



A COMPARATIVE STUDY ON OBJECTIVES OF SECONDARY LEVEL MATHEMATICS EDUCATION AMONG G4 COUNTRIES

¹Rima Ghosh, ²Debjani Guha

¹Research Scholar, ²Professor,

¹ Department of Education,

¹University of Kalyani, Kalyani, India

Abstract : Knowledge of mathematics is essential for the development of every country both as a fundamental component for science and technology and for the development of the human being. The aim of this study is to highlight the key objectives of mathematics education at secondary level among G4 countries (Brazil, India, Germany and Japan) and to make a comparative study. Comparative research approach and qualitative data analysis method are used in this study. Findings of this study suggest that there exist many similarities and differences relating to objectives of mathematics education at secondary level among G4 countries. Their ways of achieving the goal are different and are influenced by their own philosophy of mathematics education.

IndexTerms - Mathematics education, G4 Country, Secondary level, Comparative study

INTRODUCTION

Knowledge of mathematics is essential for the development of every country both as a fundamental component for science and for the development of the human being (Felda & Cotic, 2012). Mathematics is an important subject in school education. Mathematics textbooks, teaching strategies are prepared with certain curriculum goal and objectives at every level of school education and higher education. Mathematical literacy helps someone to understand the role of mathematics can play and make sound judgments and decisions needed for citizens (PISA, 2021). Mathematical proficiency is a prerequisite in most profession. Mathematics education is influenced by cultures and shaped by social, economic, historical and political factors (Radha et al, 2016). Each country has some objectives of mathematics education curriculum guided by their educational policies. The G4 countries, comprising Brazil, Germany, India, and Japan, are four nations which support each other. G4 countries were united by the shared ambition to become permanent members of UN Security Council, though they are not grouped for educational comparison. The objectives of secondary education differ significantly across G4 countries. According to TIMSS data, Japan leads the G4 nations in mathematics achievement at the fourth-grade level, followed by Germany, with India and Brazil trailing behind (Davies et.al, 2024).

Literature Review

Some related researches were studied by the researcher to justify the reason for taking this study as original. With a view to getting well acquainted with the studies and researches done in the field of comparative mathematics education among G4 countries, the researcher tried his best to review the previous studies on mathematics education in India, Germany, Japan and Brazil. Mishra & Biswal (2023) studied a research work entitled as Teaching of Mathematics at Secondary Level of Angul District. For conducting this study researchers randomly take 100 mathematics teachers as sample. Descriptive survey method was employed for this study. Researcher observed their teaching method, teaching technique, teaching skill, teaching learning material and evaluation process with the help of observation schedule. Venkatarao & Rao (2022) made an attempt to assess the mathematical achievement of 10th class pupils in Srikakulam district of Andhra Pradesh. A sample of 1000 pupils of 10th class was drawn randomly from Secondary schools located in rural as well as urban areas in Srikakulam district. The researchers developed and standardized the research tool. In this study, descriptive research method was adopted. The data were analysed using statistical measures such as Mean, Standard Deviation and t-test. The findings of the study demonstrate a substantial difference in the performance of class 10th students in secondary schools in Mathematics in relation to gender, location of the school and type of school management. Kunwar (2020) investigated the disposition of mathematics phobia of school level students in his study. The study was about the fear of mathematics, causes of it, related symptoms and ways to overcome the fear. The researcher focused on the root causes of mathematics phobia, curriculum structure, school facilities, and instructional techniques, use of tools, technologies and existing evaluation system. The study revealed that mathematics phobia exists among students, which are characterized into negative perception of the students towards mathematics and others too. Borikar & Seikdar (2019) studied on education of mathematics in India and Japan at the pre-college level. The objective of this research is to compare the components of mathematics education between India and Japan. This study is based on secondary data collected from different journals, research reports and research papers. The major findings of these paper are-Japanese students are able to make explicit links between concepts because teachers focus on developing student's mathematical thinking. The National Achievement Survey (2017), conducted by MHRD, for assessment of learning outcomes among children across India in different subjects shows that students of class three, four and five getting 64%, 53% and 42% respectively in mathematics. This is a trend of declining interest in mathematics. Central Board of

Secondary Education (CBSE) confirms that only 21% students passing secondary level opt for mathematics at the higher secondary level.

The researcher found that no such comparative study was done on objectives of secondary level mathematics education among G4 countries. The study has aimed to fill this research gap.

Objectives of the study

1. To find out the objectives of mathematics education of India at secondary level
2. To find out the objectives of mathematics education of Japan at secondary level
3. To find out the objectives of mathematics education of Brazil at secondary level
4. To find the objectives of mathematics education of Germany at secondary level
5. To compare the objectives of mathematics education at secondary level among G4 countries

METHODOLOGY USED

The study is qualitative in nature and contains the comparison between four countries. Document analysis and comparative investigation method were used for this comparison.

Sources of Research Data

Government documents, research articles, journal papers, authentic books and doctoral theses (both online and print).

