BHARATI INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH & DEVELOPMENT (BIJMRD)

(Open Access Peer-Reviewed International Journal)

DOI Link :: https://doi.org/10.70798/Bijmrd/02090001

Available Online: www.bijmrd.com|BIJMRD Volume: 2| Issue: 9| October 2024| e-ISSN: 2584-1890

Science Curriculum at Secondary School Level of India and Singapore: A Comparative Study

Anisha Nandy[1] & Surapati Pramanik[2]

1. Department. of Education, Swami Vivekananda University, Telinipara, Barasat - Barrackpore Rd, Bara Kanthalia, Barackpore, West Bengal, India – 700121, email1: anishanandy@gmail.com

2. Nandalal Ghosh B.T. College, Panpur, Narayanpur, Dist- 24 Pgs(N), India,West Bengal, PIN-743126, email: sura_pati@yahoo.co.in

Abstract:

The purpose of the study is to explore and compare the school science curricula in India and Singapore. Using qualitative data analysis and a comparative research approach, the study identifies key differences between the two education systems. A major distinction is that India's curriculum has traditionally emphasized rote learning, whereas Singapore's curriculum fosters creativity and critical thinking. In response to this gap, India introduced the National Education Policy (NEP) 2020 to address these shortcomings. This research offers a comparative analysis of the science curricula in both countries, providing insights into the strengths and weaknesses of each system. Notably, no existing literature conducted a similar comparative study, reflecting the originality and significance of this research.

Keywords: *Comparative Study, Science Education, School Science Education, Science Curriculum, NEP-2020*

Introduction:

After independence in 1947, India has engaged in self-reliance as well as sustainable and equitable growth. The country struggling for food grains once, now, is eligible for its own production not only in agriculture but also in new research and development works, making satellites and IT hubs and a strong industrial belt. The country is now eligible to produce scientifically and technically trained manpower although having the largest population in the world (retrieved from http://www.worldometers.info) with 17.47% of the total world's population. But, despite all of this, science education in Indian schools is facing challenges nowadays mainly due to a lack of three wings: a) adequate equipment, b) trained teachers, c) constructive science curriculum (Sarangapani, n.d.). On the other hand, another Asian peer country Singapore with a very less population of 5.97 million (retrieved from http://wwws.worldometers.info), being a sovereign city-state, has remarkable performance not only in various international assessments (like PISA, TIMSS etc.), but also makes prepared their people with a skilled workforce. As the country has very few natural resources and has to import almost everything that it needs, the Govt. of Singapore provides immense importance on science education to help the next generation to find out and amplify their competencies capabilities, and potential in a plenary way and cultivate creativity as well to face the ever-evolving world. Therefore,

the science education curriculum plays a vital role in this coconcentrated on the concept of 'Science as inquiry'. Here is the point of interest for researchers to find out the reason for such type of disparities mainly in the curriculum of science education of two countries from a brief historical background to recent contemporary change.

Literature Review:

As per van den Akker (2010), the definition of 'curriculum' may vary, but in essence, though it 'a plan for learning' was implicated. It may be defined as a pack of guidelines that need to be followed for both students learning and their teaching in the education system.

OECD (2020) in its Working Paper No.239, mentioned that curriculum reforms specify the involvement for change in objectives of learning depending on the necessity of student's competencies, knowledge, values, and attitudes to cope with the fast-changing world as the schools enter the 21st century. Curriculum reform has progressively shifted its vision from a 'top-down' approach to a 'bottom-up' approach emphasizing the central role of teachers in the process.

Mathew & Balachandran (2018) showed the differences prevailing in the educational system of India and Singapore and pointed out some propositions for India for extensive learning practices among students.

Pramanik and Guha (2018), and Pramanik (2019) showed that for mathematics study between India, China and the USA, the third country showed maximum flexibility while designing curriculum effective for its different states.

Vaidiyanthan (2020) suggested that by updating the curriculum and teaching methods India made the next generations able to think critically and produced a workforce for a future economy with compared to Singapore.

Sarangapani (n.d.) concluded that science education in Indian schools was facing challenges mainly due to a lack of three wings- a) adequate equipment, b) trained teachers, c) constructive science curriculum.

Kumar & Singh (2018) found in their article that every Indian should inculcate, propagate and disperse scientific temperament in society as their constitutional right. They suggested the development of science subjects as a process at the curriculum level, acquainting students with the nature of science as a pedagogical component and thus making science education productive and enjoyable to learners. OECD (2011) showed the reason for rapid improvement and its persistence in the case of Singapore's education system and focused on how the government of Singapore successfully balanced the supply and demand of education.

