Pedagogical Research
2023, 8(4), em0171
e-ISSN: 2468-4929
https://www.pedagogicalresearch.com

MODESTUM

Research Article

OPEN ACCESS

Evolution of education at the secondary school level in India with mathematics in and out of focus

Rupa Pal [1*], Mahua Basu Mallik [2]

[1] UG & PG Department of Mathematics, Bethune College, Lake Town Kolkata, West Bengal, INDIA
[2] Institute of Education (PG) for Women, Chandernagore, Hooghly, West Bengal, INDIA
***Corresponding Author:** rupapalres@gmail.com

Citation: Pal, R., & Basu Mallik, M. (2023). Evolution of education at the secondary school level in India with mathematics in and out of focus. *Pedagogical Research, 8*(4), em0171. https://doi.org/10.29333/pr/13544

ARTICLE INFO

Received: 08 May 2023

Accepted: 30 May 2023

ABSTRACT

The educationists and the statesmen of different eras have casted mathematics education in different forms, and it has swayed to and from the elites to the commoners several times. The vision of the educationists always took tolls on mathematics curriculum, which survived the maximum change during the past one century. Several unorganized or partially organized ventures of mathematics education planning were seen in the pre-colonial era whereas the colonial period displayed some extremely organized, target-oriented decisions regarding the education system as a whole, taking mathematics in and out of focus. In this article, we have focused on the change in mathematics curriculum at the secondary school level in India.

Keywords: education commissions, education policies, mathematics pedagogy, secondary education, school education

INTRODUCTION

The dilemma between mass education and exclusive education has swiveled itself with mathematics curricula over the centuries. The evolution of mathematics over the past was chiefly guided by the decisions of the state whether to educate masses or to impart sophisticated education to the elites. The reason for this can be accorded to the fact that mathematics remains the tool for precision in all of the scientific and logical discourses and thus a device for the rulers to control the masses. The vision of the state and its educationists has modified the access of the commoners to education vehemently.

In the past 50 years there was a considerable rise in the enrolment in primary and secondary classes (Index Mundi, 2023). The gross enrolment percentage at the primary school level in India was 89.70% in the early 80s. This was the result of a consistent and remarkable rise from 1.12% in 1971 (NITI Aayog, 2019). There was a rapid growth in the number of secondary schools closely following the increasing graph of enrolments in schools. Therefore the quality development of secondary education was imminent. We observed that all education commissions, before and after independence in India, considered mathematics as one of the important secondary school subjects. Some recent studies (Ponce-Campuzano, 2013; Stipek, 2013) have outlined the evolution of mathematics curriculum and teacher preparation programs in different countries. A number of studies dealt with the various dimensions of mathematics as a school subject (http://gmt.sagepub.com/search?author1=Ryan+Bazinet&sortspec=date&submit=SubmitBazinet & Marshall, 2015; Manjunath, 2010; Naik, 2008; Simon, 2006; Siraj-Blatchford & Nah, 2014; Sophian, 2013). We will explore the changes in teaching mathematics at Indian secondary school level–the evolution of teaching mathematics, through the research question–what is the changing component?

PRE-COLONIAL PERIOD

The history of the Indian education system spans over several centuries and ranges over several modes of imparting education. The pre-historic education system was rather homebound, experience-based, unorganized, and family-oriented. Later on, the education system saw complex classifications into forms and streams. The Indus Valley civilization exhibited some proofs of education, which are thought to be housebound and private teacher-centric. No evidence was found about the existence of institutional education. The Indian establishments in the Vedic period boasted of an extremely well-organized education system in world famous centers of education called *gurukuls,* with children joining at the age of 12 years. During the early Vedic period the common people had free and easy access to education that pivoted around the three R's: reading, writing, and arithmetic. The chief method of learning involved memorization practices inducing very fast mental calculations. A *brahmacari* had to learn arithmetic, geometry and astronomy as a part of the course that ended at 24 years of age, however, performing fast mental calculations in arithmetic remained the fort of Indians till the late colonial

era. The late Vedic era imposed the division of the masses into classes and eventually made education exclusive. The *ashram* or *gurukul* system continued but was open to the higher classes and elites only. This was the time when education was gender-specific and class-specific but the education system was more organized and uniform across the Indian subcontinent.

The subsequent Buddhist period saw wider participation in education disrupting the class system, but the emphasis remained on redemption, salvation and blissful living. Education was monastic, inclusive and focused at holistic development of oneself. The education centers were the *viharas*, which provided food and shelters, funded mostly by the kings, allowed entry at the age of 8 and compulsory training of 12 years. Though mathematics appeared minimally in different forms in the higher academic courses taught in the *viharas,* there was not much focus on the subject, and scope for research in mathematics had diminished.

