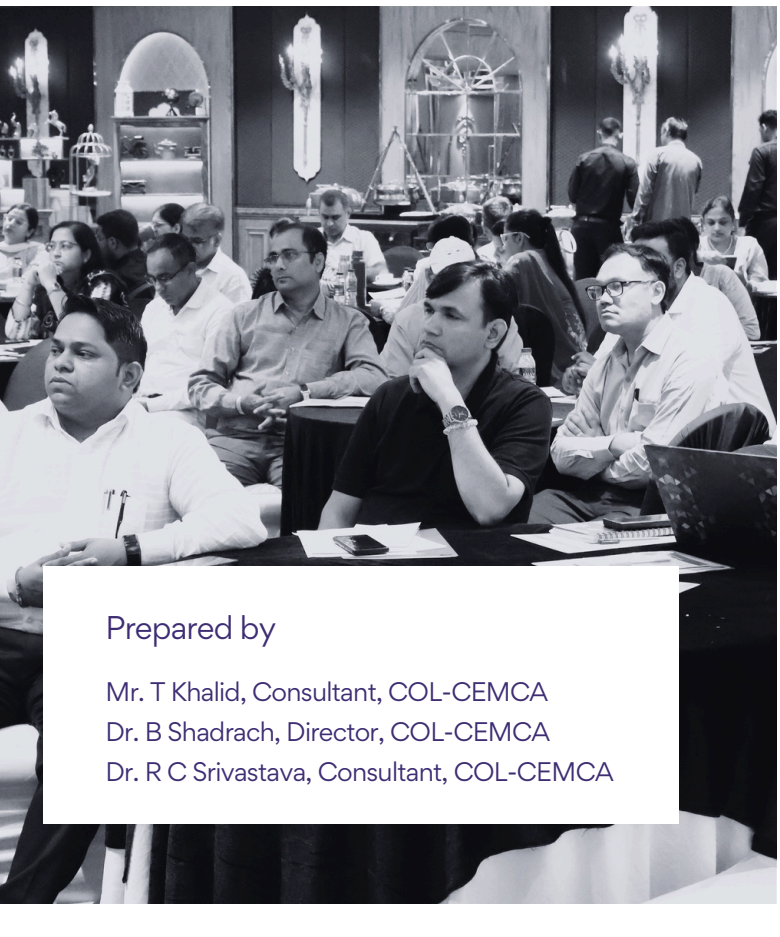
CEMCA

SEPTEMBER 2025

TEACHER IN THE LOOP AI COHORT 2.0

BOOT-CAMP REPORT



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ACKNOWLEDGEMENTS

The Commonwealth Educational Media Centre for Asia (COL-CEMCA) is taking this opportunity to acknowledge the help, support, and contribution of their partners, participants and colleagues who have worked tirelessly to make the TiL-AI Boot-camp under the Teacher in the Loop AI (TiL-AI) project a huge success.

COL-CEMCA is profoundly grateful to Dr Biswajit Saha, Director, Central Board of Secondary Education (CBSE), for his vital role in shaping this initiative and for CBSE's strong partnership with COL-CEMCA in advancing the TiL-AI project. This partnership has strengthened the TiL-AI project by on-boarding over 150 CBSE in practice, Grade 10 Mathematics teachers as TiL-AI expert teachers.

COL-CEMCA also acknowledges with thanks Dr. Sunil Bajaj, Additional Director, State Council of Educational Research & Training (SCERT) Haryana, for the collaboration and support extended by the Haryana Board, which continues to play an important role in bringing Haryana government teacher perspectives from the state education system into this national AI initiative.

The organisation expresses its sincere gratitude to Dr Joseph Emmanuel, Chief Executive and Secretary, Council for the Indian School Certificate Examinations (CISCE). This partnership has strengthened the project by addressing challenges faced by teachers across various areas of the education sector.

The deepest appreciation goes to Dr. Pooja Akshay, Assistant Secretary, Skill Education, CBSE, for her constant support and engagement throughout the bootcamp. Her insights and expertise contributed significantly to ensuring the event's success.

