

A Secondary-Data Analysis of Competency-Based Mathematics Education at the Senior Secondary Level: Evidence from Class XII CBSE Curriculum and Assessment

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Abstract

Mathematics education at the senior secondary level plays an important role in developing logical reasoning, analytical thinking, and quantitative decision-making and problem-solving abilities. However, the effectiveness of Mathematics education cannot be assessed only through students' ability to recall formulas and reproduce standard procedures. The National Education Policy (NEP) 2020 calls for a movement away from rote learning towards conceptual understanding, critical thinking, inquiry, analysis, application and problem solving. The present study examines the extent to which these objectives are reflected in the current Class XII Mathematics curriculum and assessment structure of the Central Board of Secondary Education (CBSE). The study uses secondary data obtained from official CBSE curriculum documents, the CBSE Class XII Mathematics Sample Question Paper and Marking Scheme for 2025–26, NCERT's learning-outcome framework, and Government of India policy documents.

A documentary research design was adopted. The Class XII Mathematics curriculum was analysed in terms of unit-wise weightage, while the official Sample Question Paper was analysed according to question type and marks distribution. The 2025–26 CBSE Mathematics Sample Question Paper contains 38 questions carrying 80 marks and is divided into five sections: multiple-choice and assertion-reason questions, very-short-answer questions, short-answer questions, long-answer questions and case-study-based questions. The analysis shows that 25% of the written examination marks are allocated to one-mark objective questions, 12.5% to two-mark questions, 22.5% to three-mark questions, 25% to five-mark questions and 15% to case-study-based questions. The curriculum also gives the highest weightage to Calculus (35/80 marks), followed by Vectors and Three-Dimensional Geometry (14/80), Algebra (10/80), Relations and Functions (8/80), Probability (8/80), and Linear Programming (5/80).

The findings indicate that the formal CBSE framework has incorporated several features consistent with competency-based education, particularly application-oriented questions, case-based assessment and a balance of different response formats. However, documentary evidence alone cannot establish the actual level of mathematical reasoning or critical thinking achieved by students in classrooms. The study therefore concludes that assessment reform must be accompanied by classroom-level pedagogical change, teacher capacity building and systematic use of reasoning, investigation, interpretation and real-life mathematical tasks.

Keywords: Mathematics Education, Class XII, CBSE, Competency-Based Education, Secondary Data, Mathematical Reasoning, Problem Solving, Critical Thinking, Assessment, Senior Secondary Education

Introduction

Mathematics is not simply a collection of formulas and computational procedures. It is a discipline based on reasoning, patterns, relationships, abstraction, logical argument and problem solving. At the senior secondary stage, these characteristics become increasingly important because students begin to encounter mathematical concepts that require interpretation and conceptual connections rather than simple recall. The Class XII Mathematics curriculum under CBSE includes Relations and Functions, Algebra, Calculus, Vectors and Three-Dimensional Geometry, Linear Programming and Probability. For the 2025–26 academic session, the written examination carries 80 marks and internal assessment carries 20 marks. Calculus receives the largest



allocation of 35 marks, followed by Vectors and Three-Dimensional Geometry with 14 marks. The educational purpose of Mathematics, however, extends beyond coverage of these topics. The National Education Policy 2020 explicitly emphasizes higher-order cognitive capacities such as critical thinking and problem solving and recommends moving education away from rote learning towards understanding, inquiry, discovery, discussion, analysis and application. NCERT's learning-outcome framework similarly emphasizes competency development and argues that teaching-learning and assessment should move from simple content mastery towards competency mastery. It identifies questions such as how learners learn, why they learn and how they will use knowledge as important dimensions of education. These policy directions raise an important question:

To what extent is the competency-based orientation visible in the actual Class XII Mathematics curriculum and assessment structure?

The present study addresses this question using secondary data rather than primary data. This is important because a research paper claiming to examine student competencies should not manufacture student-level evidence where no primary dataset has actually been collected.

Background of the Study

Traditional Mathematics teaching has often been associated with explanation by the teacher, formula memorisation, worked examples and repetitive practice. These practices are not inherently inappropriate. Procedural fluency remains an important component of mathematical competence.

The problem arises when procedural fluency becomes the dominant objective and students are not given adequate opportunities to:

- interpret mathematical information;
- explain why a method works;
- compare alternative methods;
- apply mathematics to unfamiliar situations;
- justify conclusions;
- represent information graphically or algebraically;
- Connect mathematical concepts with real-world situations.

The NEP 2020 provides a clear policy rationale for addressing this concern. It states that curriculum content should focus on essential concepts, applications and problem solving while creating space for critical thinking and inquiry-based, discovery-based, discussion-based and analysis-based learning. CBSE's broader competency-based framework also describes assessment in terms of competencies and provides guidance concerning content, skills, question types, assessment objectives and marking approaches. Thus, competency-based Mathematics should not be understood as the elimination of formulas or conventional examinations. Rather, it involves placing mathematical knowledge within contexts where students must understand, apply, reason and communicate.