Poon (2014) found in his study that after self-governance in 1959, Singapore government shifted its focus from providing skilled manpower to an inquiry- centered science education in 21st century. From 1960s, the entire system for science education through teaching along with learning within the classroom situation had been transformed from the viewpoint of a little nation to one of the respected international countries for its continuous achievement in international mathematics and science studies.

Maxwell (2017) concluded that four factors were attributed to the high achievement of Singapore's successful educational system and they were curriculum, pedagogy, teaching standards, leadership development, and culture.

Yue (2014) found that the Government of Singapore took dominance and very high- quality leadership to come out of the troubles by moving towards a 'knowledge-based economy'.

Research Gap:

No comparative study has been found to date about the curriculum in school science education of India and Singapore from primary to higher secondary level. The study has focused to fill that gap.

Objectives:

Objectives of this study are—

- to compare the school education system of India and Singapore,
- to analyze the science curriculum of two countries comparatively with contemporary change,
- to compare the science curriculum of the two countries.

Methodology

General methodology: Qualitative study, Methodology:
Few-country comparison,

Comparative method: Case-oriented studies, Document analysis, Content analysis

Research materials: Government documents, books, articles and book chapters in edited volume, peer reviewed journals, newspaper, blog.

Data collection process: Multiple procedures consisting of studying journals (print and online both), books, newspapers, periodicals have been used.

Data analysis: The study has employed the current document-based analytical approach. To analyze the collected data historical and sociological strategies have been adopted.

Major Findings

Overview of the Structure of Indian School Education Systems

India operates (5+3+2+2) system.

According to NCERT 2006, the stages of school education are as follows:

i. Primary (class1-5): 5-7 years of schooling, approximately 5-11 years of age
ii. Upper Primary (class6-8): 6-8 years of schooling, 12-14 years of age
iii. Secondary (class9-10): 9-10 years of schooling, 15-16 years of age
iv. Higher Secondary (class11-12):11-12 years of schooling,17-18 years of age

After the Higher Secondary Board examination, various types of tertiary education started both general and technical types.

There is a change in school education structure (5+3+3+4) due to implementation of NEP 2020. (MHRD, 2020)

Educational Structure of Singapore

Singapore operates (6+4+2) system

Primary (Grade 1-6):

6 years of schooling- Foundation Stage (1-4) +Orientation Stage (5-6)

Secondary (Grade7-10):

Depending on the PSLE (Primary School Leaving Examination) score, student can get admission to following courses-

- Express- (with PSLE score 4-22)- 4-6 years of Schooling, mainly two types of Express course- 4 years GCE 'O' Level of Science or 6 years of International Baccalaureate Diploma program in NUS High School diploma program.
- Normal (Academic)- (with PSLE score 21-25) Science course 4-5 years/GCE 'N' Level Science syllabus 'A' at secondary 4 with an additional 1 year GCE 'O' Level Science Syllabus at secondary 5 leading to junior college, Millennia Institute, polytechnic or Institute of Technical Education (ITE)
- Normal (Technical)- (with PSLE score 25-30) Science Course 4 years/GCE 'N' Level Science Syllabus 'T' at secondary 4.

There are two years of tertiary education. Meanwhile, tertiary education is of two phases. These are Junior College, Polytechnic, and university education.

Science Curriculum Development in India

The NCERT and SCERT are taking decisions regarding curriculum design for school education in India. The NCERT brought many National Curriculum Framework (NCF)s in 1975, 1988, 2000, and 2005 respectively. The school science education follows the guidelines of NCF 2005. (Pramanik & Guha, 2019)

Aims of Science Education as per NCF 2005 (NCERT, 2005)

According to NCF-2005, science education will enable the learner to

- know theories and applications of science to boost their cognitive development indicating *cognitive validity*,
- adapt the curriculum which is needful and simplified in context excluding meaningless concepts thus comprising *content validity*,
- help the learners in acquiring process leading to generate and validate scientific knowledge and thus inspiring curiosity and creativity of students and satisfying *process validity*,
- build up a historical and developmental perspective of science where science can be explained as a social enterprise. Here *historical validity* is explained,
- to make them prepared for facing the ever-challenging world and for adjusting to the environment and thus validating the *environment validity*,
- construct the values like honesty, and objectivity, be fearless as well as bias less, be cooperative cultivate a 'scientific temper', and to be aware of life and environment conservation, thus

maintaining *ethical validity.*

Science curriculum development in different stage as per NCF 2005 (NCERT, 2005)

Upper Primary stage

a) Realizing scientific principles relating with the environment through activities and surveys and familiar experiences,

b) Studying through group activities,

c) Designing simple technological units and modules on hand.