We also extend our heartfelt thanks to Ms. Jasneet Kaur, who designed and facilitated the capacity-building activities during the bootcamp. Her dynamic approach to teacher engagement enriched the sessions and helped create a highly participatory and collaborative learning environment.

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Finally, we extend our deepest appreciation to all the participating teachers from across the country. Their commitment, creativity, and openness to collaborate truly embody the spirit of the Teacher in the Loop AI initiative, placing teachers at the centre of innovation and ensuring that AI in education remains human-centric, inclusive, and grounded in classroom reality.

ACRONYMS

AI – Artificial Intelligence
AP – Arithmetic Progression
BPT – Basic Proportionality Theorem
CBQs – Case-Based Questions
CBSE – Central Board of Secondary Education
CEMCA – Commonwealth Educational Media Centre for Asia
CISCE – Council for the Indian School Certificate Examinations
COL – Commonwealth of Learning
CPA – Concrete–Pictorial–Abstract
CSA – Curved Surface Area
HCF – Highest Common Factor
ICT – Information and Communication Technology
LCM – Least Common Multiple
LSA – Lateral Surface Area
MCQs – Multiple-Choice Questions
NCERT – National Council of Educational Research and Training
OER – Open Educational Resources
SCERT – State Council of Educational Research and Training
TiL-AI – Teacher in the Loop AI
TSA – Total Surface Area

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EXECUTIVE SUMMARY

This report synthesises key findings and strategic insights from the Teacher in the Loop AI Cohort 2.0- National Bootcamp conducted in New Delhi, India, facilitated by the Regional Asian Centre of the Commonwealth of Learning (COL), The Commonwealth Educational Media Centre for Asia (CEMCA) in collaboration with the Central Board of Secondary Education (CBSE), Council for the Indian School Certificate Examinations (CISCE) and State Council of Educational Research and Training Haryana (SCERT). The national bootcamp aimed at systematically analysing the NCERT Grade 10 Mathematics curriculum to identify challenging and complex concepts from both teaching and learning perspectives.

Teachers engaged in activity during the national bootcamp

The Bootcamp brought together 180 (Offline 123 & Online- 57) secondary-level mathematics teachers from across the country. Through interactive activities and expert-led discussions, teachers identified over 100 challenging concepts and areas where students commonly struggle, as well as teaching–learning gaps faced in classrooms. The bootcamp also generated valuable insights into innovative practices, real-world applications, and differentiated assessments that can support mathematics learning.

The insights generated will serve as the foundation for developing targeted, AI-assisted teaching–learning resources, ensuring the integration of AI meaningfully addresses real classroom needs.

A cohort of dedicated teachers from across India **180+**

OBJECTIVES

1 Engage secondary level Mathematics teachers in collaborative discussions to identify and prioritise challenging concepts and topics in the NCERT Grade 10 Mathematics curriculum, from both teaching and learning perspectives.

2 Analyse teaching-learning gaps by sharing classroom experiences, highlighting common student misconceptions, and identifying difficulties faced in concept delivery.

3 Document insights and recommendations to guide the creation of relevant and practical teaching-learning resources for Grade 10 Mathematics.

4 Promote inter-board collaboration and sustained communities of practice among teachers and building road map for them to play a central role in shaping AI tools to reflect authentic classroom realities.

OUTCOMES

- A shared understanding of the TiL-AI project scope and expectations among participants.
- Identification and documentation of challenging Grade 10 Mathematics concepts, along with classroom experiences of difficulties and misconceptions.
- Showcasing of innovative practices, real-world application strategies, and differentiated approaches to strengthen mathematics teaching.
- Strengthened collaboration among mathematics teachers across different boards, fostering a community of practice and built a road map for involving teachers in shaping AI technologies.