Objectives of the Study

1. To analyse the structure of the CBSE Class XII Mathematics curriculum for 2025–26.
2. To examine the distribution of marks across major Mathematics units.
3. To analyse the question-format distribution in the official Class XII Mathematics Sample Question Paper for 2025–26.
4. To identify evidence of competency-oriented assessment within the official assessment structure.
5. To examine the alignment of the curriculum and assessment structure with NEP 2020 and NCERT competency-oriented principles.



Research Questions

The study addresses the following research questions:

1. What is the unit-wise distribution of marks in the CBSE Class XII Mathematics curriculum?
2. What proportion of the written examination is represented by different question formats?
3. To what extent does the official Sample Question Paper incorporate case-based and application-oriented assessment?
4. How is the CBSE Mathematics assessment structure aligned with the competency-oriented direction of NEP 2020?
5. What limitations remain when competency development is examined through secondary documentary evidence?

Research Methodology

Research Design

The study follows a **descriptive documentary research design** based entirely on secondary data.

Sources of Secondary Data

1. CBSE Class XII Mathematics Curriculum 2025–26.
2. CBSE Class XII Mathematics Sample Question Paper 2025–26.
3. CBSE Class XII Mathematics Marking Scheme 2025–26.
4. CBSE competency-based education and learning-framework materials.
5. NCERT Learning Outcomes at the Secondary Stage.
6. National Education Policy 2020.

Data Analysis

- frequency analysis;
- percentage calculation;
- unit-wise comparison;
- question-type analysis;
- Documentary content analysis.

Analysis of Class XII Mathematics Curriculum

The official CBSE curriculum for Class XII Mathematics 2025–26 allocates 80 marks to the written examination and 20 marks to internal assessment. The unit-wise distribution is shown below.

Table 1: Unit-Wise Distribution of Class XII Mathematics Marks

Unit	Marks	Percentage of Written Examination
Relations and Functions	8	10.00%
Algebra	10	12.50%
Calculus	35	43.75%
Vectors and Three-Dimensional Geometry	14	17.50%
Linear Programming	5	6.25%
Probability	8	10.00%
Total	80	100%

Interpretation

Calculus receives the largest share of the written examination, accounting for **43.75%** of the 80 marks. Vectors and Three-Dimensional Geometry accounts for **17.50%**, while Algebra accounts for **12.50%**. Relations and Functions and Probability each account for **10%**, while Linear Programming accounts for **6.25%**. This distribution indicates that students need substantial conceptual and procedural competence in Calculus. At the same time, the syllabus covers multiple mathematical domains requiring different forms of thinking. The high weightage of Calculus also has pedagogical implications. Calculus concepts such as continuity, differentiability, applications of derivatives, integration and differential equations can support reasoning about change, optimization and relationships. Therefore, teaching should avoid treating Calculus simply as a sequence of formulas.

Analysis of the Official Sample Question Paper

The official CBSE Class XII Mathematics Sample Question Paper for 2025–26 contains **38 questions carrying 80 marks**. It is divided into five sections. Section A contains 18 MCQs and two Assertion-Reason questions. Section B contains five two-mark questions. Section C contains six three-mark questions. Section D contains four five-mark questions. Section E contains three case-study-based questions carrying four marks each.

Table 2: Question-Type Distribution

Section	Question Type	Number Questions	of Marks Question	per Total Marks	Percentage
A	MCQ + Assertion-Reason	20	1	20	25.00%
B	Very Short Answer	5	2	10	12.50%
C	Short Answer	6	3	18	22.50%
D	Long Answer	4	5	20	25.00%
E	Case Study	3	4	12	15.00%
Total	—	38	—	80	100%

Evidence of Competency Orientation

The assessment structure contains several features that are compatible with competency-based education.

Long-Answer Questions and Mathematical Communication

Four five-mark questions account for 25% of the written paper. Long-answer questions can provide greater opportunity for students to demonstrate mathematical processes rather than simply provide a final answer. They can assess:

- sequential reasoning;
- mathematical representation;
- calculation;
- justification;
- interpretation;
- Communication of a solution.

The marking scheme provides stepwise solutions and allocation of marks to solution components, indicating that the mathematical process is important within the assessment. Nevertheless, the actual extent of reasoning assessed should be evaluated question by question in future empirical studies.