ANALYSIS OF DATA

Brazil

The field of mathematics education has extended in Brazil in the last decades (Schnorr & Pietrocola, 2022). In Brazil education is guided by the Federal Government. Ministry of Education (Ministerio de Educacao) coordinate the educational programme. Federal government gave the charge of setting up educational programmes and plans on local governments and provide the financial help. Duration of upper secondary education is of three years and it is not compulsory. Mathematics education in secondary level is guided by The Common National Core Curriculum.

Objectives of secondary level mathematics education in Brazil

- To consolidate and deepen the previous mathematics knowledge the students acquired in elementary education
- To develop skills in Algebra, Geometry, Measurements, Probability and Statistics
- To promote procedural understanding and reflective study on topics
- To incorporate information and communication technologies and concrete materials
- To incorporate the history of mathematics

- To emphasize intuitive understanding before deductive aspect specially in case of geometry (TIMSS,2023)

- To ensure that mathematics in this level has real meaning for students (Dias,2021)

India

National Council for Education and Research (NCERT) developed the national curriculum framework for secondary school education.). “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, p. 42). NEP 2020 states that “It is recognized that Mathematics and Mathematics thinking will be very important for India’s future and Indian’s leadership role in the numerous upcoming fields and professions that will involve AI, machine learning, data science etc.”

Objectives of secondary level mathematics education in India

- To understand numbers, number sets and relationship among them
- To build up inductive and deductive logical thinking
- To discover and prove algebraic identities and models
- To analysis two dimensional geometric figures
- To derive and use formula to calculate area and volume
- To enable students to apply mathematical knowledges to real-life problems
- To build up skills like optimisation, representation and mathematical modelling
- To understand contributions of India in the field of mathematics
- To prepare students for higher education (Borikar & Seikdar,2019)

Japan

In Japan courses of study is determined by MEXT in terms of the board standards for schools. Mathematics education of Japan was rooted in Chinese influence in the beginning. Mathematics is a compulsory subject in primary, junior secondary and the first year of upper secondary level. In Japan school education system follows a 6+3+3+4-year structure (Alfredo & Hiroshi, 2022). Secondary education consists of two phases- lower secondary and upper secondary level. Lower secondary education covers grades seven to nine with students age group twelve to fifteen. Compulsory education of Japan is up to grade nine (lower secondary). Only those who finished their compulsory education can proceed to upper secondary school. , the National

Council of Teachers of Mathematics (NCTM) (1980) suggested that the principle of learning mathematics is "teaching and learning mathematics through problem-solving" (Soma, 2017).

Objectives of secondary level mathematics education in Japan

There are three parts in mathematics curriculum: overall objectives for the said level, objectives and content for each level, and design of the syllabus. In Japan math is taught through a spiral progression. Total time allotted for math class is 240 mins/week and 4-5 hours/week for junior secondary and upper secondary school respectively.

To develop active learning is the main goal of mathematics education. This active learning is developed through following the three pillars-knowledge and skills, thinking, judgement, and expressiveness and capability and human qualities (Alfredo & Hiroshi, 2022).

- To develop the ability of the student to think logically
- To foster a strong positive attitude towards any kind of mathematics
- To build up deep understanding about quantities and figures
- To help student to develop mathematical conceptualization and communication skills
- To enable students to use mathematical formulas to solve real life problems
- To help students to develop the knowledge of number, symbol and spatial sense
- To help students to appreciate the cultural aspects and aesthetic nature of mathematics
- To focus on both individual and collaborative learning experiences (Borikar and Seikdar, 2019)

Germany

In Germany curriculum objectives for secondary schools are developed by The Ministries of Education and Cultural Affairs in the states. The Standing Conference has introduced educational standards for mathematics and other three subjects (Information Technology, Natural Sciences and Technology). A ten-year program named QuaMath began in 2023. Aim of this program is to strengthen mathematics education in Germany (OECD, 2024). In Germany the current education system is guided by Kultusministerkonferenz (KMK) (Uderani, 2023) which is the Standing Conference of the Ministers of Education and Cultural Affairs of the Lander in the Federal Republic of Germany.

Objectives of secondary level mathematics education in Germany

- To develop mathematical skills like reasoning, problem solving, communicating and conceptualizing mathematically
- To develop mathematical literacy for everyday life

- To develop a sense of symbols, numbers and spatial knowledge
- To grow an interest of patterns and structures
- To prepare students for academic and vocational pathways
- To appreciate cultural and aesthetic aspects of mathematics
- To integrate content areas of primary grades

FINDINGS

All four members of G4 countries share some common objectives of mathematics education. Focal points of these objectives are conceptual learning, cultural relevance, preparation for higher education and problem - solving skills. Each and every member of G4 countries encourage their students to solve problems in real life situation and inform about cultural aspects of mathematics and contribution of their countries in the field of mathematics. Indian mathematics education focuses on theoretical knowledge more than practical knowledge. In Brazil mathematics education focuses on developing skills and practical knowledges. In Germany teachers encourage students to come up with their own methods to solve any mathematical problem. Main focus of mathematics education curriculum in Japan is practical learning and independent thinking.