THE NATIONAL BOOTCAMP

The national bootcamp opened with welcome remarks by Dr. B. Shadrach, Director, COL-CEMCA, setting the tone for the day, Dr. Shadrach highlighted AI's potential in education, particularly in routine tasks. He emphasised three key aspects to leverage AI effectively: “learning to think” - developing critical thinking skills to complement AI's capabilities; “thinking within a discipline”- engaging deeply with subjects like mathematics, understanding its standards, and participating in ongoing dialogues; “applying to real-world challenges”- using AI to tackle practical problems and think collectively.

Dr. Sunil Bajaj (Additional Director, SCERT Haryana) Dr. B Shadrach (Director, COL-CEMCA) and Dr. Pooja Akshay (Assistant Secretary, Skill Education, CBSE), Dr. R C Srivastava (CEMCA) and Mr. T Khalid (CEMCA) during the Inaugural Session

Dr. Biswajit Saha, Director, Skill Education at CBSE, emphasised, “transforming math learning into a joyful and effective experience” through AI and new technologies. He stressed that “adaptive learning, diagnosing learning gaps, and real-life problem integration” can bridge the policy-implementation gap, ensuring foundational literacy and math skills for all. He advocated for a collaborative approach to leverage technology, enhancing teaching capabilities and making math learning more engaging.

Dr. Sunil Bajaj, Additional Director, SCERT Haryana, stressed AI's role in fostering learning and critical thinking by creating “tailored problems and assessing challenges”, enabling educators to better understand and support student needs. Dr. Pooja Akshay, Assistant Secretary, Skill Education, CBSE, urged teachers to push the envelope of “student imagination and problem-solving” by using AI effectively.

BOOT CAMP ACTIVITIES

The bootcamp served as a platform for inter-board collaboration, the exchange of classroom practices, and collective problem-solving.

The collaborative session was guided by two major group activities:

* **MATH MAZE:**
  Finding the Tough Turns

Collaborative roundtable activity using voting and discussion to analyse NCERT Grade 10 Mathematics and highlight the most challenging concepts chapter-wise with shared evidence from diverse Indian classrooms.

* **THINK TANK:**
  Building Solutions

An activity involving brainstorming, documentation of innovative practices, real-life applications, and differentiated assessment strategies mapping with the identified difficult and challenging concepts.

Teachers engaged during the Math Maze: Finding the Tough Turns Activity

RECOMMENDATIONS

Integrate Teacher Insights into AI Tool Development

Utilise the identified challenging and difficult concepts as the foundation for training the AI tool for developing targeted resources.

Align Teacher Training with Identified Challenges

Masterclasses, webinars, and online training for TiL-AI teachers should directly address the most critical problem areas.

Foster Collaborative Resource Development and Peer Review

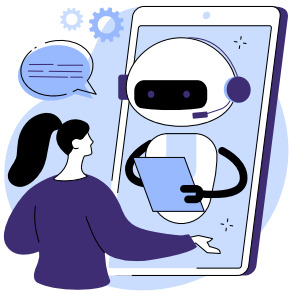
Teachers collaborate with AI and co-create AI-assisted resources for each challenging area, with systematic peer review built into the process.

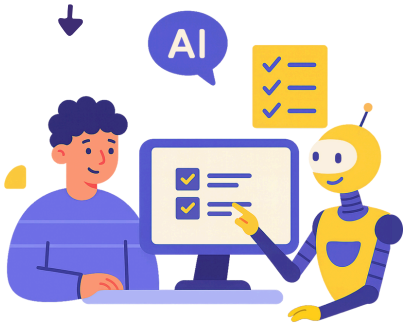
Sustain Continuous Teacher Engagement and Community of Practice

Establish a collaborative platform for teachers to share, discuss and co-develop solutions with the support of AI in addressing challenging areas.

