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Reimagining the Role of Science Education in Development of 21st Century Learning Skills with Reference to NEP 2020

Pratyusha Ranjan Sahoo

Research Scholar in Education, Utkal University, Bhubaneswar, Odisha, India

Corresponding author: sahoopratyusha93@gmail.com

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ABSTRACT

The world is growing with a faster pace in the 21st century due to rapid development of science and technology. It has brought a paradigm shift to the lifestyle and social processes as a whole. Changing scenario has brought more challenges to live in. Preparing students to live and face the world in the 21st century is challenging and daunting. Acquisition of different skills and knowledge as well as interdisciplinary approach towards the world are needed to the students to keep in pace with world. The present study draws and reviews on the policies with specific reference with National Curriculum Framework 2005 (NCF 2005) and National Education Policy (NEP 2020) to explore the role of Science Education in development of 21st Century Learning Skills which have been recommended with the intent to prepare the learners to face the challenging world. Transforming the 21st century education is an attempt to change the world and face the upcoming challenges posed by the world. This dynamic recommendations made by both the policies, if integrated and implemented properly with the same intent and spirit, it can do wonders. And education can be the powerful weapon which can be used to change the world and face the world as well.

Keywords: 21st century skills, NCF 2005, NEP 2020

> Education is the most powerful weapon which you can use to change the world
>
> **— Nelson Mandela**

The world is growing with a faster pace in the 21st century due to rapid development of science and technology. It has brought a paradigm shift to the social processes as well. It has changed the life styles of the people. But the changing world has become more challenging to live in. Many interconnected phenomena like population explosion, pollution, rise in temperature, forest fires, other environmental uncertainties, globalization, downfall of economy, terrorism, technological innovations, extending life outside earth and now pandemic COVID-19 etc. are already presented in the early part of the 21st century. And we never know, what is coming ahead of it. So, Preparing students to live and face the world in the 21st century is challenging and daunting. Acquisition of different skills and knowledge as well as interdisciplinary approach towards the world are needed to the students to keep in pace with world. Edwards and Usher (2000) suggest, "Change and uncertainty require lifelong learning," And the students need to adapt according to the growing world and challenging situations.

What critical skills does a student need to develop and work upon to face the unexpected challenge posed by the world tomorrow? This question need to be answer and it is a matter of concern for the educationist, government and other

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stakeholders in recent time which has given rise to planning strategies, formulating new policies, providing training to practice these skills as well as researches which in turns leads to a significant body of knowledge. There is a clear consensus that new approaches to learning must accommodate the characteristics of today's students, become more inclusive and address twenty-first century interdisciplinary themes (Carneiro, 2007).

Preparing the students towards acquiring the 21st century learning skills should not be delayed and no student should be restricted and debarred for gaining or acquiring these skills. There is now a significant body of literature focusing mainly on three topics – motivations for a new model of learning, the specific competencies and skills needed to function effectively in the twenty-first century, and the pedagogy required to stimulate those capabilities (Cynthia, 2015). The present study draws and reviews on the policies with specific reference with National Curriculum Framework 2005 (NCF 2005) and National Education Policy (NEP 2020) to explore the role of Science Education in development of 21st Century Learning Skills.

Overall vision of twenty-first century learning

Personalization, collaboration, communication, informal learning, productivity and content creation are central to the competencies and skills learners are expected to develop and the way in which these skills are taught. These elements are key to the overall vision of twenty-first century learning (McLoughlin and Lee, 2008; Redecker and Punie, 2013).

In addition, personal skills (initiative, resilience, responsibility, risk-taking and creativity), social skills (teamwork, networking, empathy and compassion) and learning skills (managing, organizing, metacognitive skills and 'failing forward' or altering perceptions of and response to failure) are vital to peak performance in the twenty-first century workplace (Learnovation, 2009). While many of these competencies and skills may seem modern they 'are not new, just newly important' (Salas-Pilco, 2013).

The skills which have been listed as the 21st century skills have existed before, but it may not be required in that much amount previous time as the situations, challenges and issues were different. Now with the changing world and new challenges, one required to learn and acquire these skills for successful livelihood.

