students

¹ This report was presented by Dr. Vinay P. Sahasrabudde, Chairman Department-related Parliamentary Standing Committee on Education, Women, Children, Youth and Sports on 26th November, 2021

for self-learning and self-assessment to improve not only cognitive skills but also the social -personal qualities.

- New NCF for School Education will guide the development of new generation textbooks across the subject areas. The new generation textbooks across subject areas will take care of the thematic, inter-disciplinary and multi-disciplinary approaches to highlight Indian culture and traditions, national heroes including women achievers and great regional personalities besides providing coverage to different phases of Indian history.
- NCF must focus on restructuring of stages of curriculum and pedagogy as 5+3+3+4, more focus is on Early Childhood Care and Education and Foundational Literacy and Numeracy, Integration of Pre-vocational Education from classes 6 to 8, Integration of Knowledge of India across the stages, focus on the holistic development through experiential learning, flexibility in choice of subjects etc.
- The report further informs about new ways for promotion of experiential learning, art integrated learning, sports integrated learning and competency-based learning, including internships, 10 bag less days, peer tutoring, interdisciplinary and multidisciplinary projects and development of fun-based student appropriate learning tools to promote and popularize Indian arts and culture etc.
- It also highlights different pedagogies such as group discussions, mock drills, excursion trips, visits to various places, such as zoo, museum, local store or restaurant; field study, classroom interactions, etc. were also being used to support experiential learning. Also, opportunities were provided to break subject boundaries by integration of art forms (visual or performing arts, such as dance, design, painting, photography, theatre, writing, etc.), stories, pictures, fun activities or games, sports,

etc. for holistic learning of concepts of science and mathematics without burden.

- It further states that the future syllabi and textbooks will be based on goals and competencies which will lead towards mapping of core essentials with competencies hence lessening the curriculum burden and focusing on holistic learning and development. The curriculum and syllabi should provide lots of space for experiential learning and textbooks will be based on competencies rather than content.
- NEP, 2020 recommends integration of knowledge of India across the stages and subject areas in the curriculum. Under this concern, as per the directions of new National Curriculum Framework for school education, various activities including development of digital and audio-video materials will be taken up.
- Thematic, interdisciplinary and multidisciplinary approaches to highlight Indian Culture and Traditions, our National Heroes including women achievers and great personalities from different regions of the country and perspective of equity, integrity, gender parity, constitutional values and concern for environment and other sustainable development goals.
- Experiential Learning through projects and age-appropriate activities, simple language, glossary, more in-text and end-text assessment questions and reduction of curriculum load to core essentials.
- All textbooks will be visually rich with illustrations, photographs, maps, etc., the illustrations and activities will be age/class appropriate. Local flavor will be added to the core essentials in textbooks of the States, to showcase the diversity of the country.
- Local flavor will be added to the core essentials in textbooks of the States, to showcase the diversity of the country. NCERT

has been working towards bringing dictionary on Indian sign language, which will help in developing material in sign language. The upcoming books and other materials based on the new NCFSC will follow the same pursuit in future.

- More emphasis on role of women: Role of women as rulers, their role in knowledge sector, social reforms, Bhakti movement, art and culture, freedom struggle (**Jnana Prabodhini, Pune**). Coverage of great historic women heroes belonging to different periods of Indian History including Gargi, Maitreyi, rulers like Rani of Jhansi, Rani Channamma, Chand Bibi, Zalkari Bai etc. will be taken up in the new textbooks, supplementary materials and e-content.
- National initiatives such as Swachh Bharat, Digital India, 'Beti Bachao Beti Padhao', 'Demonetization', GST etc. were integrated in the new textbooks in the review of syllabi and textbooks in 2017-18. Contents were added in history textbooks regarding knowledge, traditions and practices of India. For example, addition of material on Vikram Samvat, Metallurgy, Shivaji Maharaj, Paika revolt, Subhash Chandra Bose, Swami Vivekanand, Ranjeet Singh, Rani Avantibai Lodhi and Sri Aurbindo Ghosh.
- The objective of teaching history was to instil high self-esteem in students, National Renaissance, National unity, Social Inclusion and establish links with cultural roots. Thus following points are to be kept in mind while writing text books:
 - Depicting cultural unity
 - Linguistic heritage- importance of Sanskrit, Prakrit and Pali for national unity and international spread.
 - Linking Indian languages.
 - Civilization development -Vedic to present.

- Comparison of scientific temper with other civilizations on scientific and objective ground.
- History of sacrifices of various segments of Indian society for saving cultural values.
- Social inclusion.
- India and its cultural boundaries.
- Civilization proofs of India in other countries of the world.
- Religio-cultural emissaries from India should have proper place.
- Local, national as well as international influence of any event or thought should be highlighted. (**Bharatiya Shikshan Mandal, New Delhi**)
- The representatives of **Vidya Bharti** also put forth their views on the subject and pointed out certain factual distortions about vedic tradition, incompatibility of certain facts with constitutional ideals and values in the school textbooks. They suggested a thorough review and removing of such distortions/ discrepancies from the school textbooks. They also mentioned about 'My NEP' programme launched to reach non-academic people and to make them learn about the things in the National Education Policy in a nutshell.
- Inclusion of History of North East India: Bhakti and social movements in Assam and Manipur, tribal heroes who fought against British, contribution of Arunachal and Manipur with reference to Azad Hind Fauj and 1962 war, dynasties in Assam, Manipur, Tripura, Meghalaya. (**Jnana Prabodhini, Pune**)
- Post-independence History of Indian pride also needs to be stressed: Story of ISRO, story of BARC, story of cooperative movement (Story of Amul), story of restorations (Somnath, Hampi, archaeological sites such as Lothal) etc. (**Jnana Prabodhini, Pune**)

- The Design of textbooks should be:
 - Curriculum of history can be organized in an ascending order. The scope of curriculum grows with the growth of experience sphere of students from local to global.
 - Digitization of textbooks to make them attractive and dynamic document to go beyond text/ printed form: need to add audio-visuals with QR codes.
 - Inclusion of intellectual games, simulations. VR Games modeled to let students experience the historical times (for example ‘Real lives’) (**Jnana Prabodhini, Pune**)
- As far as the Modern period is concerned, some leaders have received more weightage as compared to others. The role of Subhash Chandra Bose, Sardar Patel, Bhagat Singh, Ram Prasad Bismil, Lala Lajpat Rai, Khudiram Bose, Surya Sen, and even the women revolutionaries must be highlighted. The contribution of Veer Savarkar needs to be given enough weightage. (**Public Policy Research Centre, New Delhi**)
- The representatives pointed out that proportionate representation across Region, Time Period, and Events should be given in the Textbooks. South and East Indian dynasties have been highly under-represented. The history of great kingdoms like the Marāthas, Coḷas, and Vijayanagara as well as the early Kāśmīra dynasties, Kalingas, Gangas, Gajapatis, Kākatiyas, Ahoms, Ceras, Pallavas, Pāṇḍyas, Pālas, Senas, and Pratihāras either get a passing mention or not even that. The crucial role they played in our history must be elaborated. They further added that we must include these dynasties, which represent the very spirit of Bhāratīya Civilization that the Radhakrishnan Committee wanted every student to imbibe. (**Samvit Research Foundation, Bengaluru**). The following points were further added:

- Bhāratīya saṃskṛti has been widespread from Mesopotamia in the West to Japan in the East, from the Himalayas in the North to Indonesia in the South
- The Zend Avesta has significant relationship with the late R̥igvedic period
- Our Itihāsas and Purāṇas, particularly the Rāmāyaṇa, have been an integral part of the culture of many regions of Southeast Asia.
- The representatives also added that the history curriculum hardly emphasizes the role played by women in our history. It is important for students to learn –
 - the importance our civilization has given to women and how women participated in all aspects of life over the centuries
 - the freedom and opportunities available to women in public life
 - the great achievements of women from ancient times until the present day
 - the temporary changes in status of women in the wake of invasions
 - to progressively appreciate that our paramparā has a beautiful and holistic perspective of strīva that is far beyond modern formulations.
- They further suggested that this can best be accomplished by exposing the children to factual information from the past:-
 - Introduce the three great goddesses of the Vedas – Bhāratī, Ilā, Sarasvatī. Introduce a few Veda-suktas for which women are the mantra-draṣṭārīṇīs. In the Vedic period, mention woman scholars, brahmavādinīs, and mantra-draṣṭārīṇīs, including instances of where women learnt the Vedas.

- Present the dynamic role played by women in the Rāmāyaṇa and Mahābhārata. Give a complete picture of women-related references in the smṛtis.
- Portrayal of women in various classical literary accounts (e.g. Kālidāsa's Mālavikāgnimitra) that indirectly shows how the society was shaping up at that time.
- The critical contributions of queens in every century and every region across communities. Prominent rājamātas who played a role in shaping their children as rulers; important women warriors, scholars, poetesses, philanthropists, public personalities, sanyāsinīs, philosophers, saints, and freedom fighters
- The Committee is of the view that there should be an appropriate comparison of the portrayal of women heroes like Rani Laxmi Bai, Zalkari Bai, Chand Bibi etc vis-a-vis their male counterparts. The Committee observes that the women heroes from different regions and eras should be given equal weightage highlighting their contributions in the history textbooks.
- The Committee also observes that notable women in all fields, and their contributions, like that of Ahilyabai Holkar, Abala Bose, Anandi Gopal Joshi, Anasuya Sarabhai, Arati Saha, Aruna Asaf Ali, Kanaklata Deka, Rani Ma Guidinglu, Asima Chatterjee, Captain Prem Mathur, Chandraprabha Saikini, Cornelia Sorabji, Durgavati Devi, Janaki Ammal, Mahasweta Devi, Kalpana Chawla, Kamaladevi Chattopadhyay, Kittur Chennamma, M. S. Subbulakshmi, Madam Bhikaji Cama, Rukmini Devi Arundale, Savitribai Phule and many others have not found adequate mention in NCERT textbooks.
- The Committee observes that generally Women are underrepresented in school textbooks, many a times shown through images in traditional and voluntary roles, leading to

formation of gender stereotypes in the impressionistic minds of students and feels that there is a need to undertake an analysis of the textbooks from the Gender perspective as well.

- The Committee observes that in the suggestions received regarding updation of NCERT books, emphasis was laid on providing equal representation to the North-East Indian States and the History. It was suggested that developmental models and economic policies should have sections dealing with and talking about the complex realities and demographics of the North-East along with the history of civilizations and tribal communities of the North-eastern region. Furthermore, the textbook content should also ensure adequate balance in representing Hill areas and Plains areas so as to recognise both communities adequately.

Subject Experts

Prof. J.S. Rajput, Former Director, NCERT in his submission before the Committee stated that Reforms in the content and design of Textbooks should focus on the following aspects:

- a. Distortion of historical facts where one ruler is remembered and other equally prominent one's finds no mention.
- b. Not only periods, history must be just and objective to considerations of regional imbalances, historical contributions of the communities, people and practices.
- c. Social and cultural distortions must not be presented by those bound by prejudices and biases.

He stated that the content and design of textbooks is a product of Policy on Education, Curriculum Framework to be developed after its sensitive comprehension, followed by the process of preparing detailed syllabus for each textbook; for each grade /class. The quality

and content of the textbook shall depend on the quality of the authors; that include depth, seriousness, professional competence and commitment of individuals and institutions assigned the task. A good textbook can be authored only by those who are lifelong learners.