Prepare for Classroom Pilots and Wider Dissemination

Once resources are validated, pilot them through the bootcamp teacher cohort in real classrooms. Feedback from these pilots will not only improve the resources but also prepare for large-scale adoption





BACKGROUND

The Teacher in the Loop AI (TiL-AI) project is a pioneering initiative led by the Commonwealth Educational Media Centre for Asia (CEMCA), the regional office of the Commonwealth of Learning (COL), in collaboration with CBSE, CISCE, SCERT Haryana and NCERT in India. The initiative is grounded in the belief that teachers must be central to the ethical and meaningful integration of artificial intelligence (AI) in school education.

Unlike many top-down technology projects, TiL-AI embraces a bottom-up approach, ensuring that teachers' voices, classroom experiences, and professional expertise forms the foundation for developing educational tools. The initiative is aimed at exploring how teachers can enhance their classroom teaching by experimenting with AI and integrating it across various aspects of instruction by empowering educators to co-create, adapt, and review AI-assisted educational resources, ensuring these materials are pedagogically sound, curriculum-aligned, and contextually relevant to Indian classrooms. The project addresses both the pressing need for scalable, high-quality digital teaching resources and the professional development of teachers in emerging technologies.

100+

AI- teacher co-developed grade 10 mathematics resources from phase 1 ready to be piloted in Indian classrooms.

PHASE 1- TEACHER IN THE LOOP AI

During the phase 1 of the initiative, through structured online and offline workshops enabled teachers in identifying challenging areas of Grade 9 NCERT curriculum and co-developing resources using an AI Powered OER Adaptation tool. Through a systematic process of AI-assisted generation, peer review, and expert validation, more than 100 high-quality Educational Resources (OERs) were developed for publication through COL's OER repository. Key outcomes include:

- **Teacher Participation:** Over 90 in-service secondary level mathematics teachers of CBSE and CISCE, from various states of India joined together.
- **Pedagogical Focus:** Identification of challenging concepts in the NCERT Grade 9 curriculum which are difficult for teachers to teach and learners to learn.
- **Capacity Building:** Delivery of blended training through offline bootcamps and online workshops.
- **Collaborative Resource Development:** Creation of over 100 AI-assisted educational resources (lesson plans, activities, teaching materials) through structured, AI creation, curation and peer review process.

- **Validation Process:** Peer review and expert validation of developed content for public dissemination.

- **Publication:** Over 100 resources (lesson plans, activities and teaching materials) aligned with Grade 9 mathematics, prepared for release through the Commonwealth of Learning's global OER repository.

This collaborative model not only enhanced the instructional design capabilities of participating teachers but also demonstrated how AI tools can support authentic, teacher-led educational transformation.

Teachers engaging with the AI tool to develop resources under Phase 1 of the Teacher in the Loop AI initiative.

PHASE 2- TEACHER IN THE LOOP AI

Building upon the success of Phase 1, COL-CEMCA in partnership with CBSE, CISCE and SCERT Haryana initiated the next Phase of the TiL-AI project (August 2025 – December 2025) with a focused thematic shift to Grade 10 Mathematics. This progression is both strategic and necessary, Grade 10 serves as a critical academic year for students across the country, forming the foundation for board examinations and impacting long-term educational trajectories. Teachers' support at this level is pivotal to improve learning outcomes and to prepare students for higher-order mathematical thinking. The Teacher in the Loop AI National Bootcamp (Cohort 2.0) engaging over 180 secondary-level mathematics teachers from across India, was the first major activity of Phase 2, serving as a strategic platform to capture classroom challenges and co-create directions for the months ahead