The Muslim invasion had brought in welcome changes with opening of *maktabas* and *madrasas* that took education to the new and formal institutional form. Religion took a rather front seat as compared to the any other era, but mathematics research activities were high too. This was the time when a broad curriculum of mathematics was taught to the students. The age of entry was remarkably low among the Muslims and the entrants were mostly trained in rote memorization of which the chief content were the *paharas* or multiplication tables. Arithmetic, geometry, understanding the calendar, the astral movements, astral navigation, and logic courses were taught in the advance levels. However, there were further advanced levels of learning, which involved sophisticated training in mathematics leading to some serious research.

COLONIAL PERIOD

The Christian missionaries who came with the trading companies tried to spread the religion and indulged into education too. The Charter Act of 1698 mentioned that it was the duty of the ministers of religion to preach as well as teach. There had been some escalating conflicts between the trading company and the missionaries, which were resolved by the Charter Act of 1813. It was the first time that a large number of funds were allocated towards the promotion of education across India and a policy was made for the purpose. There were classical as well as angelical views that divided the policy makers and the educationists. The *anglicizes* mostly dominated and the need for imparting education in mother tongue remained neglected for decades to come. The education movements in the colonial period were joined by Indian social reformers and mathematics remained in focus. It is important to note that the curriculum during the initial years of women education included arithmetic alongside needle-work, household work, first aid and nursing, though basic science was introduced much later. Later on the system became more inclusive and the decades approaching independence saw schools and colleges for women dawning into a common curriculum for boys and girls including mathematics and other sciences.

POST-INDEPENDENCE ERA

The independent India saw several commissions, committees, and policies trying to settle the most important and basic component of the education system: the secondary education system. There were attempts for ‘Walt Disneyfication’ that kept the learners guarded against the harshness of the real world. There also were advocates of the ‘deficit theory’ who wanted to incorporate relatable problems for learners from diverse socio-economic strata.

After achieving independence in 1947, the new-formed government strongly felt the necessity of reformation of secondary education. The University Education Commission (Ministry of Education, 1948) (also known as the Radhakrishnan Commission) remarked that our secondary education remained the weakest link in our educational machinery, and it needed urgent reforms. It laid great stress on the introduction of general education throughout the schooling years. The Commission clearly wanted school curriculum to diversify in such a way that many could effectively participate in real life by taking up jobs or self-employment and only very few would continue to study beyond school.

As per the recommendation of the University Education Commission (Ministry of Education, 1948), the Government of India set up a Commission for Secondary Education, also known as the Mudaliar Commission. In 1952, the Mudaliar Commission introduced the policy of developing a three-year national system of secondary education, after the completion of eight years of elementary education and proposed mathematics as a compulsory subject in schools up to class VIII.

In 1959, the National Committee on women’s education recommended that there should be identical curricula for boys and girls at primary stage but at the secondary stage there is need for differentiation of the course and that the girl students have no need to study mathematics at this stage they may take home science or any other vocational study.

To examine all aspects of India’s education sector and evolve the general education pattern, to frame guidelines and policies for the development of the education system, the Government of India set up the National Education Commission (famously known as Kothari Commission) in 1964. Calling for compulsory education up to the age of 14, the Commission remarked that the “advent of automation and cybernetics in this century marks the beginning of the new scientific-industrial revolution and makes it all the more imperative to devote special attention to the study of mathematics”. Incorporating the recommendations of the Commission, National Policy on Education 1968, the first policy on education in India, was announced, which proposed all round development in every field through technological and scientific advancements with special emphasis on mathematics teaching. Though the focus lied on the criticized ‘three language model’ there were some appreciable moves of setting up umbrella organizations to ensure continuous up gradation of the education sector. Whence followed the formation of the National Council of Educational Research and Training (NCERT, 2020), State Council of Educational Research and Training (SCERT) and strengthening of the University Grants Commission (UGC) for regular monitoring, formulation and implementation of the relevant policies.

The New National Policy on Education was introduced in 1986 to prepare India for the 21st century. The Policy stated,

> "mathematics should be visualized as the vehicle to train a child to think, reason, analyze and to articulate logically" (Dewan et al., 2012).

Realizing the social relevance of the recommendations of the Kothari Commission the Policy remarked that mathematics should be taught as a compulsory subject of general education up to class X. This opened into the era of open education and private sector providing technical education.

Again in 1990, to examine the existing education policies and to suggest new measures for promoting industrialization and development of rural areas of the country, the Ram Murti Committee was formed. Before considering the suggestions of the Ramamurthy Committee, a concrete program emerged as National Program of Action, 1992 as a modification of the NEP suggested by the Central Advisory Board of Education (Education For All In India, 2023).