It was emphasized that National level textbooks are essential for several reasons, but it must be remembered that local element of curriculum also cannot be ignored. A class three textbook on environmental education just cannot be same in Tripura and Thiruvananthapuram. Hence, it is necessary to strengthen expertise and institutions at the State level. We need high level experts in textbook writing, evaluation, assessment, growing up, guidance, and all that children could need. now education is not only about/through textbooks, but textual materials for online learning, self-learning, digital learning, open and distance learning, and a couple of other terms that are in vogue. It has to be hybrid teaching and learning in future. Things have changed drastically in 2020, and some of the impacts shall continue in future as well.

New discoveries are taking place, new facts are coming up, and textbooks just cannot remain the same. This is worsened if the history is written with certain pre-conceived biases resulting out of politically-constrained ideological bindings. History writing in India has suffered on these unacceptable considerations, and it must be extracted - and liberated -out of gross subjectivity and ideological bias to transparent objectivity, and openness of mind, willingness to enter into dialogue with those holding diametrically opposite views. New facts have emerged around us; say; Aryan Invasion theory, Saraswati River, Ram Setu, and so many more solely because of new scientific advancements and new tools that have led to new researches. These just cannot be ignored in preparing new textbooks. Indian history writing needs a thorough professional review. As it was determined to highlight certain individuals, regimes and eras, it suffers from

serious imbalances of every possible type. He further pointed out the British tried to downgrade the great contributions of ancient India in philosophy, science, mathematics, spirituality, medicine and other fields and it was continued to be neglected in our textbooks. While considerable initiatives were taken for removing gender bias and caste discriminations, history writing remained confined to the hegemony of a select group of few academics for over five decades. The post- independence history books are deficient on 'linking Indians to India'; and this includes history, heritage and culture. In fact, this aspect needs serious informed and scholarly deliberations before textbooks are prepared in response to the NEP-2020.

The second most important aspect that no textbook writer could ignore pertains to the need for strengthening social cohesion and religious amity. Racial discrimination and caste considerations - in varied connotations – have not vanished fully even in what are known as most advanced societies. We must accept that these challenges still exist even before us; and these require an attitudinal transformation. Our Children must know that different religions are a reality, that no religion could claim superiority over any other.

Shri Hukmdev Narayan Yadav, Ex-MP, Lok Sabha emphasized the importance of the subject and suggested for detailed discussion with more stakeholders and eminent educationists. The focus should not 'be only on facts and figures while writing Indian history but it should focus on the deep essence of the nature of Indian history in order to make it more understandable.

Shri Shankar Sharan, Eminent Educationist so deposed before the Committee on the above subject and highlighted various topics for inclusion/ exclusion in NCERT text-books. He drew the attention of the Committee Members as to why the text-books had references to unhistorical/ distorted facts and why a section of intellectuals insisted on keeping it. Focusing on this will only help in removing such discrepancies.

Recommendations

In view of the evidences gathered throughout the process, the Committee strongly recommends that:

- While creating the content for textbooks, inputs from experts from multiple disciplines should be sought. This will ensure balance and diversity of views. It should also be ensured that books are free of biases. The textbooks should instill commitment to values enshrined in the constitution and should further promote national integration and unity.
- There is a pressing need to develop high-quality textbooks and effective teaching methods. Thus mandatory standards related to text-book content, graphics and layout, supplementary materials, and pedagogical approaches should be developed. Such standards are needed for printed as well as digital textbooks.
- There is a need to have more child-friendly textbooks. This is possible through enhanced use of pictures, graphics, QR codes, and other audio-visual materials. Children should be taught through enhanced used of games, plays, dramas, workshops, visits to places of historical importance, museums etc. as such approaches will ignite their inquisitiveness and analytical abilities.
- The initiative of Maharashtra State Bureau of Textbook Production & Curriculum Research known as Ekatmik Pathya Pustak conceived in 2018-19 to lighten the school bag is appreciable. Towards this, the Bureau has created quarter-specific integrated material for Marathi, English, Mathematics and 'Play, Do, Learn' for Class I students into a single book. A similar approach may be adopted by others. Such initiative will be aligned to the School Bag Policy of New Education Policy (NEP), 2020 as laid out in Section 4.33.

- Education must be provided in the light of values enshrined in the constitution which cannot be taught by mere delivery of information. The pedagogy woven around textbooks has a lasting impact on the minds of the student and hence learning-by-experiment methodology should be compulsorily used by all teachers. Such an approach will enhance positive attitude towards learning amongst students.
- The prioritization of development of foundational skills amongst primary students is required by the NEP-2020, and therefore necessitates the use of information technology and digital devices. Therefore, digital content should be created and disseminated using satellite technology to enhance our students' capabilities and potentials. Such approaches will further curriculum reform and will also help develop more effective operational models for content delivery, and learning. Introduction of modern technologies/methodologies for the dissemination of information as part of teaching strategies should be undertaken preferably after enabling the possibility of the same uniformly in every part of the country. Schools in remote corners of the country should be suitably equipped for the same.
- The primary school textbooks should serve two purposes; provide strong foundation in core areas such as reading, writing and arithmetic, and provoke curiosity so that students can rapidly expand their knowledge in later years. This is also in alignment with NEP 2020's goal of promoting competency-based learning.
- The NCERT and SCERTs should primarily focus on providing core content through their textbooks. Detailed information and supplementary materials may be provided

through other texts, videos, reference books, A/V files, etc. Further, textbooks should be anchored in facticity. Any presentation of data or survey results should be appropriately referenced. Textbooks should be designed to provoke curiosity and analytical abilities, should be tuned to cognitive capability of the student, and should employ simple language. Further, efforts should be made to design textbooks in ways such that project-based, art-integrated, and experiential learning models can be deployed for effective education. In this way, our textbooks will promote scientific temper, innovation, and also the four Cs; Communication, Collaboration, Creativity, and Critical Thinking.

- The Ministry should explore the possibility of developing a core class-wise common syllabus for various subjects for implementation by CBSE, CICSE and various other State education Boards as this will go a long way in maintaining uniformity in educational standards of school students across the country.
- Our textbooks should highlight the lives of hitherto unknown men and women from different states and districts who have positively influenced our national history, honour, and one-ness. This may require content production teams to dig deeper into local sources of knowledge, including oral ones, and identify linkages between the local and the national. In this way, our textbooks should elicit “Unity in Diversity” of India emphasizing that diversity in India is in fact diverse manifestation of the innate one-ness or intrinsic unity.
- The textbooks should include content on world history and India’s place in the same. In this regard, special emphasis must be placed on the histories of other countries of the

world. This is aligned with international guidelines which argue for study of history through a multi-perspective approach. Further, sufficient emphasis must also be placed on the connects between histories of South-East Asia and India. This would be very useful in the context of India's Look East policy.

- Our history textbooks should be continually updated, and account for post-1947 history as well. In addition, an option of conducting review of National Curricular Framework at regular intervals should be kept.
- The Department of School Education & Literacy and NCERT should carefully study how other ancient civilizations/ countries teach their own histories to their respective citizens through textbook content, and areas of emphasis. The results of such a study should be used to improve our own history textbooks and teaching methods taking into consideration history at the grassroots level preferably at the district levels. Further, the State Boards may prepare district-wise history books that will impart knowledge about local historical figures to the students.
- The NCERT should consider the suggestions received by this Committee, while framing the NCF and syllabus of the textbooks. For avoiding content overload on students, NCERT in collaboration with SCERT should identify State-specific historical figures for inclusion in respective SCFs. Efforts may also be made to incorporate and highlight the contributions of the numerous local personalities in various fields in State curriculum.
- The NCERT and SCERT should incorporate the ancient wisdom, knowledge and teachings about life and society from Vedas and other great Indian Texts/ Books in the school

curriculum. Also, educational methodologies adopted in the ancient Universities like Nalanda, Vikramshila and Takshila should be studied and suitably modified to serve as a model reference for teachers so as to benefit them in improving their pedagogical skills for imparting education in the present day context.

- Contributions of ancient India in the fields of Philosophy, Science, Mathematics, Medicine, Ayurveda, Epistemology, Natural sciences, Politics, Economy, Ethics, Linguistics, Arts, etc may also be included in the textbooks. The traditional Indian knowledge systems should be linked with modern science and presented in the contemporary context in NCERT textbooks.
- New technologies should be adopted for better pedagogy for the education of History. Further a permanent mechanism to make suitable rectifications through additions or deletions in the textbooks in a structured manner needs to be established.
- All books especially history books other than published by Government agencies used for supplementary reading may be in consonance with the structure/ content of NCERT books to avoid discrepancies. Also, Ministry of Education should develop a monitoring mechanism for ensuring the same.
- There is a need for discussing and reviewing, with leading historians, the manner in which Indian freedom fighters, from various regions/parts of the country and their contributions get place in History textbooks. This will result in more balanced and judicious perception of the Indian freedom struggle. This will go a long way in giving due and proper space to the freedom fighters hitherto

unknown and oblivious in the freedom movement. Review of representation of community identity based history as of Sikh and Maratha history and others and their adequate incorporation in the textbooks will help in a more judicious perspective of their contribution.

- In order to address the underrepresentation of Women and girls in school textbooks or them being depicted only in traditional roles, a thorough analysis from the view point of gender bias and stereotypes should be undertaken by NCERT and efforts be made to make content portrayal and visual depiction gender inclusive. The textbooks should have greater portrayal of women in new and emerging professions, as role models with a focus on their contributions and pathway of achieving the same. This will help in instilling self-esteem and self confidence among all, particularly girls. Also, while examining the textbooks, other issues like environment sensitivity, human values, issues of children with special needs etc can also be looked up for adequate inclusion in the School textbooks.
- The significant role played by women in the freedom movement and in various other fields needs adequate representation in the textbooks as it would go a long way in understanding the issues in a better way for the next generation of students.
- One of the major social ills afflicting our society in the present times is the malaise of drug addiction cutting across the class divide. It has far-reaching adverse effects on the socio-economic structure of the country, and that concerted efforts are required to be made by the government agencies as well as the civil society to combat this menace. As part of these efforts, the ill effects of such addiction must be

adequately and suitably highlighted in strong words, in the content of school text books to caution the impressionable young minds of students against falling prey to luring tactics of anti-social elements and resulting in waywardness. Similarly, the textbooks should have separate elements spreading awareness against internet addiction and other such aspects that are harmful to the society.

- Taking into account the voluminous number of suggestions received from teachers, students, Institutions for updating the syllabus of NCERT textbooks incorporating various subjects, an internal Committee be set up by Ministry of Education and NCERT to examine the suggestions so received and incorporate the same in curriculum as deem fit.
- All NCERT and SCERT textbooks must be published in all Eighth Schedule languages of the Constitution of India, besides Hindi and English. Further, efforts for developing textbooks in local languages (those not part of the Eighth Schedule) be also made. These will help the children in understanding the subjects better as the content will be in their mother tongue.
- To supplement the textbook content, field visits/ excursions should be introduced as a compulsory part of learning experience. As an initiative in this regard, textbooks can introduce a “Box Format” near the name of the place being mentioned stating the importance of that place whether religious, historical, etc. promoting the readers to visit it. This would further promote North-South and East-West integration.