Secondary stage

a) Including science as a composite discipline,

b) Making more advanced tools scientifically and technically sound,

c) Perceiving knowledge on the basis of environment and health,

d) Indulging in systematic experiments to discover/verify theoretical principles,

e) Involving in local scientific projects.

Higher Secondary stage

a) Introducing separate disciplines of science such as Physics, Chemistry, and Biology emphasizing experiments with the ability of problem- solving,

b) Introducing two streams which are academic and vocational,

c) Offering subjects as crediting students' choice,

d) Rationalizing the sharp difference between secondary and higher secondary syllabuses.

Effects of NEP 2020 on School Science Curriculum (MHRD, 2020)

The new and latest education policy of India is NEP 2020 which is not still conquered in its full phase. According to it, the new school education system follows (5+3+3+4) curricular structure. Major instances for school science curriculum conferred by it are-

i. Fact-oriented and scientific thinking through the curriculum,

ii. Inspiring creativity and innovation,

iii. Attempt to diminish the differences between 'arts' against 'science', 'academic' versus 'vocational' course or 'curricular' and 'extra-curricular' activities,

iv. literacy and computational thinking, nationhood etc.,

v. Science learning in a more interactive manner encouraging collaborative and exploratory activities through experiential learning,

vi. Extensive, appropriate and equitable use of technologies,

vii. Increasing flexibility in case of choosing inter-disciplinary subjects,

viii. Reducing overload of science content,

National Curriculum Framework for School Education (NCFSE)-2023

School education structure according to NCFSE-2023 (NCERT, 2023)

According to NCFSE-2023, the four stages of school education should be improvised as

I. Foundational stage (from the age of 3 to Grade 2),

II. Preparatory stage (Grade 3 to 5),

III. Middle stage (Grade 6 to 8),

IV. Secondary stage (Grade 9 to 12).

Here we discuss the Middle stage and the Secondary stage to keep a parity for the sake of research.

Aims of science education in NCFSE-2023 (NCERT, 2023)

- To understand the natural as well as physical world Scientifically,
- To acquire the Capacities to carry out scientific inquiry,
- To understand the evolution and development of scientific knowledge,
- To understand the interdisciplinary relationships between Science and other subjects,
- To realize the relationship among Science, Technology, and Society,
- To realize and cultivate Scientific temperament,
- To foster and nurture Creativity.

Nature of Knowledge according to NCFSE-2023 (NCERT, 2023)

Science is a system of knowledge that is organized due to curiosity followed by scientific inquiry, logical reasoning along with experimentation accompanied by empirical evidence. It enables us to understand the physical as well as the natural environments and phenomena, relations including causes and effects, and supportive development of models, theories, laws, and principles. These can be generalized as-

- Science is itself a creative endeavour in fundamental stage,
- Science helps to explore and understand the world by providing the methods and tools,
- Scientific knowledge always keeps evolving as depicted from its history.

Learning Standards: Curricular Goals and Competencies

- **Middle stage (Grade 6 to 8) (NCERT, 2023)**

Maintaining the balance with Preparatory stage, the science education should be more inquiry based and understanding based. It should be in a blended form with social science and vocational education. Curriculum will be more subject-specific. The Curricular Goals (CGs) and the aligned Competencies (Cs) in Middle stage are depicted in Table no. 1.

Table no. 1 Curricular Goals (CGs) and Competencies (Cs) in Middle stage

No. of CGs	Curricular Goals (CGs)	Competencies (Cs)
CG-1	Exploring matter and its constituents, properties	To classify matter on the basis of physical and chemical characteristics, To describe physical and chemical changes in matter, To measure physical properties of matter and proper use of unit, To explain natural phenomena with scientific theory.
CG-2	Exploring the physical world in scientific and mathematical terms	To describe one-dimensional motion, To illustrate heating and magnetic effect of electricity in a simple circuit system, To describe the magnetic properties, To demonstrate rectilinear propagation of light and laws of reflection, To identify and study the nature of celestial objects (stars, planets, natural and artificial satellites, constellation, moon etc.)
CG-3	Exploring the living world in scientific terms	To describe the diversity of living things, To distinguish the characteristics between living and non-living things, To analyse relationships between living organisms and their environments, To explain the conditions for sustaining life on Earth and other planets.
CG-4	Understanding the components of health, hygiene, and wellbeing	To explain the effect of nutrition on health on the basis Indian culinary and modern food habits, To examine different dimensions of diversity of food, To describe the biological changes during adolescence and to ensure its overall well-being, To recognize and discuss about abuse in students' lives.
CG-5	Understanding the relationships of Science, Technology, and Society	To illustrate the use and abuse of science and technology in our lives, To observe and monitor various incidents in our surroundings with respect to science, technology and societies.