Similarities

The key similarities are to develop cultural relevance, conceptual understanding, problem solving skills among secondary level learners and to prepare them for future higher education. There is a focus on building skills progressively, with the increasing complexity and depth at the secondary level among G4 countries (Organization for Economic Co-operation and Development, 2024).

Differences

India and Japan – both gave importance on conceptual understanding but Japan stresses more on developing multiple solution strategies and collaborative learning skills (Borikar & Seikdar, 2019). Brazil emphasizes more on real-life applications and intuitive understanding before formal deduction in learning Geometry (Dias, 2021). Germany integrates digital tools and interdisciplinary approaches more explicitly and places more focus on application of mathematical literacy for day to day life (OECD, 2024).

Comparative analysis

G-4 Countries	Main Focus
India	Mathematization of thought process
Brazil	Improvement of Mathematical Literacy
Germany	Development of Critical thinking
Japan	Deep conceptual understanding

CONCLUDING REMARKS

There are some similarities and differences in objectives of mathematics education curricula at secondary level among G4 countries. Each country has its own philosophy of mathematics which influences the objectives of mathematics education. India and Germany both countries put emphasis on the improvement of overall intellectual development of students. Mathematics curriculum in Japan is deeply influenced by problem-solving and students are encouraged to solve mathematical problems by their own. In India mathematics curriculum focuses on theoretical knowledge more than practical problems. In Brazil mathematics curriculum mainly emphasizes on the enhancement of skills which helps students in practical application of mathematical knowledge. Differences of objectives of mathematics education show the reflection of educational priorities and unique cultures of G4 countries. Each and every member of G4 countries admit the importance of mathematics education at secondary level as the foundational tool for professional and personal development. Their way to achieving these objectives vary in a significant way.

References

- Alfredo, N., and I. Hiroshi.2022. "Comparative Study of Mathematics Education in the Philippines and Japan." *Journal of Hokkaido University of Education*.72:173-187.
- Borikar, S.M., and S. M. Seikdar. 2019. Education of mathematics in India and Japan at the Pre-College Level: A Comparison & Contrast. *International Journal of Research and Review*.6(1),208-210.
- Clarke, D.2011. "International Comparative Research in Mathematics Education." *Springer International Handbooks of Education*.10:143-184.
- Dias, M.D.O.2021. "Reforms of mathematics curriculum Guidelines for middle Education in Brazil and Paraguay." *Pedagogical Research*, 6(3): em0096, <https://doi.org/10.29333/pr/10950>
- Felda, D., and Cotič, M. 2012. "Zakaj poučevati matematiko [Why teach math]." *Journal of Elementary Education*, 5(2/3): 107-120.
- Kunwar, R.2020. "Mathematics Phobia: Causes, Symptoms and Ways to Overcome." *International journal of Creative Research Thoughts*, 8(8): 818-822.
- Mishra & Biswal.2023. "Teaching of Mathematics at Secondary Level of Angul District." *International Research Journal of Modernization in Engineering Technology and Science*, 5(3): 2966-2973.
- National Council of Educational Research and Training .2005. "National Curriculum Framework for School Education." *New Delhi: Publication Department, NCERT*
- Ministry of Human Resource Development, Govt. of India. 2020. "National Educational Policy-2020." Retrieved on 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.2023. "National Curriculum Framework for School Education." *New Delhi: Publication Department, NCERT*.

- Nurlaili, Wahyuni, Y., Ananda, A., Gistituati, N., and Rusdinal.2022. “Comparison of Mathematics Learning Curriculum in Singapore, Japan, Malaysia, and Indonesia.” *International Journal of Research Publications*, 103(1):168-177. doi:10.47119/IJRP1001031620223398.
- OECD .2024. “An Evolution of Mathematics Curriculum: Where It Was, Where It Stands and Where It is Going.” *OECD Publishing*, <https://doi.org/10.1787/0fffd89d0-en>.
- T. Radha, M. Vasuki and A. Dinesh Kumar 2016. “Math Education Across Cultures: A Comparative Analysis of Global Approaches”, *Journal of Engineering Scientific Research and Applications*, 2(1): 235-247.
- Schnorr, S.M. and Pietrocola, M. 2022. “Science and Mathematics Education in Brazil: a Systematic Review of 25 Years of Research (1994–2018).” *Revista Brasileira de Pesquisa em Educação em Ciências*.22: e40543,1–29,<https://doi.org/10.28976/1984-2686rbpec2022u743771>.
- Uderani, K., Jain, A, Jadon, P.S., and C. Jain. 2023. “Comparative Analysis of the Education Systems of India and Germany.” *International Journal for Multidisciplinary Research*, 5(2): 1-15.
- Venkatarao, N. and P.D. Rao.2022. “Assessment of Mathematical Achievement of Secondary School Pupils.” *International Journal of Creative Research Thoughts*,10 (3): d138-d143.
- Von Davier, M., Kennedy, A., Reynolds, K., Fishbein, B., Khorramdel, L., Aldrich, C., Bookbinder, A., Bezirhan, U., and L. Yin, 2024. “TIMSS 2023 International Results in Mathematics and Science.” *Boston College, TIMSS & PIRLS International Study Center*. <https://doi.org/10.6017/lse.tpisc.timss>.