Chapter–3

NEP & DEVELOPING NEW TEXT BOOKS¹

Prof. Chand Kiran Saluja

Director, Sanskrit Promotion Foundation, New Delhi

Prof. Chand Kiran Saluja emphasizes upon the various aspects of New Education Policy- 2020 such as building a culture of reading across the country. NEP-2020 has focused upon the development of curriculum, syllabus and textbook and it envisions a new way of learning which is not merely text book focused. Earlier, NCF 2005 had also mentioned that learning should be active rather than textbook centric only. Textbooks as a single source of education are not enough; they are important but are not only a teaching material. Therefore, a large number of packages should be developed at State and District levels with adequate provision for cluster and school level modifications and supplementary materials. To understand a textbook one needs to understand the curriculum and the aims of education. The present-day classroom practices

1 Based on the Keynote Address delivered by Prof. Chand Kiran Saluja in the Preparatory Workshop on Textbooks: Indian Knowledge System and Languages organized by VBUSS on 3rd & 4th February, 2022 and Keynote Lecture in the Two-day National Workshop on Sanskrit in the light of NEP 2020 & Indian Knowledge Systems organized by Central Sanskrit University, Delhi and Shri Lal Bahadur Shastri National Sanskrit University, Delhi on 4th & 5th June 2022.

are, in almost all schools of the country, totally dominated by the textbook. As a result, it has acquired an aura and a standard format. What is needed is not a single textbook but package of teaching learning method and material that could be used to engage the child in active learning. The textbook thus becomes a part of this package and not just a teaching learning material e.g., it connects the past with the present and should lead to experiential learning which means taking classroom to the field and vice versa. Therefore, a large number of packages should be developed at state and district levels with adequate provision for cluster and school level modifications and supplementary materials. This essentially means establishing proper coordination between the textbook designing committees at national and regional levels. The establishment of NCERT and SCERT are the part of this purpose only. The cluster system envisaged in the NEP, 2020 is also a part of this exercise. The availability of a number of alternative TLM packages of approved quality to the increased choice of the teachers may go a long way in introduction of IKS. To understand the textbook, one must understand the relationship between the curriculum and aims of education. There is a difference between curriculum and syllabus. The syllabus is something that is taught to the student in the classroom but curriculum involves vast level of activities including the syllabus. In simple terms, the curriculum starts from the moment a student enters the school environment and continues to be involved into till the end of the school hours and thereafter too in the form of doing various activities given by the teachers. Part I of the NEP, 2020 document outlays various objectives of education.

Textbooks are to be prepared based on certain pre-suppositions in relation to imparting of education and these presuppositions are guided by social, physical and psychological aspects of learners.

- The presentation of the textbook should be organized keeping certain things in mind such as what should be the topic of a lesson, how should study be conducted, how should vocabulary related to the lesson be organized etc.
- The objective of the textbook should not aim at merely addressing the curiosity in the minds students alone but also to create more curiosity among them. Therefore, the preparation of the textbooks should aim at invoking curiosity in the minds of learners.
- Textbook is an instructional material. It is not only for teaching but for learning as well. Therefore, textbooks should be designed keeping teaching-learning textual material based on a teaching model in mind.
- We must collect material for the preparation of textbooks first. As envisaged in the NEP, 2020, such material useful for the preparation of textbooks should be able to establish proper explanation of the idea to be taught, should be able to invoke thinking process among children, the textbook should be able to develop critical faculty among students and they should highlight Indianness or Indian values embedded in them.
- A Teaching Model essentially means designing educational activities and situations (classroom situations to learn).
- Constructive Teaching Learning Situation: NEP 2020 in its part 4 maintains that textbooks should not be an exercise of merely providing answers to the questions but students should be enabled to find out answers to the questions in their minds. Constructive approach used in NEP document means students should be equipped to find out answers that are already in their minds through the means of textbooks. NEP document says education should move towards less content and more towards learning about how to think critically and solve problems, how

to be creative and multidisciplinary, and how to innovate, adapt and absorb new material in novel and changing fields.

- Pedagogy must evolve to make education more experiential, holistic, integrated, inquiry driven, discovery oriented, learner-centric, discussion based, flexible and of course, enjoyable.
- Education should evolve into a process that recognizes, accepts and develops the potential of the learner.
- This must also be born in mind that while teaching, a teacher is not merely teaching in the classroom but he/she is also learning from the experiences of his/her students which he/she can bring in use for teaching the next batch of students. Part 4 of the NEP 2020 also emphasizes on art oriented and play oriented ways of teaching-learning process. Art cannot be understood only in terms of narrow understanding like drawing but seeing and perceiving things with different aspects associated with a particular issue is also an art.
- Textbooks should be prepared by drawing connections between cause and effect related to a particular issue as well.
- Activities prescribed for students should not be merely individual student centric but they should also develop group behavior among them. The NEP too has said that such activities will help students to keep in tune with the developments of the 21st century and should imbibe constitutional values among students, e.g., fundamental duties, environmental concerns etc.
- Approach to preparing textbooks should not be followed in isolation but must have an inter-disciplinary approach for example, textbook preparing committees on science, social sciences and languages should come together and device strategies in this regard.

- Textbooks for students should enable them not to learn what's being taught in the classroom for that moment or year alone but they should develop the sense of learning things continually.
- Thus, textbook should inculcate the thoughts and ideas on social justice, equality, scientific development, and national unity, cultural preservation of India, developing wholesome personality, developing resources to their fullest and using them in sustainable ways.
- Section 4.31 of the NEP provides for developing textbooks at national level keeping local issues and local aspects in the center stage. It lays emphasis on the constructive approach based on the discussions, explanations and utility of the learnt knowledge in practical life. It also talks of including supplementary material in the textbooks. It also talks of including bunch of books derived from the national and local sources.
- The reduction in content and increased flexibility of school curriculum renewed emphasis on constructive rather than rote learning. This must be accompanied by parallel changes in school textbooks. All textbooks shall aim to contain the essential core material (together with discussion, analysis, examples and applications) deemed important on a national level, but at the same time contain any desired nuances and supplementary material as per local contexts and needs. Wherever possible schools and teachers will also have choices in the textbooks they employ from among a set of textbooks that contain the requisite national and local material - so that they may teach in a manner that is best suited to their own pedagogical styles as well as to their students and communities' needs.
- Section 4.32 of the NEP provides for coordination between NCERT and SCERT to develop textbooks in various

languages spoken in India. They must derive from the sources across regions in India. “The aim will be to provide such quality textbooks at the lowest possible cost -namely, at the cost of production/printing - in order to mitigate the burden of textbook prices on the students and on the educational system. This may be accomplished by using high-quality textbook materials developed by NCERT in conjunction with the SCERTs; additional textbook materials could be funded by public-philanthropic partnerships and crowd sourcing that incentivize experts to write such high-quality textbooks at cost price.

- States will prepare their own curricula (which may be based on the NCFSE prepared by NCERT to the extent possible) and prepare textbooks (which may be based on the NCERT textbook materials to the extent possible), incorporating State flavour and material as needed. While doing so, it must be borne in mind that NCERT curriculum would be taken as the nationally acceptable criterion. The availability of such textbooks in all regional languages will be a top priority so that all students have access to high-quality learning. All efforts will be made to ensure timely availability of textbooks in schools. Access to downloadable and printable versions of all textbooks will be provided by all States/UTs and NCERT to help conserve the environment and reduce the logistical burden.”
- Section 4.33 provides for “Concerted efforts, through suitable changes in curriculum and pedagogy, will be made by NCERT, SCERTs, schools, and educators to significantly reduce the weight of school bags and textbooks.
- In this regard, it’s important to look at 1992 Committee Recommendations on how should the textbooks be also the 2005 NCF recommendation on the curriculum.

- Textbooks should include topic, role of the concerned topic, syllabus, self-study material, pictorial representations, structuralism, experiential learning, communication, students' participation, empowering teachers, culture, constitutional values, skills required for the 21st century, research aptitude, supplementary books etc.
- Education should be the process of humane learning presupposing a specific social nature and a process by which children grow into the intellectual life for those around them.
- Education should enable the child to look at the environment around her/ his in a holistic manner and does not compartmentalize any topic into science and social science.
- Therefore, an attempt should be made in the textbook so that it will help a child to locate every theme in physical, social and cultural contexts critically so that the child can make informed choices in his/her life.
- The challenge in relation to writing a textbook at national level lies in the fact that it should reflect the multicultural dimensions of the Indian society. Every effort should be made to include every community in the country giving due space to their culture and way of life so that all of them feel important.
- The position paper by the textbook preparation committees previously constituted had observed that- While writing textbooks.....“who is the child we are addressing was the big question. Does a child study in the big of school of the metro city or the school in the slums, a small-town child, one in village school or one in the remote mountainous areas? One also needed to tackle the difference of gender, class, culture, religion, language, geographical locations etc. These are some of the issues addressed in the book, which the teacher will also

have to handle sensitively in her own ways.” While preparing textbooks these issues of concern must be deliberated over.

- There is need to inculcate the habit of reading among our students and for that to happen the books must be prepared in a way that they become attractive for them.
- We need to pay attention to the section 4.35 of the NEP in this regard. It says, “The progress card of all students for school-based assessment, which is communicated by schools to parents, will be completely redesigned by States/UTs under guidance from the proposed National Assessment Centre, NCERT, and SCERTs. The progress card will be a holistic, 360-degree, multidimensional report that reflects in great detail the progress as well as the uniqueness of each learner in the cognitive, affective, and psychomotor domains. It will include self-assessment and peer assessment, and progress of the child in project-based and inquiry-based learning, quizzes, role plays, group work, portfolios, etc., along with teacher assessment. The holistic progress card will form an important link between home and school and will be accompanied by parent-teacher meetings in order to actively involve parents in their children’s holistic education and development. The progress card would also provide teachers and parents with valuable information on how to support each student in and out of the classroom. AI-based software could be developed and used by students to help track their growth through their school years based on learning data and interactive questionnaires for parents, students, and teachers, in order to provide students with valuable information on their strengths, areas of interest, and needed areas of focus, and to thereby help them make optimal career choices.” These issues must be kept in mind while preparing textbooks.

- The interdisciplinary approach of seeking knowledge is not new to us in India. The Sushrutsamhita has quite elaborately spoken about it in the following words-

एकंशास्त्रमधियानो न विद्याछास्त्रनिश्चयं
 तस्माद् बहुश्रुताः शास्त्रंविजनीयचिकित्स्काः
 शास्त्रंगुरुमुखोदीर्णमादायोपास्य चासकृत
 यः कर्मकुरुतेवैद्यः स वैद्योन्य तू तस्कराः
 (सुश्रुत संहिता सूत्रस्थानम. 6-8)

- Our education should make students competent, experienced and capable enough to expand their knowledge on their own. While writing books, the interests of all students of society belonging to different gender, class, culture, religion and geographic locations should be kept in mind.
- The textbooks should be structured primarily in the five parts, viz. 1. Curriculum or syllabus as per our educational needs and objectives. 2. Collection of the material and its sequencing or sorting for the intended purpose, for example, the collected material can be used for designing syllabus of various classes. 3. Evaluation of the utility of the syllabus or curriculum. 4. Presentation of the collected material in the textbooks and 5. background checking meaning whether there is any need for further improvement in the designed books and its syllabus (पतिपृष्टि). It has been very beautifully said in the Indian knowledge traditions in the following shloka of Shukarhasyopanishad-

श्रवणं तु गुरोः पूर्वं मननं तदनन्तरम् ।
 निदिध्यासनमित्येतत् पूर्णबोधस्य कारणम् ॥
 (शुकरहस्योपनिषद्)
 श्रवण > मनन > निदिध्यासन



**THE VISION OF NEP 2020: INTEGRATING
BHARTIYA KNOWLEDGE SYSTEM IN
COMPUTER SCIENCE/I.T. -
WORKSHOP REPORT**

India enjoys a rich heritage of ancient knowledge which has played an important role in molding the consciousness and conscience of the nation. The National Education Policy 2020 calls for intellectual brainstorming with an aim to conserve, develop, introduce, promote and disseminate these knowledge paradigms. Keeping this in focus, Vidya Bharati Uchcha Shiksha Sansthan (VBUSS) has undertaken the onerous task of understanding the relevance of the knowledge and societal applications of Indian knowledge System in the field of information technology also. In this context a National Workshop on “Computer Science/I.T. in the light of NEP 2020 & Indian Knowledge Systems’ was organized by VBUSS in collaboration with Department of Computer Applications, National Institute of Technology (NIT), Kurukshetra, School of Engineering (JNU) and Software Technology Park of India(STPI) in NIT Kurukshetra on 25th & 26th May, 2022.