Alignment with NCERT Learning-Outcome Approach

NCERT's learning-outcome framework emphasizes competency development and states that assessment should be integrated with teaching-learning processes. It also encourages movement from content mastery towards competency mastery. This provides an important theoretical basis for Mathematics education. A student who can reproduce a differentiation formula has demonstrated knowledge of a procedure. A student who can determine when differentiation is appropriate, explain the reasoning, interpret the result and apply it to a new context demonstrates a broader mathematical competency. Therefore, Mathematics assessment should increasingly consider the complete process of:

Understanding → Representation → Strategy → Procedure → Reasoning → Interpretation

Discussion

The secondary data analysed in this study provide evidence of a formal shift towards diversified and competency-oriented assessment. The most important quantitative finding is that the 80-mark written examination is not exclusively based on one type of question. Twenty-five percent of the marks are allocated to one-mark objective questions, 22.5% to three-mark questions, 25% to five-mark questions and 15% to case-study questions. The presence of case-study questions is particularly relevant because contextual assessment can connect mathematical knowledge with situations requiring interpretation and application.

At the same time, the findings should not be overstated. It would be methodologically incorrect to conclude from the Sample Question Paper alone that **75% of the examination measures higher-order thinking**, for example. The marks distribution tells us the format of assessment, not automatically the cognitive level of every question. Similarly, the presence of case-study questions does not guarantee that students develop problem-solving competencies. Actual competency development depends upon:

- classroom pedagogy;
- teacher questioning;
- quality of practice tasks;
- student participation;
- feedback;
- assessment literacy;
- availability of learning resources;
- Opportunities for mathematical exploration.

Proposed Pedagogical Framework

Based on the secondary evidence, the study proposes a **RACE Framework** for Class XII Mathematics:

R – Reason: Students should first understand the mathematical situation and identify relationships.

A – Apply: Students should apply mathematical concepts to familiar and unfamiliar situations.

C – Connect: Students should connect Mathematics with real-world, interdisciplinary and contextual problems.

E – Evaluate: Students should verify solutions, analyse errors and justify conclusions.



For Mathematics Teachers

Teachers should combine procedural practice with conceptual questioning. Instead of asking only: **“What is the answer?”** teachers should also ask:

- Why?
- How do you know?
- Can you solve it another way?
- What happens if the condition changes?
- Is your answer reasonable?

For Schools

Schools should provide opportunities for:

- Mathematics clubs;
- mathematical investigations;
- case-based activities;
- project work;
- peer explanation;
- mathematical exhibitions;
- Technology-supported exploration.

For Teacher Training

Teacher development programmes should focus not only on content knowledge but also on:

- competency-based pedagogy;
- assessment design;
- higher-order questioning;
- mathematical discourse;
- classroom differentiation;
- Use of technology for mathematical exploration.

Limitations of the Study

- First, it is based on documentary secondary data and does not include primary data from Class XII students.
- Second, the analysis focuses primarily on the official CBSE curriculum and the 2025–26 Sample Question Paper.
- Third, the study cannot determine whether students actually possess the competencies intended by the curriculum.
- Fourth, the analysis of competency orientation is partly interpretive because question format alone does not completely determine cognitive demand.

Suggestions for Future Research

1. A five-year analysis of CBSE Class XII Mathematics board papers.
2. Comparative analysis of CBSE and state-board Mathematics assessments.
3. Student-level analysis of mathematical reasoning skills.
4. Experimental research comparing traditional and competency-based Mathematics teaching.
5. Teacher perception studies concerning case-based Mathematics assessment.



Conclusion

The present secondary-data analysis demonstrates that the CBSE Class XII Mathematics curriculum and assessment structure for 2025–26 contains several features consistent with the broader movement towards competency-based education. The curriculum allocates 80 marks to the written examination across six major units, with Calculus receiving the highest weightage of 43.75%. The official Sample Question Paper distributes the 80 marks across five different sections, including 15% for case-study-based questions and 25% for long-answer questions. These structures are broadly compatible with the NEP 2020 emphasis on conceptual understanding, critical thinking, inquiry, analysis and problem solving. They are also consistent with NCERT's competency-oriented approach, which emphasizes movement from content mastery towards competency mastery.

However, the study establishes an important methodological point: **the presence of competency-oriented curriculum and assessment structures does not by itself prove competency achievement among students**. The success of reform depends upon the connection between curriculum, classroom pedagogy and assessment. Therefore, the future of Class XII Mathematics education should not be framed as a choice between **formula learning** and **competency learning**. Students need both procedural fluency and higher-order mathematical thinking. The desired progression should be:

Remember → Understand → Apply → Reason → Analyse → Evaluate → Create

A mathematically competent Class XII learner should not merely know a formula. The learner should understand its meaning, identify when it is useful, apply it appropriately, evaluate the result and communicate the reasoning behind the solution. The secondary evidence examined in this study indicates that CBSE's current assessment architecture is moving in this direction. The next major challenge is ensuring that classroom practices consistently translate this intended reform into actual mathematical learning.

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