CG-6	Exploring the nature of Science through scientific knowledge and scientific inquiry	To realize the evolution of scientific knowledge and scientific temper over time, To form questions using scientific terminology and evaluate it.
CG-7	Communicative approaches related to Science	To communicate scientifically in all respect, To design and build simple models to demonstrate scientific concepts, To represent real world events and relationships through scientific diagrams and representations.
CG-8	Understanding and appreciating the contribution of India from past to present times to Science education	To know and explain the significant contributions of India to all matters, taught in its curriculum in integrated manner
CG-9	Developing science awareness and accepting upcoming future discoveries	To state concepts representing the most current understanding of the matter being studied, depending on the developmental stage of the students, To state questions related to matters in the curriculum.

- **Secondary stage (Grade 9 to 12) (NCERT, 2023)**

Multidisciplinary and choice-based courses are introduced and encouraged from secondary level without maintaining any specific borderline between arts, science, humanities, vocational along with curricular and co-curricular activities. 'Greater breadth' and 'greater depth' both the concepts are envisioned through students' curriculum. Students have to complete 'sixteen essential courses' within grade 10 and 'sixteen choice-based courses' within grade 12. The Curricular Goals (CGs) and the aligned Competencies (Cs) in Secondary stage are depicted in Table no. 2.

Table no. 2 Curricular Goals (CGs) and Competencies (Cs) in Secondary stage

No. of CGs	**Curricular Goals (CGs)**	**Competencies (Cs)**
CG- 1	Exploring matter and its interactions and properties at the atomic level	To describe classification of elements by periodic table and atomic structure, To investigate the nature and properties of chemical substances, To explain chemical interactions and chemical equations.

CG- 2	Exploring the physical world and understanding scientific principles and laws	To apply Newton's first law in one-dimensional force, To explain mass and weight of a substance, To explain optics, To illustrate application of electricity, To apply theories of work and energy, To demonstrate machines and mechanical energy, To explain sound energy.
CG- 3	Exploring the structure and function of the living world at the cellular level	To explain the role of cellular components and functions of different body organs, To describe various physiological process like, nutrition, transport, reproduction etc., To explain heredity and variation.
CG- 4	Exploring interconnectedness between organisms with their environment	To explain cellular diversity in organisms along with the ecological aspect, To illustrate organizations of living organisms in different levels from molecules to organisms, To analyse different levels of biological organization from organisms to ecosystems and biomes, To explain inheritance of traits, To describe biological evolution.
CG- 5	Drawing connection between science and other subjects' curriculum	To connect science with literature and arts, To relate the Science in human life from the perspective of both Social Sciences and ethics, To apply scientific principles to explain occurrence in other subjects.
CG- 6	Understanding and appreciating India's science contribution throughout	To know and explain the India's significant contributions to all matters, studied in an integrated curriculum.
CG- 7	Developing science awareness and accepting upcoming future discoveries	To state concepts representing the most current understanding of the matter being studied, depending on the developmental stage of the students,

		To state questions related to matters in the curriculum.
CG- 8	Exploring the nature of science by doing science	To develop accurate and appropriate models to represent real-life events and phenomena using scientific principles, To design and implement a plan for scientific inquiry guided by scientific knowledge and scientific technology.

Developing 21st Century Capacities as mentioned in NEP-2020 (MHRD, 2020)

It comprises of-

- Communication in all way,
- Capability of using more than one language,
- Science-oriented temperament,
- Art and Craft and its aestheticism,
- Ability to solve problems,
- Sustainability in living,
- Literacy about our culture,
- Balanced sociological and emotional attributes,
- Indulging in lifelong learning.

Science Curriculum Development in Singapore

Science Curriculum Framework (MOE, 2024g)

'Science for Life and Society'- a tagline at the core of this framework directs the goals of science education.

Science Education and its Goal (MOE, 2024g)

- To provoke and make all the students have scientific literacy which guides them to have their own decisions. They will be responsible for their livelihoods,
- To develop strong science background for learners to innovate and pursue STEM for their future lives and works.

Science Education and its Vision (MOE, 2024g)

It covers the desired and overall learning outcomes of students studying science education through three underlying principles:

- ✓ Inspired by science- Students enjoy the science subject not only in learning but also, they feel happy through correlating this in everyday lives. In the 21st century, they are inspired to make careers related to science serving mostly the nation.
- ✓ Inquire as a scientist- With a profound science, students learn the spirit generated due to scientific inquiry. Besides they can formulate questions and solve them scientifically and can judge the situation logically.

- ✓ Innovate using science- Being enthused by science, the student can solve their real-world problems whether they are personal or societal and thus encouraging scientific innovation.