The main objective of this Workshop was to create awareness about the implementation of the National Education Policy 2020 among teachers, students and Society and to develop approach papers for the National Curriculum Framework. Additionally, it sought

to understand the policy parameters of curriculum modification, the shift in the pedagogical skills, and its implementation for a 360-degree holistic development of all stakeholders. The Workshop was attended by delegates from all regions of the country, faculty members, school teachers, students, and research scholars working in computer applications. Renowned speakers and delegates from academia engaged in brainstorming shared their expertise and domain knowledge. Some of the academicians who graced the workshop were Prof. B.V. Ramana Reddy, Director of NIT Kurukshetra, Prof. Binod Kumar Kanaujia, Director, NIT Jhalandhar, Prof. Girish Nath Jha, School of Sanskrit and Indic Studies, JNU, Prof. Ashutosh Kumar Singh, Head, Department of Computer Applications, NIT Kurukshetra, Dr Lalit Mohan Goyal, YMCA Faridabad, Dr Aparna Lalingkara, Director, Aksharbrahma Consultancy for Research and Training in Educational Technology, Pune, Dr Gajendra Pratap Singh, Assistant Professor, JNU, Mr Aniruddha Singhal, a Researcher in TCS.

The following are the highlights of the workshop:

Day 1: 25 May 2022

The National Workshop commenced with the inaugural session attended by Prof. B.V. Ramana Reddy, Director of NIT Kurukshetra, as a keynote speaker and the Chief Guest. Prof. B. V. Ramana Reddy performed the lamp lighting ceremony and commenced the workshop program with Sarasvati Vandana and National Anthem. Prof. B.V. Ramana Reddy, Director, NIT Kurukshetra, emphasised that the education policy should be based on sustainable development. The results of education must be reflected in society. He mentioned that no country can become a superpower until education has social and practical learning. He showed his concern that skilled people from our country are migrating to other countries for livelihood, better work culture, and a good lifestyle. Parents are happy and assisting

the kids with this cause, and they do not feel bad, instead the parents show off that our kids are serving in foreign countries. He added that India is producing the best software developers, even better than China (which may be a leader in hardware development) in the world, and they are working for other countries. He also pointed that India is on the path to becoming a superpower in information technology. Our curriculum is more material-oriented and leads to more comfortable and material growth. He further suggested that mechanisms are required to reverse this brain drain process. Digital technologies have changed human behaviour and methods of social interaction. More virtual interaction through social media platforms and, in reality, family and social interactions are decreasing. He expressed that we have to revisit our ancient knowledge and discover how it can help in the advancement of any of the technological areas for sustainable development. Further, he emphasised a value-based education model instead of an outcome-based education model for materialistic development. He also stated the need to add humanity or spiritual values to the current curriculum of the students in order to inculcate some moral values among them. He explained that the outcome is based on three parameters, viz., making a good human being, the ability to earn bread, and entrepreneurship.

Session I

The first session after the inauguration was based on the title "Panni's Grammar and Computer Science." Professor Girish Nath Jha, a renowned speaker, delivered his speech. Prof. Girish Nath Jha from Jawaharlal Nehru University (JNU) clarified the concepts of Panini's grammar and complimented its usage in computer science. He argued that Panini was a Sanskrit philologist, grammarian, and revered scholar in ancient India dated between the 6th and 4th century BCE. Panini is considered as the "first descriptive linguist and even labeled as "the father of linguistics". Pāṇini is

known for his text *Astadhyayi*, which consists of 3,959 sutras in eight chapters, which are each subdivided into four sections or *padas*. He emphasized that the text takes material from lexical lists (*dhatupatha*, *ganapatha*) as input and described algorithms to be applied to them for the generation of well-formed words. His treatise is generative and descriptive, uses metalanguage and meta-rules. Prof. Jha compared it to the Turing machine which is being used as the logical structure of any computing device. He argued that Panini saw how the intrinsic resources of the spoken Sanskrit of his time could themselves be used to formulate a metalanguage for exact description of Sanskrit as the object language. In this way, Panini created the first computing language and in oral form.

Certainly, this grammar can be used in the modern theoretical computer science. Prof. Jha complimented that how the theme of the modern programming language was drawn by an Indian saint before the 2700 years ago of the boring invention of the computers. He also explained *ASTADHYAYI*, which is a collection of the grammar rules defining the structure and the syntaxes of the Sanskrit language. Prof. Jha argued that gradually panini's grammar gave rise to the Saussure, bloomfield, Chomsky and Backus Naur Form and panini's technique and notations described new programming languages like ALGOL and eventually to intelligent computing, web, resources and big data. So, there is a huge potential for multidisciplinary and exploiting overlapping methods especially in India because of its diverse and multilingual society. Furthermore, he suggested that current focus of India in academics and various industries in the diverse areas needs to be revised.

Session II

Second session was on the "Role of New Education Policy In Computer Education" addressed by Prof. Ashutosh Kumar Singh, Head of the Department of Computer Applications. At

the beginning of the session, Prof. Ashutosh explained after-independence education policies, followed by NEP-2020 in detail. He added that National Education Policy 2020 envisions an India-centric education system that contributes directly to transforming our nation sustainably into an equitable and vibrant knowledge society with the aim to provide high-quality education to all. He explained that the major points of NEP 2020 such as coding to be taught from class 6th onwards, providing e-content in regional languages, multiple entries and exit in study programs. He added that the Central Government is planning to setup a new Indian Institute of Translation and Interpretation (IITI) in line with the recommendations of the New National Education Policy NEP 2020. National Research Foundation (NRF) is emphasizing to become a multidisciplinary institution. It can be materialized by strengthening the Central Advisory Board of Education, Financing Affordable and Quality Education for all and the last one which is very essential is implementation. Further, he highlighted on the role of computer/ICT in NEP through online teaching platforms like SWAYAM, DIKSHA etc and to supply teachers with a structured, user-friendly, rich set of assistive tools for monitoring the progress of learners.

Session III

Third session was based on “Adoption of IKS in Computer Science books: Challenges and Importance” addressed by Dr. Lalit Mohan Goyal, YMCA, Faridabad. In his session, he focused attention on the Bharatiya Knowledge System (BKS) in schools. He argued that BKS comprises of three things: one is the training of the mind, second is process of thinking and the last one is acquisition of knowledge. He said that main objectives of ancient study is to live and let others live in peace and harmony not only among human being but with other creatures and nature. Secondary objective is

to make the students ready to live in adverse conditions of the life. He explained that our modern education provides knowledge and skills which help the student to be employable so making them career ready but not ready for the future challenges of life. Further, he added the views on course curriculum of computer science in schools. He argued that we should teach our student for first five years (No Computer Book) by playing Indian games on computer and by Indian rhymes and Stories for strengthening their belief in honesty, social and ethical behaviour and making them spiritual. Next six years we should use computers as a learning tool and in high level schooling we should use computer as research and application tool but opined that curriculum design is the major challenge for the schools.

Day 2: 26 May 2022

Session I

On the second day, the opening session was addressed by Dr. Aparna Lalingkar, a mathematician and an educational technologist on “Changes required in current CS books”. She discussed about the rich Indian heritage. Further various guidance suggestions were given to school teachers for effective implementation of NEP-2020. She emphasised on the requirement to update computer Science books, teaching methods and learning methods to overcome the shortcomings they have at present moment. At the end of the session, various tips and tricks were discussed to acquire and enhance innovative skills among students. She suggested that books should be written in regional languages to make concepts more understandable to students. She also suggested that the institutes to teach regional languages can be established in every state, and translator universities can be set to translate the regional research work for national and international validation.

Session II

Further, the next session was addressed by Dr. Gajendra Pratap Singh, Assistant Professor, JNU Delhi, who enlightened the delegates on the contrast between “Pingala System And Modern Number Systems”. He emphasized that understanding of Pingala system can provide impetus to the development of Indian vedic mathematics into computers. He argued that ancient Indian prosodist and mathematician Pingala was the first to develop and use the binary number system while studying and analyzing Sanskrit poetic meters (chandas) in his work Chandahshastra composed around 3rd century BCE. Letters in Sanskrit can be either long (Guru (G)) or short (Laghu (L)) syllables. These two types of syllables are the basic building blocks of Sanskrit prosody as well as current technology based digital computers. He explained that a verse in classical Sanskrit literature has four quarters or pada in a stanza. The metre of a verse is determined by the number of syllables (G/L) and their order of arrangement in a quarter. He also added that replacing G with 0 and L with 1 we get our modern number system. He attributed the development of the Fibonacci number and the binomial theorem for index 2 to Pingala. He inspired that learning from the ancient Pingala system is still relevant in modern computer technology.

Session III

Next session was addressed by Mr. Aniruddha Singhal, Researcher in TCS on “Vedantic Logic: Artificial Intelligence And Computer Science”. He discussed how vedic philosophy can help in solving the new world’s problems, where bivalued logic is no longer valid. Moreover, he talked about how a vedic logic system i.e. trivalued or multivalued can be used to investigate various problems like that of fuzzy system.

Open House and Valedictory Session

The open house discussion was chaired by Prof. Binod Kumar Kanaujia, Director NIT Jalandhar. Valedictory session was presided by Prof. Akshilesh Swarup, Director (Acting), NIT Kurukshetra by felicitating the Chief Guest Prof. Binod Kumar Kanaujia, Director NIT Jalandhar. Dr. Aparna Lalingkara (IIIT Bangalore), Dr. Gajendra Pratap Singh (JNU Delhi), Prof. Sathans, Dean Academic, Prof. S M Gupta, Dean IIR, NIT Kurukshetra, Dr. Sandeep Kumar Sood, Dr. Gaurav Saini, Dr. Sarika Jain and Dr. Kapil (Department of Computer Applications, NIT K.), Dr. Arvind Sharma (Department of Electronics and Communication), Dr. Lokesh Jindal, JNU Delhi, faculty members from various departments, participants from various institutes, schools and research scholars were present during the valedictory function. Various agendas were discussed during the session. Dr. Sarika Jain queried how is it possible for students to study in their regional language while interstate migration, as there are numerous languages in India. In her answer, Dr. Aparna suggested that the institutes to teach regional languages can be established in every state and the translator universities can be set to translate the regional research work for national and international validation. Moreover, Dr Sandeep Kumar Sood expressed his opinion that regional languages are for better understanding of concepts in that region. It does not mean that good literature available in Hindi or English is being ignored. Dr. Binod Kumar Kanaujia also explained that regional language is to understand things fast since it is easy to understand things in local languages instead of English or any other language in which you are not comfortable. These regional languages are not to replace Hindi or English at all in NEP 2020.