Teacher in the Loop AI Cohort 2.0

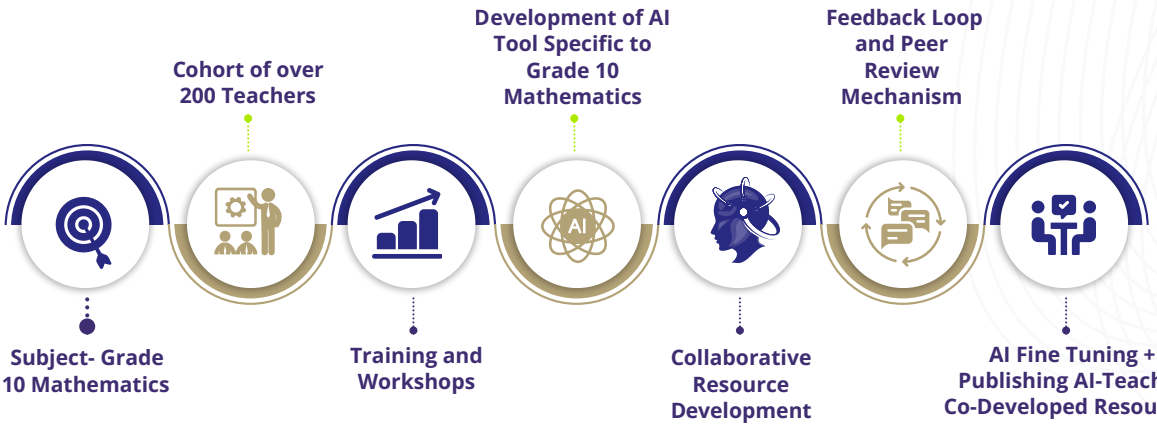


Diagram 1: Implementation Roadmap of the Teacher in the Loop AI Initiative

BOOTCAMP METHODOLOGY

The bootcamp followed a participatory, activity-based format designed to capture the lived classroom experiences and strategic inputs of mathematics teachers. Instead of expert lectures dominating the day, teachers worked in roundtable groups where peer dialogue, consensus-building, and collective problem-solving were at the center. The bootcamp involved two major activities:

Teachers engaged in brainstorming and presentation activities during the national bootcamp

ACTIVITY 1 – MATH MAZE: FINDING THE TOUGH TURNS

In this exercise, teachers worked in groups of 8–9, each allocated specific chapters of the Grade 10 NCERT Mathematics textbook. One teacher would propose a challenging concept or a topic, while the rest of the group used a color-coded card voting system to categorise it:

COLOR-CODED CARD VOTING MECHANISM

Red Card	Topic is difficult for both teaching and learning
Yellow Card	Topic is difficult for students to learn but manageable to teach
Green Card	Topic is neither difficult to teach nor learn

This voting process allowed teachers to democratically prioritise the most difficult concepts, while also recognising areas where student struggles were greater than teaching complexity. This approach ensures equal involvement of teachers within a group and enables collective decision making.

The significance of this activity lay in its ability to surface authentic, ground-level challenges and to do so through consensus. The output was a comprehensive list of over 100 challenging areas across all 14 chapters.

Teachers engaged in the color-coded card voting activity

ACTIVITY 2 – THINK TANK: BUILDING SOLUTIONS

Building on the first activity, the same groups reconvened to brainstorm practical solutions for the identified challenges. For each concept marked as challenging, teachers from different parts of the country, representing over 20 states contributed insights and real classroom experiences under three categories:

CURRENT INNOVATIVE PRACTICES

What strategies are already being used successfully in classrooms against the identified challenging area?

REAL-LIFE APPLICATIONS

How can the difficult concepts be tied to real-world contexts to improve students engagement in classroom set-up?

DIFFERENTIATED ASSESSMENTS

How can different assessment strategies be tailored for diverse learners?

This activity ensured that the bootcamp was not just a problem-identification exercise but also a solution-building forum. The documented outputs represent a knowledge base of classroom wisdom that will directly feed into TiL-AI's collaborative resource development and AI tool fine-tuning.

TiL-AI is a bottom-up, scalable, teacher-centric AI approach that advances the goal of a safe, inclusive, and human-centric AI ecosystem.

PARTICIPANTS

The Bootcamp brought together a diverse group of 200 mathematics educators (123 offline & 59 online) from across India, representing the Central Board of Secondary Education (CBSE), the Council for the Indian School Certificate Examinations (CISCE), and Haryana State Education Board (SCERT). Participants were selected based on their demonstrated commitment to classroom innovation, experience in mathematics teaching, and engagement with educational technology and resources.