Besides the above three principles, the learning outcomes in science are covered by–

- Core Ideas,
- Practicing,

Science Syllabus at Lower Secondary Express Course /Normal (Academic) [LSSE/N(A)]

- ❖ **Aims (MOE, 2024g)**

These are to-

- practice science as a collective human endeavour for better understanding rather than just a fact,
- make students scientifically eligible to take decisions of their own and be liable for their society,
- develop strong fundamentals in science that contribute to scientific inquiry and science innovation along with problem-solving ability.

- ❖ **Syllabus framework (MOE,2024g)**

This LSSE/N(A) curriculum depends on several themes that are classified in the primary level science syllabus and form the base-stone for upper secondary science. These themes along with topics are discussed in Table 3.

Table 3. Overview of the Lower Secondary Science Syllabus [Express/ Normal (Academic)] (MOE,2024g)

Themes	**Topics**
	The Scientific representation of Endeavour
Diversity	Exploration of Diversity of Matter through Physical Properties, Chemical Compositions and by Separation Techniques
Models	Light and its Ray Model, Life and its Basic Unit (Models of Cells), Matter and its Particulate Nature (Model of Matter), the Atoms and the Molecules (Model of Matter)
Interactions	Applying Forces and Transferring Energy, Effects of transferring Heat Energy, Chemical Changes, Ecosystems along with its interactions
Systems	Electrical Systems, Digestive system in Human Body, Transport Systems within Living Things, Reproductive System in Human Body

Now-a-days, the above mentioned LSS/N(A) syllabus is termed as G2/ G3 Lower Secondary Science syllabus according to Subject-Based Banding. (MOE, 2024i)

Lower Secondary Normal (Technical) [LSSN(T)] course

- **Aims (MOE, 2024j)**

These are described to-

- develop competencies appropriate for 21st century which make the students eligible for their own critical and inventive thinking while solving problems and communicating others,
- make the students familiar with not only contextualized but also hands-on learning applicable for their everyday life being enabled with science and technology along with ICT,
- prepare students as lifelong learners who can motivate others and contribute as future citizens.

- **Syllabus framework (MOE, 2024j)**

The topics of the LSSN(T) syllabus under various modules are elaborated through the Table 4.

Table 4: Overview of the Lower Secondary Science Syllabus [Normal Technical] (MOE,2024j)

Modules	Topics
	Laboratory measurements and procedures
Machines around us	Force, Energy, Electricity, Heat
Our environment	Matter, Water pollution, Air pollution
Our body and health	Cells, Food energy, Human reproduction, My body

Now-a-days, the above mentioned LSS/N(T) syllabus is termed as G1 Lower Secondary Science syllabus according to Subject-Based Banding. (MOE, 2024h)

Upper Secondary Biology/ Chemistry/ Physics course

- **Aims (MOE, 2023a; MOE, 2023b; MOE, 2023c; MOE, 2023d; MOE, 2023e; MOE, 2023f)**

The Upper Secondary science (Biology, Chemistry and Physics) syllabus are based on-

- development of students' understanding, skills with ethics, attitudes having relevance to the science practice through practical applications of the concerned fields in real world,
- deepening interests as well as knowledge in the three subject,
- becoming a responsible person for 21st century,
- being eligible to use minimum number of basic principles and disciplinary ideas while solving problems in physical world.

- **Syllabus content of Biology in Upper secondary in GCE 'N' level and GCE 'O' level (MOE, 2023a; MOE, 2023b)**

The sections and the topics underlying them are described in Table 5.

Table 5: Content mentioned in Upper Secondary Biology in GCE 'N' level and GCE 'O' level (the topics assigned for GCE 'O' level are shown in italics)

Sections	Topics
Cells and Bio chemistry	Cellular structure and its organization, Substances' movement, Bio-molecules
Life cycle in Human Body	Nutrition of Human body, Transport system in Humans, Respiratory system in Human, Infectious Diseases in Human body
Plants and Animals while living together and *Ecosystems*	Mechanism of Nutrition and Transport system in Flowering plants, *Organisms with their Environmental relation*
Life and its Continuity	*Molecular Genetics, Human Reproductory system, Inheritance*

- **Syllabus content of Chemistry in Upper secondary in GCE 'N' level and GCE 'O' level (MOE, 2023c; MOE, 2023d)**

The sections and the topics underlying them are described in Table 6.

Table 6: Content mentioned in Upper Secondary Chemistry in GCE 'N' level and GCE 'O' level (the topics assigned for GCE 'O' level are shown in italics)

Sections	Topics
Structural properties of Matter	Experimental Chemistry, Matter and its Particulate nature, Chemical Bonding
Chemical Reactions	Chemical Calculations, Chemistry of Acid-Base, Qualitative analysis, *Redox Reactions*, Periodic Table, *Chemical Energetics, Reactions' Rate*
The role of Chemistry in Sustainable world	Organic Chemistry, Maintenance of Air quality

- **Syllabus content of Physics in Upper secondary in GCE 'N' level and GCE 'O' level (MOE, 2023e; MOE, 2023f)**

The sections and the topics underlying them are described in Table 7.