One of delegate queried that why Indian students are still coding in foreign languages. In this response, Dr. Sandeep Kumar Sood argued that it does not matter who developed the language or compiler but logical skill matters. Since software developers have to work

globally with different countries software developers and compilers available in English are good means even to write codes to solve any regional problem. Dr. Binod Kumar Kanaujia complimented that logic is quite strong in Indian students and added that they are leaders in software development and are working throughout the globe in all companies of repute. Another delegate queried that when we will move from theoretical education to practical oriented concepts. In response to this query Dr. Sandeep Kumar Sood added that the government of India is keen to put theoretical and logical concepts practically and they are doing it in many scenarios like Fast tag can be used to locate the vehicle, overall toll collection, crime detection. Similarly, multiple usages of the Adhar card can be explored for population count, income tax collection, land records, GST collection and many more applications. Dr. Binod Kumar Kanaujia further added that NEP 2020 emphasised on practical-based education. Further one of delegate asked why we did not prefer the Indian author books or regional books in higher education. In its response, Dr Gaurav Saini elaborated that already steps have been taken to provide higher education books in regional languages by our concerned agencies. Dr. Gajendra Pratap Singh complimented that there are number of many good books written by Indian authors. Dr. Kapil added that there is a lack of publicity of Indian writers' content which is even sometimes much better than foreign writers. Moreover, the new edition of books are needed to be updated using errata and accordingly refinement has to be done to make books error-free. Prof. Sathans ellobrated the merits of NEP 2020.

The workshop was ended with vote of thanks by Dr. Gaurav Saini from NIT Kurukshetra.



DEVELOPING NEW TEXT MATERIAL IN COMPUTER SCIENCE: AN APPROACH PAPER

Introduction

This chapter aims to initiate an intellectual discourse on some of the threads that may be used for weaving a new framework for computer science education in schools to fulfil the mandate of NEP 2020. The chapter first outlines the importance of computer science education as per NEP 2020. It also provides the scope of possible pedagogical innovations. It further sets the objectives of incorporating Bharatiya Knowledge System (BKS) in computer science textbooks and contours the expected outcomes.

Importance of Computer Science Education as per NEP 2020

NEP recognizes the importance of rapid global changes in the scientific and technological domains. The policy document cites the rise of big data, artificial intelligence, blockchains and machine learning as the upcoming new technologies that will lead to an explosive demand for a skilled workforce with computer and data science skills. It would entail developing multidisciplinary skills across science, humanities, and social science streams for collaboration, addressing issues, solving problems and meeting global needs. It

posits that nation-building and development of India will require a renewed vigour for digitization requiring computer skills. Naturally, it will require revision in the school curriculum.

As per NEP 2020, the Curriculum and Pedagogic reform required for school education aim at holistic development. NCERT recommends four focus areas for it, namely

- (a) Imparting 21st Century Skills
- (b) Manifestation of Knowledge as Perfection
- (c) Abandonment of Rote Learning
- (d) Grooming productive human beings relevant to Society.

The strategy is to engage in Curriculum and Pedagogical reorientation through identification of and involvement in core skills and value-sets. These would need to be integrated at each stage of learning, requiring the development of appropriate frameworks and transaction mechanisms. The paring of curriculum would pave the way for critical thinking, holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning.

This requires adopting a 5+3+3+4 structure, with the last stage or secondary stage focusing on multidisciplinary study, development of critical thinking and flexibility of learning across disciplines.

NEP 2020 contemplates and sets out the importance of computer science education. Coding and computational thinking may be utilized in computer science to solve everyday real-life problems. As an illustration, students may be asked to solve the traffic problems for their specific neighbourhoods. It would entail learning multidisciplinary skills such as geographical skills, the study of psychology of commuters, sociological behaviour, usage of computational coding skills and development of algorithms, levy of fees and changes from the study of Economics, the effect of slope of the road from Physics etc. It would require the student to move across disciplines and streams freely. NEP 2020 envisages curricular

integration of essential subjects, skills and capacities. As per para 4.23 of NEP 2020 certain subjects, skills, and capacities should be learned by all students to become good, successful, innovative, adaptable, and productive human beings in today's rapidly changing world including coding and computational thinking. Para 4.25 recognizes mathematics and mathematical thinking will be very important for India's future and India's leadership role in the numerous upcoming fields and professions that will involve artificial intelligence, machine learning, and data science, etc. In light of it mathematics and computational thinking will be given increased emphasis throughout the school years, starting with the foundational stage, through a variety of innovative methods, including the regular use of puzzles and games that make mathematical thinking more enjoyable and engaging. Activities involving coding will be introduced in Middle Stage.

The specific pedagogical and curriculum reorientation required in such "learning" can be inspired and incorporated from the methods employed in our ancient knowledge and education system focused on imbibing "transversal competencies". The traditional System beautifully demonstrates the weaving of skill-based learning with values of sustainability, humanity and morality to impart "holistic learning".

Along similar lines, a highly customized, broad-based and humanistic education system focused on practical problem solving can be evolved for the present education system. This is what the national curriculum framework demands when it recommends a shift of classroom transactions towards competency-based learning and education and coverage of "indigenous and traditional ways of learning". It entails an introduction to practical-oriented contemporary subjects such as Artificial Intelligence, Design Thinking, Organic Living, Environmental Education etc., in the earlier stages. As teaching is revamped, it will naturally transform

assessment for student development. The proposed National Assessment Centre, PARAKH (Performance Assessment, Review, and Analysis of Knowledge for Holistic Development), will be instrumental. NEP 2020 proposes to set up PARAKH as a standard-setting body which sets norms, standards, and guidelines for student assessment and evaluation for all recognized school boards of India. It also guides the State Achievement Survey (SAS) and undertakes the National Achievement Survey (NAS), monitoring achievement of learning outcomes in the country. Further it encourage and helps the school boards to shift their assessment patterns towards meeting the skill requirements of the 21st century. Implementing such a vision requires the development of capacity and capability building of Teachers and Teacher trainers. It would require developing advocacy and training material in the multilingual medium.

Pedagogical Innovations & Presentation

This section explores the scope of possible pedagogical innovations as per NEP 2020. India enjoys a rich heritage of ancient knowledge and its scientific dissemination. The interface of "knowledge" and "Education" is unique to the central tenets and Ethos of the traditional Indian education system. It provides a transformative learning experience to students that not only aims at knowledge inculcation but simultaneously holistically develops skills and personality. It incorporates human values, ethics, morality, and sustainability in learning. The concept of *Bhartiyata* embodies and promotes the notion of *Vasudhaiva Kutumbakam* as an essential paradigm of learning.

The present education system requires moving beyond conventional categories of thought. It needs nourishment by revisiting and incorporating the roots. Only a revitalized education system can help us appreciate the richness of our heritage and its utility in addressing critical issues faced by modern Society. A new

education system would play an essential role in moulding the consciousness and conscience of the nation.

NEP 2020¹ focuses on capacity building to incorporate the required changes as part of the reform process of the present education system. It will include in its ambit the following elements:

- Adopting innovative mechanisms to group or rationalize schools.
- Adequate number of counsellors/trained social workers and teachers (shared or otherwise) for teaching all subjects
- Adequate resources (shared or otherwise)
- Building a sense of community is built to overcome the isolation of teachers, students, and schools.

It also focuses on capability building on the following parameters:

- Joint professional development programmes, sharing teaching-learning content, joint content development, and joint activities.
- Cooperation and support across schools for the education of children with disabilities.
- Improving governance of the schooling system as an integrated semi-autonomous unit.
- Adopting new technologies involving artificial intelligence, machine learning, blockchains, smart boards, handheld computing devices, adaptive computer testing for student development, and other educational software and hardware forms.²
- Adapting to emerging disruptive technologies that will necessarily transform the education system.³

1 Para 7.5 of NEP 2020

2 Para 23.2 NEP 2020.

3 Para 23.7 NEP 2020.

Aims of The Incorporation of BKS In Computer Science Text Books

Para 4.27 of NEP 2020 recommends incorporation of BKS or “Knowledge of India” into the school curriculum. It includes knowledge from ancient India and its contributions to modern India and its successes and challenges, and a clear sense of India’s future aspirations with regard to education, health, environment, etc. It entails inclusion and coverage of ancient knowledge, indigenous and traditional ways of learning in mathematics, astronomy, philosophy, yoga, architecture, medicine, agriculture, engineering, linguistics, literature, sports, games, as well as in governance, polity, conservation. Certain objectives may be met by incorporation of BKS into the informationtechnology/computer science text books prescribed in the school curriculum.

1. Introduction, development, promotion, dissemination and conservation of the ancient knowledge paradigms in Computer Science.
2. Understand the relevance of the knowledge and societal applications of Sanskrit in the field of Computer Science.
3. Inculcate the identified elements of ancient knowledge systems in the school computer science curriculum.
4. Identify the primary texts to be used as source material for the curriculum.
5. Deliberate on the emerging computer science trends and analyze ancient knowledge systems' role in addressing them.
6. Develop a conceptual understanding of the grammatical structure of Sanskrit, its procedural fluency and its application in evolving new perspectives in computer science education.
7. Implement the objectives of NEP 2020 by working on and

- redesigning textbooks, curriculum, pedagogy and existing methodologies in computer science education.
8. Collaborate and coordinate to promote interdisciplinary research involving computer science and other modern disciplines.
 9. Develop an interdisciplinary interface of knowledge, expertise and experiences in curriculum enrichment.
 10. Incorporate historical perspective and pride in our heritage and develop contemporary insights for global applications in the subject.

Learning Outcomes for the Students

1. Better understand ancient knowledge systems' relevance to the computer science field.
2. Learn to implement alternative methods to encode and process information.
3. Promote knowledge of indigenous experiential learning relevant to Indian Society.
4. Learn to incorporate sustainable development in modern technological areas.
5. Inculcate and cultivate “*Bharatiyata*”.
6. Spiritual and social progress through value-based learning.



THEMATIC HIGHLIGHTS

This chapter is devoted to sketching out the specific thematic highlights for integrating BKS into the textbook curricula. Four specific themes may be included in the Computer Science Textbooks at the 11th and 12th levels. These are namely

- Theme I *The interface between Panini's Grammar and Computer Science*
- Theme II *Relevance and application of Pingala's System into modern computing*
- Theme III *Integration of Bharatiya Knowledge System in Computer Science Textbooks*
- Theme IV *Importance of Sanskrit in Computer Science & Natural Language Processing*

Theme I: *Interface between Panini's Grammar and Computer Science*¹

It focuses on outlining the interface between Panini's Grammar and Computer Science. Panini a Sanskrit philologist, grammarian and revered scholar in ancient India is considered the first descriptive linguist and often labelled as "the father of linguistics". Pāṇini is

1. This section on Panini's Grammar and Computer Science is adapted from the address of Prof. Girish Nath Jha in the Workshop on "Computer Science/I.T in the light of NEP 2020 & Indian Knowledge Systems" at NIT.K.

known for his text *Aṣṭādhyāyī*, which consists of 3,959 sutras in eight chapters, each subdivided into four sections or *pādas*. Material was taken from lexical lists (*dhātupāṭha*, *gaṇapāṭha*) and applied algorithms for the generation of well-formed words. His treatise is generative and descriptive and uses meta-language and meta-rules.

It can be compared with the Turing machine which describes the logical structure of any computing device. Panini work demonstrates how the intrinsic resources of spoken Sanskrit could be used to formulate a meta-language for a detailed description of Sanskrit as the object language. In this way, Panini created the first computing language in oral form. Panini's System is more formal and consists of largely straightforward procedures leading to more accessible programming.