The cohort reflected a balanced mix of experienced senior educators and early adopters of technology, creating a dynamic environment for professional exchange. The presence of teachers from both urban and rural schools representing over 20 states of India ensured that the discussion captured a wide spectrum of classroom realities, from high-resource schools to those facing infrastructural challenges in India.

Participants		
Gender	**In Numbers**	**Percentage %**
Female	108	60%
Male	72	40%
Total	180	100%

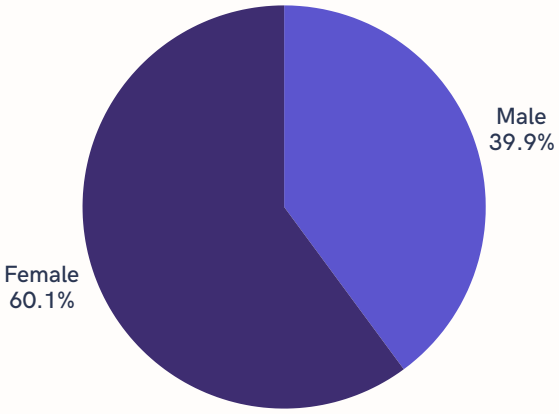


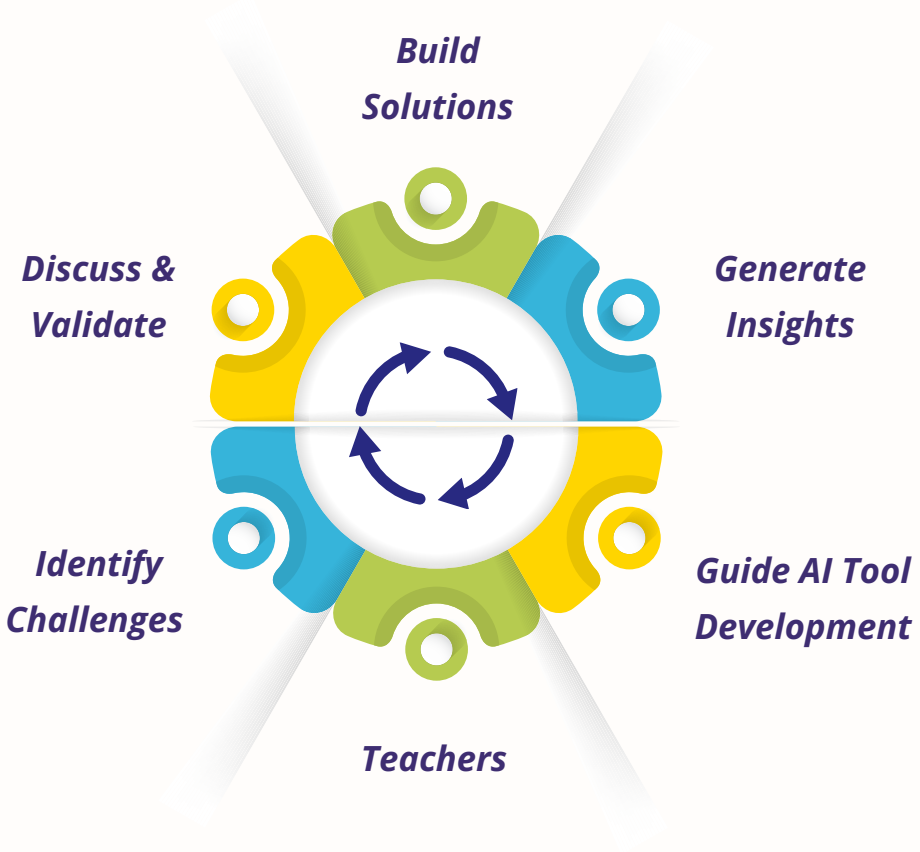
Diagram 2: Pie Chart showing the diversity of participants gender

Teachers were grouped based on the 14 chapters of the Grade 10 Mathematics curriculum. To enhance engagement, the 57 online participants were further divided into smaller groups and assigned to breakout rooms for more interactive discussions.