Table 7: Content mentioned in Upper Secondary Physics in GCE 'N' level and GCE 'O' level (the topics assigned for GCE 'O' level are shown in italics)

Sections	Topics
Measurements	Units along with Measurements of Physical Quantities
Mechanics	Kinematics, Force with Pressure, Dynamics, *Forces with its Turning Effect*, Energy
Thermal Physics	Matter and its Kinetic Model, Thermal Processes
Waves	Wave Properties (General), Electromagnetic Spectrum, *Light*
Magnetism and Electricity	Current Electricity, Circuits (D.C.), Particle Electricity, *Electromagnetism with Magnetism*
Radioactivity	Radioactivity

Upper Secondary Science Syllabus [Normal Technical]

- **Aims (MOE, 2024k)**

The aims are to-

- build up 21st-century competencies in students,
- advise students in gathering not only knowledge and skills but also values to apply on a daily basis both theoretically and practically,
- apply ICT,
- make the students prepared for future learning and workforce so that they can develop more useful and relevant skills,
- prove themselves as a lifelong learner,
- be habituated to safe and ethical practices.

- **Syllabus Framework (MOE, 2024k)**

It comprises three interlinking and correlated modules, discussed along with their topics in Table 8.

In the Upper Secondary level, no particular order in which the module should be taught is shown but the modules should be followed while teaching and learning.

Table 8. Layout of Upper Secondary Syllabus in Science [Normal Technical]

Module	Topics
Surrounding machines	Energy, Wave, Electricity, Force and its effects
Food matters	Food sources, Food safety, Food chemistry
Human body concerning health	Being healthy, Digestion, Breathing, Blood circulation

21st -Century Competencies and Scientific Literacy (MOE, 2024h; MOE, 2024i)

To thrive in and ensure in a modern globalized world of the 21st century, the framework assigned for students' Competencies and Outcomes identifies the Core Ideas, Social and Emotional competencies. These are referred to as 21st Century Competencies i.e., 21CC.

Improvement of 21CC through science curriculum (MOE, 2024h; MOE, 2024i)

It can be done through-

- To increase Civic Literacy, Global Awareness, and Cross-cultural skills,
- To incorporate Critical and Inventive thinking,
- To enthuse Communication, Collaboration, and Information Skill.

Results and Discussions Comparative analysis

Similarities:

1. Both countries encourage holistic science education which results in the holistic development of children,
2. Both countries accentuate to promote the indigenous property, to provoke nationalism, and preparing lifelong learners. This is the pledge for the 21st century taken by both countries.

Differences:

1. India operates (5+3+2+2) education system till date (as the effect of NEP 2020 is not prevailed in all stages) whereas Singapore follows (6+4+2) education system. Maximum variation occurs in the secondary stage.
2. India maintains compulsory education up to class eight (age up to 14 years). Singapore maintains 10 years of compulsory general education. In the primary level, for India duration is 5 years, and for Singapore, itis 6 years.
3. For India a unified curriculum up to the secondary level is followed irrespective of students' diversity, but in Singapore, different secondary schools like- IP, NUS are working depending on the same, India opts for multilingualism for science education, whereas bi-lingual policy is discouraged in Singapore,

4. The advancement of the science curriculum of Singapore is dynamic due to inculcating curiosity and creativity from a very primary level. India has also started encouraging creative and analytical thinking rather than rote learning in a slow but undergoing process.

5. In India, group activities and surveys have been incorporated after 2005mainly at the secondary level, whereas for Singapore hands-on activities have been encouraged from the primary level after 1979.

6. For India, Laboratory activities are mainly confined to higher secondary level, whereas for upper-primary and secondary level projects are encouraged. For Singapore, hands-on activities are done through the Science garden at the primary level and the Science laboratory at the secondary level.

7. Although having a sound background in science due to a lack of practicality at the secondary level, Indian students have lagged behind in International Tests like- TIMSS, PISA, etc. But Singaporean students participate in practical experiments and problem-solving with more ease and interest at the lower secondary level which helps them to rank extraordinarily high in the international TIMSS, PISA test.

8. Science learning at the primary level appears as a wing of the subject 'Environmental Studies' for India, whereas for Singapore different science syllabus is followed,

9. Science education is appeared as a composite subject at the Indian secondary school level, whereas a more advanced and elaborated syllabus is pursued the same in Singapore.