In 2005, adopting a new policy based on the "common minimum program'', the national curriculum framework (NCF) was published. The shift in treating mathematics education as an instrument over the years for national development via the development of the abilities of future citizens was perceptible in the position papers. Position papers on teaching of mathematics published with NCF 2005 state that

> "developing children's abilities for mathematization is the main goal of mathematics education. The narrow aim of school mathematics is to develop 'useful' capabilities, particularly those relating to numeracy–numbers, number operations, measurement, decimals, and percentages. The higher aim is to develop the child's resources to think and reason mathematically, to pursue assumptions to their logical conclusion and to handle abstraction. It includes a way of doing things, and the ability and the attitude to formulate and solve problems" (NCERT, 2005).

This has rendered the study of mathematics child-friendly and envisaged that a child's active engagement in mathematics leads to arming them with life skills like "enquiry, exploration, questioning, debates, application and reflection leading to the energy building and creation of ideas/positions in mathematics", which will, in turn, enrich the young mind. This affected the mathematics syllabi directly. The focus of learning changed from rote memorization of variables, formulas, theorems, figures, charts to understanding the ideas of arithmetic, algebra, geometry, data handling and framing results through experiments and relatable experiences. The idea of mathematics laboratories came up to facilitate the paradigm shift.

National education policy (NEP) 2020, a comprehensive framework for elementary education to higher education as well as vocational training in both rural and urban India was revealed aiming at universalization of the Indian education system (NEP, 2020). NCF for school education 2020 includes the new societal and pedagogical requirements of the decade but stays within the broad guidelines of the national policy on education 1986 and 1992. Among the major components in the qualitative improvement mentioned in the policy papers we find the recommendation of

> "bringing mathematics closer to life and setting up of mathematics corner in the existing science laboratories for practical mathematics up to the secondary stage".

NEP 2020 also recognizes 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 (UN, 2020). 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".

ROLE AND VALUES OF MATHEMATICS IN SCHOOL EDUCATION

In his book '*Mathematics, the mirror of civilization*', Lancelot Hogben states that

> "since much of man's relation to man and nature has come to be treated in mathematical terms, it is dangerous to ignore the new language [mathematics]" (Hutchins & Adler, 1990).

From a very ancient time the relation of mathematics with civilization and culture was established and society has also recognized the importance of mathematics. Mathematics is such a cornucopia of subjects, which enables us to understand, explain and improve the simple daily life. The study of mathematics enables men to develop their power of logic, habit of critical thinking, confidence in scientific analysis, habit of methodical, accurate and systematic work, and attitude of independent work.

The place of mathematics in modern education must be determined by an analysis of the culture of civilization of modern society. The Kothari Commission report (1964-66) rightly points out that the study of mathematics plays a prominent part in modern education. It says,

> "one of the outstanding characteristics of scientific culture is quantification. Mathematics, therefore, assumes a prominent position in modern education. Apart from its role in the physical sciences it is now playing an increasingly important part in the development of the biological sciences."

Mathematics, therefore, assumes a prominent position in modern education. Mathematics education in schools improves concept development, fosters higher cognitive abilities and skills. Mathematics is a very useful subject for most vocations and higher specialized courses of learning. At the higher secondary and university stages, most of the physical and social sciences require the applications of mathematics but their approaches, ways and requirements are distinct, as it is for students from different socio-economic backgrounds.

Table 1. Evolution of mathematics teaching at secondary level

Education commissions in independent India	Importance of mathematics in secondary education	Aims of mathematics teaching	Methods of teaching	Method of evaluation
Mudaliar Commission, 1952	Compulsory subject in schools up to class VIII for boys	To develop numerical abilities	Stress on computational process	Summative evaluation, no part marking
National Committee on Women's Cducation, 1959	Compulsory subject in schools up to class VIII for both genders	To develop numerical abilities	Stress on computational process	Summative evaluation, no part marking
National Policy on Education, 1968	Compulsory subject of general education up to class X for both genders	To develop numerical abilities & logical reasoning ability	Stress on computational process	Summative evaluation, no part marking
National Policy on Education, 1986	Compulsory subject of general education up to class X	To develop numerical abilities & logical reasoning ability	Stress on activity- & project-based methodology	Summative evaluation, no part marking
National Curriculum Framework, 2005	Compulsory subject of general education up to class X	Mathematization of child's thought process	Stress on activity-based learner centric, & project-based methodology	Continuous comprehensive evaluation
National Educational Policy, 2020	Compulsory subject of general education up to class X	To enhances power of thinking, reasoning, sequencing, ordering, & to handle abstraction	A variety of innovative methods that should lead to enjoyable, engaging, & experiential learning	Continuous comprehensive evaluation & no year-end qualifying examinations till X

Thus a course in mathematics cannot be equal or uniform for all. Principles and standards for school mathematics states it in the similar tone mentioning that

> "equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students."