The International Commission on Education for the Twenty-first century produced one report Learning: The Treasure Within in 1996 under the chairmanship of Jacques Delors of France and later known as Delors Report. It was submitted to UNESCO. The report proposed one of the first frameworks to identify competencies and skills needed for the twenty-first century. The four visions of learning outlined in this landmark report – knowledge, understanding, competencies for life and competencies for action – remain appropriate reference points and organizing principles for identifying competencies for twenty-first century learning (Cynthia, 2015). The Delors Report also formulated four principles identified as the Four Pillars of Education: Learning to Know, Learning to Do, Learning to Be and Learning to Live Together. The Delors framework remains relevant today and can be redefined and expanded for the twenty-first century.

Many International organizations and commissions, governments, private institutions have proposed many policies, frameworks and guidelines and outlined skills and strategies to address the twenty first century challenges. Dede (2010) and Salas Pilco (2013) compared several frameworks to identify the evolution of themes over time and the points they have in common. While frameworks differ in complexity, each is useful for the specific context for which it was developed. The comparison also draws attention to the absence of these competencies and skills from current learning processes.

In accordance to this, several frameworks and policies have been formulated in last two decades in India. The researcher intended to explore the recommendations of National Curriculum Framework 2005 (NCF 2005) and National Education Policy (NEP 2020) to study the role of Science Education in development of 21st Century Learning Skills.

National Curriculum Framework-2005 on Science Education

The National Curriculum Framework 2005 (NCF 2005) is the fourth National Curriculum Framework

published in 2005 by National Council of Educational Research and training (NCERT) in India. The NCF 2005 serves as a guideline for syllabus, textbooks and teaching practices for the schools in India.

According to NCF 2005, the main areas relevant for curricular planning have remained remarkably stable for a long time, despite major changes in social expectations and the academic study of different broad disciplines. It is important that each curricular area is revisited in depth, so that specific points of entry can be identified in the context of emerging social needs. We must bring the arts, extra-curricular activities squarely into the domain of the curricular, infusing them in all areas of learning while giving them an identity of their own at relevant stages. Schools have a major role to play in ensuring that children are socialized into a culture of self-reliance, resourcefulness, peace-oriented values and health.

Science Education

NCF 2005 has various recommendations in relation to subject and the values they should foster. The following section from the NCF 2005 has discussed the aim of science education towards the learner and society as a whole, the framework also recommended various changes to science curriculum according to the different stages of learner.

According to NCF 2005, one important human response to the wonder and awe of nature from the earliest times has been to observe the physical and biological environment carefully, look for any meaningful patterns and relations, make and use new tools to interact with nature, and build conceptual models to understand the world. This human endeavor has led to modern science.

Broadly speaking, the scientific method involves several interconnected steps: observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences, verification or falsification of theories through observations and controlled experiments, and thus arriving at the principles, theories and laws governing the natural world. Science is a dynamic, expanding body of knowledge, covering ever-new domains of experience in a progressive forward-looking society; science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition. Good science education is true to the child, true to life and true to science.

Aims of Science Education

The general aims of science education follow directly from the six criteria of validity: cognitive, content, process, historical, environmental and ethical. To summarize, science education should enable the learner to:

- ❒ know the facts and principles of science and its applications, consistent with the stage of cognitive development,
- ❒ acquire the skills and understand the methods and processes that lead to generation and validation of scientific knowledge,
- ❒ develop a historical and developmental perspective of science and to enable her to view science as a social enterprise,
- ❒ relate to the environment (natural environment, artifacts and people), local as well as global, and appreciate the issues at the interface of science, technology and society,
- ❒ acquire the requisite theoretical knowledge and practical technological skills to enter the world of work,
- ❒ nurture the natural curiosity, aesthetic sense and creativity in science and technology,
- ❒ imbibe the values of honesty, integrity, cooperation, concern for life and preservation of environment, and
- ❒ cultivate 'scientific temper'-objectivity, critical thinking and freedom from fear and prejudice.

Science curriculum at different stages

Consistent with the criteria above, the objectives, content, pedagogy and assessment for different stages of the curriculum are summarized below:

At the primary stage the child should be engaged in joyfully exploring the world around and harmonizing with it. The objectives at this stage are to nurture the curiosity of the child about the world (natural environment, artifacts and people), to have the child engage in exploratory and hands on activities to acquire the basic cognitive and psychomotor skills through observation, classification, inference, etc.; to emphasize design and fabrication, estimation and measurement as a prelude to development of

technological and quantitative skills of later stages; and to develop the basic language skills: speaking, reading and writing not only for science but also through science. Science and social science should be integrated as 'Environmental Studies' as at present, with health as an important component. Throughout the primary stage, there should be no formal periodic tests, no awarding of grades or marks, and no detention.