10. Incorporation of technology in the science curriculum is more in Singapore than that in India.

11. Inter-disciplinary subject change is more feasible in Singapore from a lower secondary stage than that in India.

12. Proposal has been taken recently to form a 'knowledge-based economy' for India, whereas for Singapore this has been continued from 1979 onwards.

13. Values and Ethics are more extensively followed in the science curriculum of Singapore with respect to India.

Conclusions:

In India, having the second largest population in the world, the percentage of GDP has stayed stagnant at 2.9% since 2019 (retrieved from https://economictimes.indiatimes.com) and is only marginally up from 2.8% in FY2016. Whereas in Singapore, MOE has received the third largest budget for the education sector in FY2023 with a projected total expenditure of USD 10.89 billion (retrieved from https://www.trade.gov/market-intelligence/singapore-budget-2023). This sharp difference in the budget clearly reflects why Singapore makes more approachable opportunities for their students with more ease. With a more flexible, purposeful, activity-based science curriculum Singaporean students set their benchmark high in various international tests, whereas India has yet to reach that goal. With NEP 2020, India has presented a revolutionary change in its school curricular system which will definitely reflects in their students' science achievements. As both countries stand firm to maintain 21st-century goals, it is desirable that they can originate scientifically and technically well-equipped manpower and a better world.

References:

Govt. of India. (1986). *New Education Policy*, New Delhi: Ministry of Education.

Kim, Y., Chu, H.-E. & Lim, G. (2015). Science Curriculum Changes and STEM Education in East Asia. In M.S. Khine (ed.), *Science Education in East Asia*: *Pedagogical Innovations and Research-informed Practices*. Springer. doi: 10.1007/978-3-319-16390-1_7

Kumar, R. & Singh, S. (2018). Aspects of science education in India: A synoptic review and possible directions for the future. *Current Science, 114* (9), 1825-1828. http://www.jstor.org/stable/26495328

Lee, Y.-J. (2008). Thriving in-between the cracks: Deleuze and Guerilla science teaching in Singapore. *Cultural Studies of Science Education, 3*, 917-935.

Mathew, R. & Balachandran, U. (2018). Comparison of the educational system in Singapore and India and how India can reform its current practices to improve the quality of learning. International *Journal of Advance Research and Development, 3*(1), 245-248.

Maxwell, D. (2017, January 15). *Lessons from Singapore*. Teacher's Notes. https://teachersnotes.net/2017/01/15/lessons-from-singapore/

Ministry of Education (MOE), Singapore. (n.d.). Courses and subjects for secondary schools. (Retrieved on 11 august, 2024 from https://www.moe.gov.sg/secondary/courses)

Ministry of Education (MOE), Singapore. (2024a). Science (Biology) syllabus: Upper secondary Express course sec 5 Normal (Academic) course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/syllabuses/science/updated-2024/2023-olevel-sciencebiology-syllabus-updated-2024.pdf

Ministry of Education (MOE), Singapore. (2024b). Science (Biology) syllabus: Upper secondary Normal (Academic) course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/syllabuses/science/updated-2024/2023-nlevel-sciencebiology-syllabus-updated-2024.pdf

Ministry of Education (MOE), Singapore. (2024c). Science (Chemistry) syllabus: Upper secondary Express course sec 5 Normal (Academic) course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/syllabuses/science/updated-2024/2023-olevel-sciencechemistry-syllabus-updated-2024.pdf

Ministry of Education (MOE), Singapore. (2024d). Science (Chemistry) syllabus: Upper secondary Normal (Academic) Course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/syllabuses/science/updated-2024/2023-nlevel-sciencechemistry-syllabus-updated-2024.pdf

Ministry of Education (MOE), Singapore. (2024e). Science (Physics) syllabus: Upper secondary Express course sec 5 Normal (Academic) course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/syllabuses/science/updated-2024/2023-olevel-sciencephysics-syllabus-updated-2024.pdf

Ministry of Education (MOE), Singapore. (2024f). Science (Physics) syllabus: Upper secondary Normal (Academic) course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/syllabuses/science/updated-2024/2023-nlevel-sciencephysics-syllabus-updated-2024.pdf

Ministry of Education (MOE), Singapore. (2024g). Science syllabus: Lower secondary Express course Normal (Academic) course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/syllabuses/science/2021-science-lower-secondary-expressnormalacademic-syllabus.pdf

Ministry of Education (MOE), Singapore. (2024h). Science syllabus: Lower secondary General 1 course. Singapore: Curriculum Planning and Development Division. file:///D:/2021%20G1%20Lower%20Secondary%20Science%20Syllabus%20updated%20Apr%202024.pdf