No other subject can be a substitute for mathematics. Thus mathematics has now become compulsory in the school curriculum.

EVOLUTION OF MATHEMATICS TEACHING AT SECONDARY LEVEL

Table 1 shows evolution of mathematics teaching at secondary level.

CONCLUSIONS

With a target to "ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling" the United Nations under millennium development goals has declared that the enrolment in primary education in the developing nations has reached 91.00%". But with about 8.00-9.00% (almost the most or highest populated age group) of the Indian population in the secondary school age in the past 10 years and about 50.00% gross enrolment in secondary education, the development of this section of the population remains a necessity for the future of the country.

In school education quality index report 2019 collated by NITI Aayog (2019), the quality of education is measured at three levels, class 3, 5, and 8, and one of the indicators of the quality of education is learning outcomes measured via the responses in learning language and mathematics. The report says

> "it measures students' preparedness for transition to the next level of education positively correlated with improved enrolment, retention and completion rates at higher levels of education as well as with improved labor market outcomes. Improved outcomes in foundational learning are also related to improved health-seeking behavior and reduced delinquency."

The learning targets of mathematics are knowledge of ideas, reasoning, disposition of a problem, skills of finding a solution, and the idea of success. Factually these are by large the learning targets for every discipline and philosophically of any problem or life at large. Thus, we look forward to future educational policies with a special focus on the improvement of mathematics as a curricular subject and experiential learning of the subject too.

Author contributions: All authors have sufficiently contributed to the study and agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Acknowledgements: The authors are grateful to the learned and esteemed referee for his/her valuable comments for the artcle.

Ethical statement: Authors stated that the study involved no patients or animals, no personal or sensitive data of people, organisations or government. Ethical documentation was not applicable for the study.

Declaration of interest: No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Bazinet, R., & Marshall A. M. (2015). Ethnomusicology, ethnomathematics, and integrating curriculum. *General Music Today, 28*(3), 5-11. https://doi.org/10.1177/1048371315573566

Dewan, H., Batra, N., & Chabra, I. S. (2012). Mathematics up to the secondary level in India. In R. Ramanujan, & K. Subramanium (Eds.), *Mathematics education in India: Status and outlook*. Homi Bhaba Center for Science Education.

Education For All In India. (2023). *Education for all in India*. www.educationforallinindia.com/1953%20Secondary_Education_Commission_Report

Hutchins, R. M., & Adler, M. J. (1990). *Gateway to the great books*. Encyclopædia Britannica Inc.

Index Mundi. (2023). *India–School enrollment*. https://www.indexmundi.com/facts/india/school-enrollment

Manjunath, D. (2010). *Use of mathematics laboratory for teaching mathematics*. http://www.ejournal.aiaer.net/vol21109/10/20Manjunath.pdf

Ministry of Education. (1948). *The report of the University Education Commission (December 1948-August 1949).* Government of India.

Naik, S. S. (2008). Mathematics teacher education in India–demanding change and reform in teachers' professional development. In *Proceedings of the International Conference on Mathematics Instruction*.

NCERT. (2005). *National curriculum framework 2005*. National Council of Educational Research and Training.

NCERT. (2020). *National curriculum framework for school education.* National Council of Educational Research and Training.

NEP. (2020). *National education policy 2020*. Ministry of Human Resource Development.

NITI Aayog. (2019). *School education quality index 2019*. Government of India.

Ponce-Campuzano, J. C. (2013). Developing prospective mathematics teachers in Mexico: A lesson on the relationship between integration and differentiation. *International Journal of Mathematical Education in Science and Technology, 44*(7), 996-1006. https://doi.org/10.1080/0020739X.2013.826386

Simon, M. A. (2006). Key developmental understandings in mathematics: A direction for investigating and establishing learning goals. *Mathematical Thinking and Learning, 8*(4), 359-371. https://doi.org/10.1207/s15327833mtl0804_1

Siraj-Blatchford, I., & Nah, K.-O. (2014). A comparison of the pedagogical practices of mathematics education for young children in England and South Korea. *International Journal of Science and Mathematics Education, 12*(1), 145-165. https://doi.org/10.1007/s10763-013-9412-1

Sophian, C. (2013). Vicissitudes of children's mathematical knowledge: Implications of developmental research for early childhood mathematics education. *Early Education and Development, 24*(4), 436-442. https://doi.org/10.1080/10409289.2013.773255

Stipek, D. (2013). Mathematics in early childhood education: Revolution or evolution? *Early Education and Development, 24*(4), 431-435. https://doi.org/10.1080/10409289.2013.777285

UN. (2020). *Demographic yearbook–2020*. https://unstats.un.org/unsd/demographic-social/products/dyb/dyb_2020/