Application in Computer Science

- Ancient Indian grammatical rules can be used in modern theoretical computer science. The students may be acquainted with the theme of the current programming language drawn by an Indian saint 2700 years before the invention of the computers. Panini's technique and notations and the idea and method of describing natural language (or programming languages) exactly using re-write rules preceded the practices employed by new programming languages. There is a vast potential for multidisciplinary and exploiting overlapping methods, especially in India because of its diverse and multilingual Society..
- Panini impacts core areas of linguistics and computing. In the present context, Computer language is a formal language with its syntax and vocabulary to represent knowledge in a step-by-step process or algorithm. Panini's grammar incorporates the same characteristics. *AṢṬĀDHYĀYĪ* is a collection of grammatical rules on the structure and the syntaxes of the Sanskrit language.

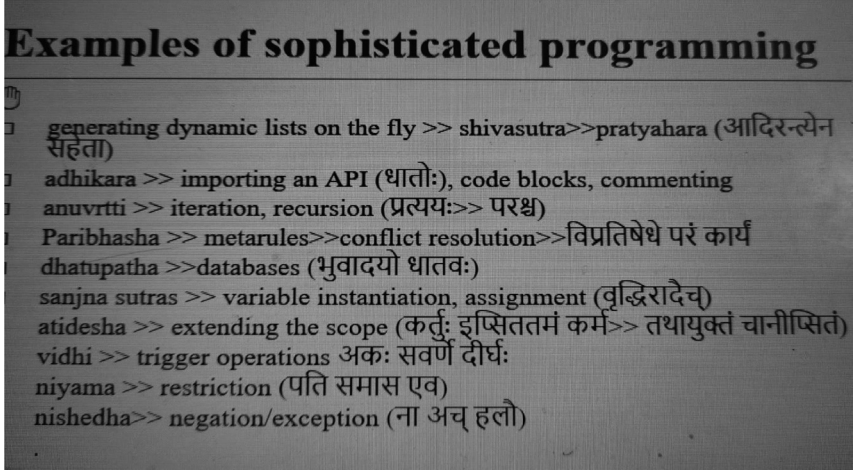


Figure I: Examples of sophisticated programming in BKS

The students can be shown how the work of Ferdinand de Saussure (a Swiss linguist who worked in both linguistics and semiotics) and John Backus (who introduced the Backus-Naur form, which is a mathematical way to describe a language) share similarities with the work of Indian scholars, who preceded them by thousands of years. For example unity of signifier-signified in the sign somewhat resembles the notion of Sphoṭa (Patanjali/Bhartṛhari).

Theme II: *Relevance and Application of Pingala's System in Modern Computing*

Piṅgala was an Ancient Indian mathematician who developed a binary number system to analyze Sanskrit poetic meters (*Chandaḥ*). He can be credited with creating the Fibonacci series and binomial theorem for Index 2. His most famous work was *Chandaḥśāstra* (छन्दशास्त्र). He assigned Sanskrit letters as *Guru* (G) *Laghu* (L) syllables as the basic building blocks of Sanskrit prosody. The same System is utilized for modern computing as well. Typically Sanskrit verses have four quarters

or *pāda*. The Classification of verses is determined by the number of syllables (G/L) and their order of arrangement in a quarter.¹ This pattern is known as a metre. The modern number system is similar if we replace G with 0 and L with 1. The same System is utilized for modern computing as well. Modern Computer technology can be further researched using the ancient Piṅgala system.

Application in Computer Science

- Pingala had developed an algorithm called *Prastāra*² (प्रस्तार meaning to unfold or to open up). In this procedure, all possible combinations of syllables of a given length can be generated sequentially (recursively). They were first starting with a sequence of 1 syllable. It is represented by a table of two rows, row 1 as G (Guru) and row 2 as L (Laghu), as shown in Table 1. If we replace G with 0 and L with 1, the representation is also shown in Table 1.

Table 1: Combination with 1 syllable

1	G	1	0
2	L	2	1

Every new sequence of increasing length can be obtained in two steps. In step 1, copy the previous array just below itself. In step 2, add one column with the upper half with G" s and the lower half with L"s.

Combination with 2 syllables: In step 1, the previous array is replicated below it (shown in Grey of Table 2). In step 2, one column is added with the upper half filled with 2 G" s and the lower half filled with 2 L" s, as shown in Table 2. Table 2 also indicates when G is replaced with 0 and L with 1.

1. Source: <https://cs.annauniv.edu/insight/Reading%20Materials/chhandas/pages/typepage.htm>.
2. Source: A History of Piṅgala's Combinatorics, Jayant Shah Northeastern University, Boston, Mass.

Table 2: Combination with 2 syllables

1	G	G
2	L	G
3	G	L
4	L	L

1	0	0
2	1	0
3	0	1
4	1	1

Combination with 3 syllables: In step 1, copy the previous array just below itself. And in step 2, one column is added to the right and filled the upper half of the column with 4 G "s and lower half with 4 L "s as shown in Table 3.

Table 3: Combination with 3 syllables

1	G	G	G
2	L	G	G
3	G	L	G
4	L	L	G
5	G	G	L
6	L	G	L
7	G	L	L
8	L	L	L

1	0	0	0
2	1	0	0
3	0	1	0
4	1	1	0
5	0	0	1
6	1	0	1
7	0	1	1
8	1	1	1

For the combination of large sequences, this procedure is repeated recursively. And if we replace every G with 0 and L with 1, we can get the pattern in a binary sequence.

Pingala's rule for binary conversion, लर्धे । सैके गु । (छन्दः शास्त्रम् 8.24-25)¹

- The procedure of conversion (Decimal number to binary) using the Pingala system (*Nasta*) is as follows:
 - Divide the number by 2. If perfectly divisible, then write 1 in the sequence. Otherwise, write 0.

1. Source: Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan, V.R. Bhat, Nagendra Prvana R.N.

- If the number is not divisible by 2, then write 0 and add 1 to the number, and divide by 2.
 - Repeat the procedure until the final remainder is obtained.
2. The procedure of conversion (binary to decimal) using the Pingala system (*Uddista*) is as follows:
- Start scanning of binary sequence from the right.
 - Search the first 1 in the sequence; multiply the current number by 2.
 - Move the scanner to the left; if the number is 1, multiply it by 2; if the number is 0, multiply it by 2 and subtract 1 from it.
 - Scan the sequence till the end.

Theme III: Integration of Bharatiya Knowledge System in Computer Science Textbooks

For the purpose of recommendation, a brief outline of the chapters of present NCERT books on Computer Science is given. Further suggestions are made and appropriate BKS elements have been delineated for incorporation.

a) Computer System¹

The present overview of the NCERT book chapter

- *Introduction to Computer Systems*: Introduces computer system, defines computer, and describes its components.
- *Evolution of Computer*: Evolution of Computer with a timeline showing key inventions in computing technology from 500BC to 1970. Examples of change from Abacus to Integrated Circuits.

1. Chapter 1, NCERT XI Textbook

- *Computer Memory*: specifies that a computer system needs memory to store the data and instructions for processing, units of memory, and types of memory.
- *Data Transfer between Memory and CPU*: focuses on transferring data between different components of a computer system.
- *Data and Information*: focuses on structured, unstructured and semi-structured data and data processing.
- *Microprocessors*: specifies that they have evolved in terms of their increased processing capability, decreasing physical size and reduced cost over time.
- *Software*: gives its definition, its need, explains system software, programming tools, Application software and open source software.
- *Operating System*: gives its definition, function and user interface.

Suggested approach for incorporation of BKS

Specific examples of contributions of ancient India and particular forms of computational systems may be integrated in this chapter. General examples of BKS can be added to the "Explore Yourself Section" given at the end of every chapter.

Few examples of BKS under this approach

- NCERT textbooks give the timeline showing key inventions in computing technology as given in Figure 2. Pascal 'invented a mechanical calculator known as Pascal calculator or Pascaline to do addition and subtraction of two numbers directly and multiplication and division through repeated addition and subtraction'. Pascaline can be related to Pingala's Algorithm *Meru Prastāra* as illustrated in Figure 3.

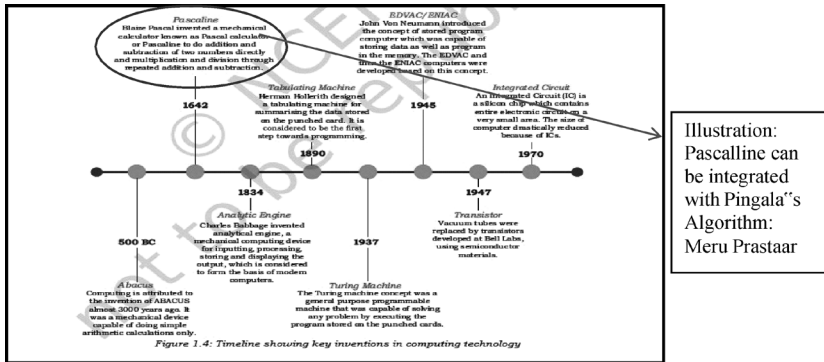


Figure 2: Timeline showing key inventions in computing technology¹

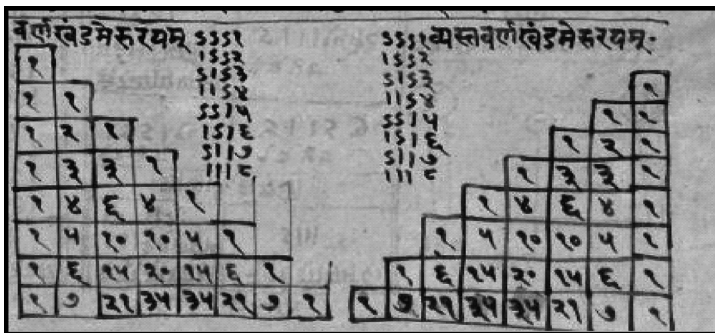


Figure 3: Meru Prastāra²

Similarly the timeline also mentions the Turing machine as ‘a general purpose programmable machine that was capable of solving any problem by executing the program stored on the punched cards’. *Aṣṭādhyāyī* distinguishes between usage in the spoken language and usage that is proper to the language of the sacred texts. The *Aṣṭādhyāyī* is generative as well as descriptive. The use of metarules, transformations, and recursions, make the *Aṣṭādhyāyī*'s grammar similar to the Turing machine, an idealized mathematical model that reduces the logical structure of any computing device to its essentials.³

1. Chapter 1, Computer System, NCERT XI Textbook
2. Source: https://commons.wikimedia.org/wiki/File:Meru_Prastaara.png
3. Source: <https://www.britannica.com/topic/Ashtadhyayi#ref1167413>

b) Number System¹

The present overview of the chapter

- *Introduction to Encoding:* Describes the text interpretation by computers and some of the encoding schemes.
- *UNICODE:* It has been developed to incorporate all the characters of every written language of the world. UNICODE provides a unique number for every character, irrespective of the device (server, desktop, mobile), operating system (Linux, Windows, iOS) or software application
- *Number System:* describes the decimal number system, binary number system, octal number system, hexadecimal number system and also the applications of the Hexadecimal Number System.
- *Conversion between Number Systems:* explains the conversion from decimal to other number systems and from other number systems to decimal number systems. It also explains converting the binary number to octal/hexadecimal and vice-versa. The conversion of a number with a fractional part is also explained.

Suggested approach for incorporation of BKS

- **Encoding:** Encoding is the process by which a messages is converted into codes. *Katapayadi* system, *Bhutasamkhya* system and *Aryabhata* numeration were used in India for recording numerals in Sanskrit words. For example The *katapayādi* (कटपयादि) system encoded numbers as words by substituting each digit with a character². Figure 4 shows the Sanskrit stanza giving the rule for this process.

1. Chapter 2, NCERT XI Textbook

2. Source: K. Lakshmi Priya and R. Parameswaran, A Study on the Encoding Systems in Vedic Era and Modern Era, International Journal of Pure and Applied Mathematics, Volume 114 No. 7 2017, 425-433.