At the upper primary stage the child should be engaged in learning principles of science through familiar experiences, working with hands to design simple technological units and modules (e.g. designing and making a working model of a windmill to lift weights) and continuing to learn more on environment and health through activities and surveys. Scientific concepts are to be arrived at mainly from activities and experiments. Science content at this stage is not to be regarded as a diluted version of secondary school science. Group activity, discussions with peers and teachers, surveys, organization of data and their display through exhibitions, etc. in schools and neighborhood are to be an important component of pedagogy. There should be continuous as well as periodic assessment (unit tests, term end tests). The system of 'direct' grades should be adopted. There should be no detention. Every child who attends eight years of school should be eligible to enter Class IX.

At the secondary stage the students should be engaged in learning science as a composite discipline, in working with hands and tools to design more advanced technological modules than at the upper primary stage, and in activities and analysis on issues surrounding environment and health. Systematic experimentation as a tool to discover/verify theoretical principles, and working on locally significant projects involving science and technology are to be important parts of the curriculum at this stage.

At the higher secondary stage science should be introduced as separate disciplines with emphasis on experiments/technology and problem solving. The current two streams, academic and vocational, being pursued as per NPE 1986 may require a fresh look in the present scenario. The students may be given an option to choose the subjects of their interest freely, though it may not be feasible to offer all the different subjects in every school. The curriculum load should be rationalized to avoid the steep gradient between secondary and higher secondary syllabus. At this stage, core topics of a discipline, taking into account recent advances, should be carefully identified and treated with appropriate rigor and depth. The tendency to superficially cover a large number of topics of the discipline should be avoided.

Recommendations of NCF 2005 for different stages of learners were well researched and recommended according to the changing needs of the society; it can help a learner to develop different skills to face the growing world. On the basis of the recommendations made by NCF 2005, NCERT has made a sincere attempt to redesign the syllabi and written textbooks for science starting from upper primary to senior secondary stage. An integrated approach of curriculum was made till the secondary stage and as a different discipline at the senior secondary level.

Planning, designing, implementing and evaluating are the different aspect of the curriculum by which the thinking comes to the practice in reality. Recommending and implementing are two different parts of the coin. One is valueless without the other. However, the changes which are expected to come through practice should be taken care of at the implementation and transaction level. But the intended changes are some where lacking at the practice. With the change in technology, it is expected to integrate technology in the teaching learning process but the existing classroom process still continues to be by the same traditional method. Still the teacher centric classroom is followed where there is no opportunity for the learners to engage themselves, so expecting these recommended skills to be developed is still in doubt. Things are being done for just the sake of doing it rather it should be done as intended to be done.

National Education Policy 2020 on Science Education

Ministry of Human Resource Development (MHRD) has produced the National Education Policy 2020 document. With the following objective the transformation of curriculum and pedagogy is recommended.

"Curriculum and pedagogy are transformed by 2022 in order to minimize rote learning and instead encourage holistic development and 21st century skills such as critical thinking, creativity, scientific temper, communication, collaboration, multilingualism, problem solving, ethics, social responsibility, and digital literacy."

To achieve the objectives, the committee has given several recommendations. The following sections from the NEP 2020 mainly based on the recommendations on Science education.

Recommendations of NEP 2020 related to science education

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

The curricular and pedagogical structure and the curricular framework for school education will therefore be guided by a 5+3+3+4 design:

- 5 years of the Foundational Stage: 3 years of pre-primary school and Grades 1, 2.
- 3 years of the Preparatory (or Latter Primary) Stage: Grades 3, 4, 5.
- 3 years of the Middle (or Upper Primary) Stage: Grades 6, 7, 8.
- 4 years of the High (or Secondary) Stage: Grades 9, 10, 11, 12.

(a) The Foundational Stage will comprise five years of flexible, multilevel, play-based, activity-based, and discovery-based learning, continuously incorporating the latest research in ECCE as well as the various time tested Indian traditions for cognitive and emotional stimulation of children.