Ministry of Education (MOE), Singapore. (2024i). Science syllabus: Lower secondary General 2 course General 3 course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/fsbb/syllabus/2021-g2g3-lower-secondary-science-syllabus-updated-apr-2024.pdf

Ministry of Education (MOE), Singapore. (2024j). Science syllabus: Lower secondary Normal (Technical) course. Singapore: Curriculum Planning and Development Division. https://www.moe.gov.sg/-/media/files/secondary/syllabuses-nt/science/2021-science-syllabus-lower-secondary-nt.pdf

Ministry of Education (MOE), Singapore. (2024k). Science syllabus: Upper secondary Normal (Technical) course. Singapore: Curriculum Planning and Development Division. file:///D:/2023%20Upper%20Secondary%20Science%20NT%20Syllabus%20updated%20Apr%202024.pdf

Ministry of Human Resource Development, Govt. of India (2020), *National Educational Policy-2020*. Retrieved March 25, 2024 from https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

National Council of Educational Research and Training. (2000). *National Curriculum Framework for School Education*. New Delhi: Publication Department, NCERT.

National Council of Educational Research and Training. (2005). *National Curriculum Framework for School Education*. New Delhi: Publication Department, NCERT.

National Council of Educational Research and Training (NCERT). (2023). *National Curriculum Framework for School Education*, (pp. 1-600). New Delhi: Publication Department, NCERT. https://www.ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf

Pramanik, S. (2019). Contemporary mathematics education at secondary level in India, China and USA: A comparative evaluation. (Doctoral thesis). University of Kalyani: India.

http://hdl.handle.net/10603/459894

Pramanik, S., & Guha, D. (2019). A comparative study on development of secondary mathematics curricula of India and China. In M. Chakrabarti (Ed.), *Cognizance: The new vistas of education & psychology: Vol. 2*. 140-149. Paschimbanga Anchalik Itihas O Loksanskriti Charcha Kendra (PAIOLCK).

Poon, C.-L. (2014). Five decades of science education in Singapore. In A.-L. Tan, C.-L. Poon & S.S.L. Lim (Eds.), *Inquiry into the Singapore science classroom: research and practices*, 1-25. Springer. doi:10.1007/978-981-4585-78-1_1

Sarangapani, P. M. (n.d.). *Three challenges facing Indian school science education.* Retrieved on March 25, 2024 from http://www.esocialsciences.org/eSS_essay/Science_education/Three%20Challen ges%20Facing%20India_Sarangapani.pdf

Singapore Budget 2023, (February 21, 2023), International Trade Administration Department of Commerce, United States of America. Retrieved from

https://www.trade.gov/market-intelligence/singapore-budget-2023#:~:text=In%20the%20area%20of%20education,students%20and%20salaries%20for%20educators.

Sharpe, L. & Gopinathan, S. (2002). After effectiveness: New directions in the Singapore school system? *Journal of Educational Policy, 17*, 151-166

Tan, K.C.D., Teo, T.W. & Poon, C.L. (2016). Singapore science education. In M.-H. Chiu (ed.), *Science Education Research and Practice in Asia*, 155-1174. Springer. doi:10.1007/978-981-10-0847-4_9

The Organization for Economic Cooperation and Development (OECD). (2011). *Lessons from PISA for the United States, Strong Performers and Successful Reformers in Education*. OECD Publishing. http://dx.doi.org/10.1787/9789264096660-en

The Organization for Economic Cooperation and Development (OECD), (2020). *Curriculum reform: A literature review to support effective implementation. Working Paper No. 239.* OECD Publishing. https://www.oecd-ilibrary.org/docserver/efe8a48c-en.pdf?expires=1692547949&id=id&accname=guest&checksum=48F23AD353 C075FD9EF80EBE5B0CDA35

Trends in International Mathematics and Science Study (TIMSS), International Study Centre. (2019). *Highlights of results from TIMSS.*

Vaidiyanthan, S. (2020). *Comparing school education in India and Singapore.* Retrieved March 25, 2024 from www.thepeninsula.org.in

van den Akker, J. (2010). Building bridges: how research may improve curriculum policies. In S.M. Stoney (ed.). *Beyond Lisbon 2010: Perspectives from research and development for educational policy in Europe,* 175-195. CIDREE.

Yue, C.S. (2014). Singapore: towards a knowledge-based economy. Retrieved on March 25, 2024 from http://www.nomurafoundation.or.jp/en/wordpress

Citation: Nandy. A. & Pramanik. S., (2024) "Science Curriculum at Secondary School Level of India and Singapore: A Comparative Study", *Bharati International Journal of Multidisciplinary Research & Development (BIJMRD)*, Vol-2, Issue-9, October-2024.