नञावचश्च शून्यानि संख्याः कटपयादयः ।
 मिश्रे तूपान्त्यहल् संख्या न च चिन्त्यो हलस्वरः ॥

Figure 4: Sanskrit stanza describing *kaṭapayādi process*¹

In this system, letters ka (क), ṭa (ट), pa (प) and ya (य) is encoded by 1, kha (ख), ṭha (ठ), pha (फ), and ra (र) is encoded by 2 and so on as shown in Figure 5².

The rule is
 ka (क), ṭa (ट), pa (प) and ya (य) denote 1
 kha (ख), ṭha (ठ), pha (फ), and ra (र) indicate 2
 ga (ग), ḍa (ड), ba (ब) and la (ल) stand for 3
 gha (घ), ḍha (ढ), bha (भ) and va (व) symbolize 4
 gna (ङ), ṇa (ण), ma (म), and śha (श) represent 5
 ca (च), ṭa (ट), and sha (ष) stand for 6
 cha (छ), tha (थ), and sa (स) means 7
 ja (ज), da (द), and ha (ह) stand for 8
 jha (झ) and dha (ध) characterize 9
 nya (ञ), na (न) and all vowels means 0

Figure 5: *Kaṭapayādi encoding process*³

- In case of Number systems, Indian work may be incorporated and some of the specific recommendations are
 - Bhaskaracharya *Līlāvati* on decimal system and its place values may be introduced to the students. Figure 6 shows the Sanskrit verse of Lilavati of Bhaskaracharya explaining the place value of digits.

1. Source: K. Lakshmi Priya and R. Parameswaran, A Study on the Encoding Systems in Vedic Era and Modern Era, *International Journal of Pure and Applied Mathematics*, Volume 114 No. 7 2017, 425-433.

2. Id
 3. Id

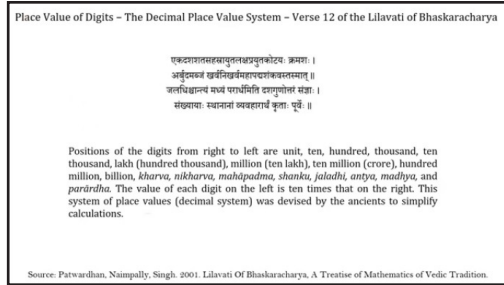


Figure 6: Place Value of Digits – Verse 12 of Lilavati of Bhaskaracharya¹

- Binary System by Ancient Indian prosodist and mathematician Pingala may be introduced to the students. He was the first to develop and use the binary number system while studying and analyzing Sanskrit poetic meters (*chandah* / छन्दः) in his work Chandahshastra composed around the 3rd century BCE. Letters in Sanskrit can be either long (*Guru* / गुरु स्वर (G)) or short (*Laghu* / लघु स्वर (L)) syllables. These two types of syllables are the basic building blocks of Sanskrit prosody. Figure 7 shows the Binary Numbers in Indian Antiquity.

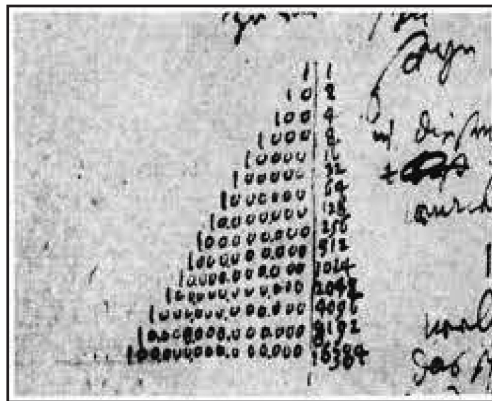


Figure 7: Binary Numbers in Indian Antiquity²

1. Source: Patwardhna, Naimpally, Singh 2001: Lilavati of Bhaskaracharya, A Treatise of Mathematics of Vedic Tradition
2. Source: Van Nooten, B. Binary numbers in Indian antiquity. J Indian Philos 21, 31–50 (1993). <https://doi.org/10.1007/BF01092744>

- After explaining the binary number system, Pingala's rule for binary conversion: लर्धे | सैके ग् | (छन्दः शास्त्रम् 8.24-25) may be introduced to the students. Figure 8 shows the sequence of binary conversion of decimal numbers by using Pingala's algorithm

Row/Index Number	Sequences of G and L
1	GGGGG
2	LGGGG
3	GLGGG
4	LLGGG
5	GGLGG
6	LGLGG
7	GLLGG
8	LLLGG
9	GGGLG
10	LGGLG
11	GLGLG
12	LLGLG
13	GGLLG
14	LGLLG
15	GLLLG
16	LLLLG
17	GGGGL
18	LGGGL
19	GLGGL
20	LLGGL
21	GGLGL
22	LGLGL
23	GLLGL
24	LLLGL
25	GGGLL
26	LGGLL
27	GLGLL
28	LLGLL
29	GGLLL
30	LGLLL
31	GLLLL
32	LLLLL

Figure 8: Binary Conversion by Pingala's Algorithm

- It may be incorporated that Pingala had developed a technique (*pratyay*, प्रत्याय) or algorithm called *Prastaar*

(प्रस्तार, meaning to unfold or to open up) for enlisting all the possible combinations of syllables for a quarter with length and letters.

Emerging Trends¹

The present overview of the chapter

- *Artificial Intelligence (A.I.):* It describes Machine Learning, Natural Language Processing, Robotics, Immersive experiences, which include Virtual Reality, Augmented Reality.
- *Big Data:* Data sets of enormous volume and complexity are called *Big Data*. Characteristics of data and data analytics are discussed in this section.
- *Internet of Things (IoT):* The "Internet of Things" is a network of devices that have embedded hardware and software to communicate (connect and exchange data) with other devices on the same network.
- *Cloud Computing:* is an emerging trend in information technology, where computer-based services are delivered over the Internet or the cloud and accessible to the user from anywhere using any device.
- *Grid Computing:* A grid is a computer network of geographically dispersed and heterogeneous computational resources that is more application specific. It creates a sense of a virtual supercomputer with enormous processing power and storage.
- *Blockchains:* Blockchain technology works on the concept of a decentralized and shared database where each computer has a copy of the database. A block can be considered a secured chunk of data or a valid transaction.

1. Chapter 3, NCERT XI Textbook

Suggested Approach for Incorporation of BKS

- The Sanskrit language is the best suitable language for machine learning because the grammar given by Panini "s is highly structured. The systematic view of Panini "s Grammar is as follows:
 - Phonetic Component (अक्षरसामान्य)
 - Rulebase (सूत्रपाठ)
 - Verbs database (धातुपाठ)
 - Nominals database (गणपाठ)
- A programming language, IAL (International Algebraic Language) ALGOL) by John Backus (IBM designer in the 1950s), was created using techniques similar to that of Panini.
- Artificial Intelligence has evolved into knowledge-based and intelligent system design, and the knowledge base and inference engine have become standard subsystems of an intelligent system. *Nyāya* in BKS has specifically focused on how one can systematically inquire into a problem and establish new knowledge in a structured process which may be introduced to the students. The *Nyaya-sastra* with means of obtaining '*pramana*' may be introduced.
- In data science, both inductive and deductive reasoning are important *Nyaya-sastra* proposed an inductive/deductive framework. It has five steps in process.¹
 1. *Pratijna*: Development of a knowledge
 2. *Hetu*: Establishing the proposition through reasoning
 3. *Udhaharana*: Homogenous or Affirmative examples to support the propositions
 4. *Upananya*: Establishing the validity of the proposition

1. Source: Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan, V.R. Bhat, Nagendra Prvana R.N.

5. *Nigamana*: Restating of the proposition

- Natural Language Processing (NLP) is a branch of linguistics mainly concerned with processing natural language data using computers and programming techniques. NLP uses linguistics, computer science and artificial intelligence ideas to understand natural language.
- Recent research areas in Machine learning and NLP with Sanskrit can be discussed with the students to create their interest.

Getting Started with Python¹

The Present Overview of The Chapter

- *Introduction to Python*: This section defines high-level and low-level programming languages. This section also explains the features of Python. It explains the two types of execution modes, i.e. interactive mode and script mode.
- *Python Keyword*: These are the reserved words. It has a specific meaning, and the keywords can be used in the program only for the purpose for which it has been defined.
- *Identifiers* are the names used to identify a program's variable, function, or other entities. There are specific rules to declaring an identifier. Variables in a program are uniquely identified by a name (identifier).
- *Comments*: Comments are not executed by the interpreter. They are added to make the source code easier for humans to understand.
- *Data Types*: Different types of data types like int, string, list, tuples, dictionary etc. have been defined. The mutable data type is defined as the variables whose values can be changed, and the immutable type is those whose values cannot be changed.

1. Chapter 5, NCERT XI Textbook

- *Operators:* Different types of Operators are Arithmetic Operators, Relational Operators, Assignment Operators, Logical Operators, Identity Operators and Membership Operators.
- *Expressions:* An expression combines constants, variables, and operators.
- *Precedence of operators:* Evaluation of the expression is based on the precedence of operators. When an expression contains different kinds of operators, precedence determines which operator should be applied first.
- *Input and Output:* A program needs to interact with the user "s to get input data or information from the end user and process it to give the desired output. Some functions are explained, which are used to take input from the user and print output for the user.
- *Type Conversion:* It is a process to change the data type of a variable to another. Such data type conversion can happen in two ways: explicitly (forced) when the programmer specifies for the interpreter to convert a data type to another type; or implicitly, when the interpreter understands such a need by itself and does the type conversion automatically.
- *Debugging:* The process of identifying and removing mistakes, also known as bugs or errors, from a program is called debugging. Errors are i) Syntax errors, ii) Logical errors, and iii) Runtime errors.

Suggested Approach for incorporation of BKS

- Students may be introduced that variables are the means to store some values and these variables can be related to the key contribution of ancient Indians work where they have used symbols to denote unknown values.

- While explaining the arithmetic operators to students, this may be incorporated that Indians discovered the usage of fundamental arithmetic operators¹. They discovered the usage of fundamental arithmetic operators "yu" for *yuta* (addition), "ksa" for *ksaya* (subtraction), "gu" for *guna* (multiplication) and "bha" for *bhaga* (division). They used the first letters of the names of different colours to denote different unknown variables. This may also be emphasized that Brahmagupta describes multiplication as a practical illustration. The multiplicand is repeated like a string for cattle as often as integrant portions are in the multiplier. It is repeatedly multiplied by them, and the products are added together. It is multiplication. Or the multiplication is repeated as many times as there are component parts in the multiplier.²
- While explaining semantics to the students, *Nirukta* (covers "etymology"), the study concerned with correctly interpreting Sanskrit words in the Vedas may be incorporated with this.

Flow of Control³

The present overview of the chapter

- *Introduction to Flow of Control*: Python supports two types of control structures- selection and repetition.
- *Selection*: Selection is selecting the option according to your priority and is implemented by the if and else statement.
- *Indentation*: Python used indentation to specify the blocks.