(b) The Preparatory Stage will comprise three years of education, building on the play-, discovery-, and activity-based pedagogical and curricular style of the Foundational Stage, but also gradually beginning to incorporate textbooks as well as aspects of more formal classroom learning. There would mostly be generalist teachers during this stage, with the possible exception of some specialist language and art teachers (who may be shared across the school or school complex). The aim of this stage will be to lay the general groundwork across subjects, including reading, writing, speaking, physical education, art, languages, science, and mathematics, so that students are prepared to delve deeper into learning areas through specialized subjects and subject teachers in the stages that follow.

(c) The Middle Stage will comprise three years of education, building on the more formal pedagogical and curricular style of the Elementary Stage, but will see the introduction of subject teachers for learning/ 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.

(d) The Secondary Stage will comprise four years of multidisciplinary study, and will build 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. Each year of the Secondary Stage will be divided into 2 semesters, for a total of 8 semesters. Each student would take 5 to 6 subjects each semester. There will be some essential common subjects for all, while simultaneously there will be a great flexibility in selecting elective courses (including in the arts, vocational subjects, and physical education) so individual interests and talents. A system of modular Board Examinations - restructured to test only core concepts, principles, critical thinking, and other higher-order skills in each subject - will help to pin down the common courses, while great flexibility will be offered for remaining courses. The notions of "higher secondary" or "junior college" will be eliminated; Grades 11 and 12 will be considered an integral part of the secondary stage.

2. ***Reorientation of the content and process of school education***

The entire school education curriculum will be reoriented to develop holistic learners and develop in learners higher order skills of critical thinking, creativity, logical deduction, collaboration/ teamwork, social responsibility, multilingualism, quantitative reasoning, and digital literacy. Learning will thus move away from rote memorisation; if and when rote learning is used, it will always be pre- accompanied by context and motivation, and post-accompanied by analysis, discussion, and application.

3. ***Reduce curriculum load in each subject to its essential core content, in order to make space for more holistic, experiential, discussion-based, and analysis-based learning***

The mandated contents in the curriculum will be reduced, in each subject area, to its core, focusing on key concepts and essential ideas. This will thereby yield more space for discussion and nuanced understanding, analysis, and application of key concepts. Teaching and learning will strive to be conducted in a more interactive manner; questions will be encouraged, and classroom sessions will regularly contain more fun, creative, collaborative, and exploratory activities for students for deeper and more experiential learning.

4. ***Increased flexibility in choice of subjects***

Students will be given an increased flexibility and choice of subjects to study, particularly in secondary school - including subjects in physical education, the arts, and vocational crafts - so that they may be free to design their own paths of study and life plans.

5. ***No hard separation of content in terms of curricular, extra-curricular, or co- curricular areas***

All school subjects will be considered curricular rather than extra-curricular or co- curricular, including sports, yoga, dance, music, drawing, painting, sculpting, pottery making, wood working, gardening, and electric work. NCERT will prepare syllabi and textbooks as per the National Curriculum Framework, to incorporate these subjects into the national curriculum, which the State Councils of Educational Research and Training (SCERTs) in States may edit, supplement, and rewrite as per States' needs. Subjects such as physical education, the arts, and vocational crafts will be seriously incorporated throughout the school curriculum, with a consideration for what is interesting and safe at each age.

6. ***No hard separation of arts and sciences***

All students will have the opportunity to engage deeply in the arts and humanities as well as in the study of the sciences and social sciences. Such a separation will be discouraged in higher education as well.

7. ***No hard separation of "vocational" and "academic" streams***

The curricula for elementary and secondary education will ensure that there will be no hard separation of "vocational" and "academic" streams as all students will have the opportunity of developing both kinds of capacities. With the rapidly changing economic scenarios, fundamental capacities have become even more important than specific skills.

8. ***Learning science bilingually***

Students whose medium of instruction is the local/home language will begin to learn science bilingually in Grade 8 or earlier, so that by the end of Grade 10 they can speak about science both in their home language and English. This will enable students to think about scientific concepts in more than one way, and enable future scientists to talk about their work and about science to their families and to local news channels, write about their work for regional newspapers, and speak to children about their work in their home States and towns to help inspire the next generation.

9. ***Inculcate scientific temper and encourage evidence-based thinking throughout the curriculum***

Evidence-based reasoning and the scientific method will be incorporated throughout the school curriculum - in science as well as in traditionally "non-science" subjects - in order to encourage rational, analytical, logical, and qualitative thinking in all aspects of the curriculum.