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1. Source: Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan, V.R. Bhat, Nagendra Prvana R.N.
 2. Source: Brahmagupta; Bhāskara II (1817). Algebra, with Arithmetic and Mensuration, from the Sanscrit of Brahme Gupta and Bhāscara. Translated by Henry Thomas Colebrooke. John Murray. p. 319.
 3. Chapter 6, NCERT XI Textbook

- *Repetition:* Repetition is also known as iterations implemented by for and while loop.
- *Break and Continue:* Break is used to exit the loop, and continue is to skip some of the statements.
- *Nested Loops:* Nested loops are also defined as loops within the loops

Suggested approach for incorporation of BKS

➤ Students can be given programs for coding based on the concepts defined in this chapter. A multidisciplinary approach can be adopted for programming techniques. Applications of Vedic mathematics in computer science can be highlighted to students. Vedic maths may be used for developing logical thinking and interpretation skills. There can be multiple solutions/programs for a particular problem. The students may be asked to solve standard programs using the techniques given in *Vedic* mathematics. Students can code all these methods to make the class multidisciplinary and innovative. Specific illustrations of some concepts which may be incorporated into the textbooks are given below:

- I. Fibonacci series is one of the most common example in computer programming languages when the students start doing coding. During the understanding of this series, it should be incorporated that *Fibonacci series* was first introduced by *Virahanka* (Devanagari: विरहाङ्क), an Indian prosodist known for his work on mathematics. Figure 9 shows the fibonacci series representation.

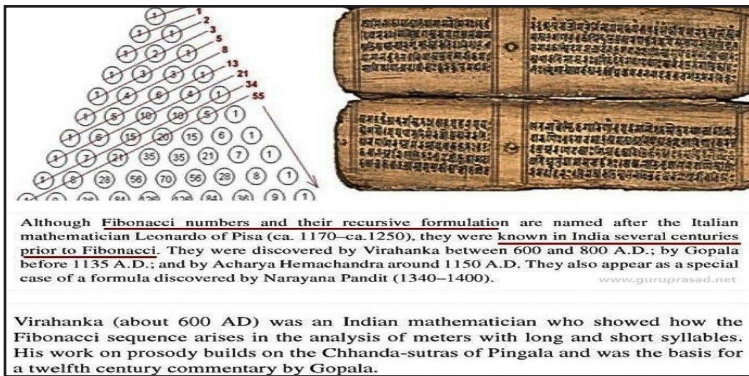


Figure 9: Fibonacci Series representation¹

- II. Students perform many programs/coding based on pattern generation. During the explanation of these types of programs, the pattern generation by Pingala system may be incorporated.
- III. To improve the coding skills of the students, every possible algorithm should be explained to solve a particular problem. They should be encouraged to perform coding by different innovative methods. Example is square of a number, the square of a number can be calculated by using the simple multiplication method. This can also be done by using the algorithm explained by Aryabhata as given by the verse shown in Figure 10.

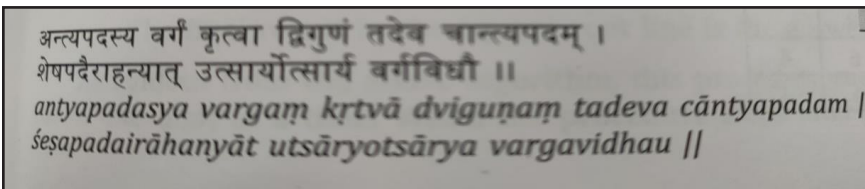


Figure 10: Aryabhata algorithm to find the square of a number²

1. Source: https://twitter.com/guruprasad_gp/status/832977286936748032
2. Source: Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan, V.R. Bhat, Nagendra Prvana R.N.

Square of a number can also be calculated by using algorithms explained in Vedic Mathematics. Students should be motivated to use Vedic mathematics technique in coding solve mathematical problems faster. Some of the steps to calculate a square of the number in Vedic mathematics:

- *Yavadunam* is a specific shortcut to square numbers using Vedic Mathematics whenever a number is closer to the power of 10. (10, 100, 1000,)
- *Ekadhikena Purvena* finds the square of a number ending with 5.
- *Dvanda Yoga: Dvanda Yoga* is a general method to square any number in Vedic maths. *Dvanda Yoga* or Duplex Method is a shortcut method for squares of large numbers.

One more example of coding is Multiplication of Numbers which can be done by using Vedic Mathematics Multiplication techniques:¹

- *Nikhilam Sutra* (Specific Technique): This Sutra is a Specific method of Multiplication in Vedic Mathematics which shows shortcuts to multiply numbers closer to the power of 10 (10, 100, 1000, etc.)
- *Anurupyena Sutra* (Specific Technique): This is a sub-type of *Nikhilam Sutra* and another Vedic math multiplication trick when numbers are not closer to the power of 10 but are closer to themselves.
- *Urdhva Tiryak Sutra* and Vinculum Process (General Technique): This is another excellent shortcut method of multiplication using Vedic Mathematics. *Urdhva Tiryak* is the General method of multiplication in Vedic Maths which provides a shortcut to multiplying any

1. Source: <http://educratsweb.com/content.php?id=77>.

number. It can be applied very easily to multiply 3-digit numbers, multiply 4-digits numbers and even more than 4-digit numbers.

- *Ekayunena Purvena* (Specific Technique): This sutra is applicable whenever the multiplier has only 9" s as digits.
- *Antyaordaske'pi* (Specific Technique): This sutra has another great multiplication trick in Vedic Mathematics which can be applied when the last digits of both numbers total 10.
- 16 sutras of Vedic Mathematics shown in Figure 11 can be incorporated into chapters where it is found relevant. Students can work and perform the coding on these sutras.
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1. सूत्र - 1 - एकाधिकेन पूर्वेण।।
2. सूत्र - 2 - निखिलं नवतश्मचरमं दशतः
3. सूत्र - 3 - ऊर्ध्वतिर्यग्भ्याम्
4. सूत्र - 4 - परावर्त्य योजयेत्
5. सूत्र - 5 - शून्यं साम्यमुच्चये
6. सूत्र - 6 - अनुरूप्ये शून्यमन्यत्
7. सूत्र - 7 - संकलनव्यवकलनाभ्याम्
8. सूत्र - 8 - पूरणापूरणाभ्याम्
9. सूत्र - 9 - चलनकलनाभ्याम्
10. सूत्र - 10 - यावदूनम्
11. सूत्र - 11 - व्यष्टिसमष्टिः
12. सूत्र - 12 - शेषाप्यङ्केन चरमेण
13. सूत्र - 13 - सोपान्त्यद्वयमन्त्यम्
14. सूत्र - 14 - एकन्यूनेन पूर्वेण
15. सूत्र - 15 - गुणितसमुच्चयः
16. सूत्र - 16 - गुणकसमुच्चयः

Figure 11: Sixteen Sutra of Vedic Mathematics¹

1. Source: [http://www.vedamu.org/veda/1795\\$vedic_mathematics_methods.pdf](http://www.vedamu.org/veda/1795$vedic_mathematics_methods.pdf)

- Recursive Functions are the important concept in computer languages. The "Divide and conquer" strategy in computer science can be related to Pingala efficient recursive algorithm. Pingala (200 BC), in his book on '*Chandashastra*', a text related to the description and analysis of meters in poetic work, describes algorithms which deal with Combinatorial Mathematics. These algorithms essentially deal with converting Binary numbers to Decimal numbers and vice versa, finding the value of 'n choose r', evaluating 2^n , etc. All these algorithms are recursive. There are also shreds of evidence of making use of stack variables to stack the intermediate results for later use.¹

Some introductory chapters may be included in class XI and XII

In addition to the changes in the present chapters, new chapters highlighting the application of BKS in computer science may be incorporated in Class XI and XII textbooks.

- The outline of the proposed chapter with Title “**Bharatiya Knowledge System in Computer Science**” for **Class XI** computer science textbooks is given below
 - Introduction of the Ancient Computational Methods and Tools
 - Vedic recitation rules (*prakṛti* and *vikṛti pātha*) [1500 BCE-1000 BCE]
 - Root-based theory of *Yaska* (*Dhātūja Siddhānta*) [800 BCE]
 - Epistemology of *Nyāya* (*pramā, prameya, pramātā, pramāṇa* and *hetvabhāsa*) [300 BCE]

1. Source: Amba Kulkarni, Recursion and Combinatorial Mathematics in Chandashastra, 2007.

- Binary theory of Piṅgala (Analysis of Sanskrit metre) [300 BCE]
- Computational features of Sanskrit language (Sanskrit as a programming language)
- The outline of the proposed chapter with Title “**Introduction to Sanskrit Grammar in Computer Science**” for **Class XII** computer science textbooks is given below
 - Introduction to Pāṇinian grammar
 - History and background of the study of Sanskrit grammar
 - System of Panini, methods and techniques
 - Panini and formal language studies
 - Phonetics/Phonology: *śivasūtra*
 - Morphology: *Sup/ṭiṅ* (inflectional), कृत्, *taddhita*, *samāsa* (derivational)
 - Syntax/semantics: *Kāraka* (Problems in computing Karaka semantics)
- The outline of the proposed chapter with Title “**Introduction to Pāṇinian framework in Computer Science**” for **Class XII** computer science text books is given below
 - Implementing Pāṇinian Rules
 - Formalizing Aṣṭādhyāyī
 - The Paninian framework and its application to other languages
 - A survey of computer applications on Aṣṭādhyāyī
 - Students can work on a specific section on Aṣṭādhyāyī, leading to a web-application

Theme IV: Importance of Sanskrit in Computer Science & Natural Language Processing

Natural Language Processing (NLP) is a branch of linguistics mainly concerned with processing natural language data using computers

and programming techniques. NLP uses linguistics, computer science and artificial intelligence ideas to make natural language understandable. The relatively unambiguous nature of this language and its well-laid-out grammatical structure make this language appropriate for adoption as a language for processing.

Application in Computer Science

- Sanskrit has a well-defined grammar based on scientific rules, making it amenable for Natural language processing. An example is the precise and unambiguous meaning given by the use of *Vibhakti* in Sanskrit.¹ This makes an approximation to a programming language with classes and objects.²

Conclusion

India enjoys a rich heritage of ancient knowledge and its scientific dissemination. The interface of 'knowledge' and 'Education' is unique to the central tenets and ethos of the traditional Indian education system. It provides a transformative learning experience to students which not only aims at knowledge inculcation but simultaneously develops skills and personality in a holistic manner. It incorporates human values, ethics, morality, sustainability in the learning process. The concept of Bharatiyata, embodies and promotes the notion of Vasudhaiva Kutumbakam as an essential paradigm of learning.

The present education system requires moving beyond conventional categories of thought. It needs nourishment by revisiting and incorporating the roots. Only a revitalised education system can help appreciate the richness of our heritage and its utility to address critical issues faced by the modern society. A reinvigorated education system would play an important role in moulding the

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1. Source: Use of Sanskrit for natural language processing Chandana Bathulapalli, Drumil Desai and Manasi Kanhere.
 2. Id

consciousness and conscience of the nation. There is a need to develop progressive thematic approach to build the information technology text books prescribed in the school curriculum using the principles based on ancient texts.

NEP 2020 recognizes the importance of rapid global changes in the scientific and technological domains. The policy document cites the rise of big data, artificial intelligence, blockchains and machine learning as the upcoming new technologies that will lead to an explosive demand for a skilled workforce with computer and data science skills. It would entail developing multidisciplinary skills across science, humanities, and social science streams for collaboration, addressing issues, solving problems and meeting global needs. It posits that nation-building and development of India will require a renewed vigour for digitization requiring computer skills.



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LIST OF WORKSHOP PARTICIPANTS

This is the list of delegates who came from different institutions from all over India to participate in the two-days National Workshop on “Computer Science/I.T. in the light of NEP 2020 & Indian Knowledge Systems’ organized by Vidya Bharti Uchcha Shiksha Sansthan, in collaboration with NIT Kurukshetra, School of Engineering (JNU) and Software Technology Park of India on 25th & 26th May, 2022 at NIT Kurukshetra.

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