10. ***Incorporation of communication in every subject in the Middle and Secondary years***

In the Middle and Secondary stages, communication in front of one's peers will continue, with the aim to discuss more sophisticated and course-specific topics. For example, in science class, students may be asked to explain a creative solution to a problem at the board, or in ethics class, explain their own perspective on an ethical dilemma or discuss examples from their own lives. At the Middle and Secondary stages, students will also formally learn to talk about social, scientific, technological, agricultural, medical, and environmental problems facing India and the world.

11. ***Integration of digital literacy***

The new curriculum will also integrate digital literacy for all learners at the basic level, with hands-on assessments and worksheets keeping in mind the available digital infrastructure on the ground.

12. ***Incorporation of basic ethical and moral reasoning throughout the school curriculum***

Students will be taught at a young age the importance of "doing what's right", and will be given a logical framework for making ethical decisions.

13. ***Basic health and safety training, as a service to oneself and to those around us***

Basic training in health, including preventative health, mental health, nutrition, personal and public hygiene, and first-aid will also be included in the curriculum, as will be scientific explanations of the detrimental and damaging effects of alcohol, tobacco, and other drugs. Sex education will also be included in secondary school for future judgment surrounding consent, harassment, and respect for women, safety, family planning, and STD prevention

14. ***Revision of the National Curriculum Framework***

The NCF 2005 outlines many excellent strategies that are still relevant for accomplishing a more constructivist type of learning. This document will be revisited and updated by the end of 2020, taking into account the changing context of education today and, in particular, all the above Policy points, and will be made available in all regional languages.

15. ***A new paradigm of assessment for learning and development***

Guidelines will be prepared by NCERT, and teachers prepared, for a transformation in the assessment system by 2022, to align with the NCF 2020. The focus will be on formative assessment, i.e., assessment for learning. Every student has innate talents, which must be discovered, nurtured, fostered, and developed. The culture of assessment must shift from one that primarily tests rote memorisation to one that is more formative, promotes learning, and tests higher-order skills. Making individual interests and talents an important consideration in instructional approaches; designing a variety of learning experiences and academic support strategies, such as themes or topic-centered learning activities; project-based learning; etc. that are intended to respond to the distinct interests, talents and dispositions of individual students.

16. ***Establish topic-centered and project-based clubs at the school, school complex, block, and district levels***

A system of Topic-centered and Project-based Clubs and Circles in Mathematics, Science, Music, Chess, Poetry, Language, Literature, Debate, Sports, etc. will be set up and funded in accordance with student needs in various localities, in order to foster singular interests and talents of students across the country

17. ***Olympiads and competitions***

Olympiads and competitions in various subjects will be strengthened across the country, with clear coordination and progression from school to local to State to national levels.

18. ***Internet-based apps, assessments, and online communities for students with singular interests and talents***

Once internet-connected smart phones or tablets are in the hands of all students, online apps with quizzes, competitions, assessments, enrichment materials, and online communities for shared interests will be developed, and will work to enhance the initiatives.

Recommendations and implementations are two inseparable aspects of educational processes. They go hand in hand with each other. According to NEP 2020, any policy is regarded as good when it is implemented with the same spirit and intent.

As we are in a fast growing world experiencing to witness many activities daily, the NCF 2005 needs to be revisited in the light of NEP 2020. The evaluation system also be revisited, implemented as intended and evaluated as per the CCE guidelines suggested by the NCERT (2016). It has been recommended about the flexibility in the curriculum and reducing the curriculum load. So, while redesigning the curriculum this aspect also needs to be looked in depth.

CONCLUSION

This paper explores the several recommendations by NCF 2005 and NEP 2020 related to science education which clearly states the role of science curriculum in developing different 21st century learning skills to face the real world. The world is posing several challenges for individuals, the policies or recommendations were done by keeping in mind the future challenges the world may pose and the, it has been recommended with the intent to prepare the learners to face the challenges. Transforming the 21st century education is an attempt to change the world and face the upcoming challenges posed by the world. This dynamic recommendations made by both the policies, if integrated and implemented properly with the same intent and spirit, it can do wonders and help learners to learn and acquire these skills which in turns help them adapt to different situations. "Survival of the fittest" is a phrase that originated from the Darwinian evolutionary theory is most related when it comes to survive in this changing world. It was rightly said by him, "It is not the strongest of the species that survives, or the most intelligent, but the one most responsive to change. So one need to accept the change and adapt according to the situation. This value only can be inculcated through the most powerful weapon that is Education.

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