BOOTCAMP FINDINGS

The Teacher in the Loop AI Bootcamp served as a landmark exercise in setting the foundation for training the AI tool by identifying and analysing the most challenging areas within the NCERT Grade 10 Mathematics curriculum. Through a combination of structured dialogue, peer collaboration, and reflective analysis, teachers mapped over one hundred areas that pose significant conceptual or pedagogical challenges. The findings provide a nationally validated perspective on mathematics teaching and learning, and ensured teachers' direct involvement in shaping Artificial Intelligence to address real classroom challenges.

The collective insights gathered from 180 participating teachers revealed patterns that transcend individual classrooms reflecting systemic learning difficulties, conceptual gaps, and opportunities for innovation. The bootcamp's outcomes extend beyond diagnosis, they include a rich documentation of tested strategies, applications, and assessment methods that can directly enhance classroom practice.



HIGHLIGHTS OF THE FINDINGS

01

Comprehensive Map of Challenges:

The bootcamp produced a detailed, teacher-validated mapping of challenging concepts across all 14 chapters of Grade 10 Mathematics. These findings capture both the teaching and learning perspectives, supported by evidence from teachers' day-to-day experiences.

02

Repository of Pedagogical Innovations:

Teachers shared a wide range of classroom tested innovative teaching practices, ranging from hands-on classroom experiments and peer-learning models to context-based activities, that effectively address complex mathematical concepts.

03

Real-World Applications:

Many discussions highlighted the importance of contextualising mathematics through real-life examples, such as linking geometry to architecture, trigonometry to sports and astronomy, and statistics to social and economic data.

04

Differentiated Assessment Strategies:

Teachers collectively shared in practice alternative assessment approaches to cater to diverse learner needs, including tiered worksheets, project-based evaluations, and diagnostic tools to identify learning gaps early.

05

Strengthened Community of Practice:

The exercise fostered a collaborative ecosystem of educators across boards and states, reinforcing TiL-AI's central goal of empowering teachers as co-creators of AI-aligned educational innovations.

RECOMMENDATIONS

Based on the findings, the following recommendations are made for the next steps of the project:

1 Develop a National Repository of Challenging Concepts

The chapter-wise challenges identified during the bootcamp should be consolidated into a structured repository. This resource will serve as the foundation for resource crowd sourcing for AI fine tuning, teacher training and AI-assisted resource development in Phase 2.

2 Align Teacher Training with Identified Challenges

Conduct readiness programmes for the teachers engaged through cohort 2.0 including Masterclasses, webinars, and online training on AI and resource development aligned with the identified challenging areas. The succeeding major activities like AI offline and online workshops shall too directly address the most critical problem areas in teaching and learning practices (e.g., trigonometry, proofs, probability). This ensures teachers are well-prepared to guide the AI tool in generating relevant and practical resources.

3 Integrate Teacher Insights into AI Tool Development

The AI tool designed for Grade 10 Mathematics under the Phase 2 of the Teacher in the Loop AI initiative should be fine-tuned using bootcamp outputs. Teachers must remain central to this process, continuously validating and providing feedback on whether the tool's outputs address the specific classroom challenges identified.

4 Foster Collaborative Resource Development and Peer Review

Engage teachers to co-create AI-assisted resources through a systematic process of creating, curating and peer reviewing, for each challenging area. This will guarantee quality, curriculum alignment, and contextual relevance before final publishing. This process will further empower teachers with practical skill to exploit AI in developing resources responsibly and ethically for classroom use.

5 Prepare for Classroom Pilots and Wider Dissemination

Once resources are validated and finalised, pilot them through the in-practice teachers of the cohort to monitor and evaluate its real classroom effectiveness and impact. Feedback from these pilots will not only improve the resources but also prepare for large-scale adoption via CBSE, CISCE, and state boards. The AI-Teacher Co-developed resources will be published through a large global open repository and made available for educators across the world.

6 Sustain the Community of Practice

The bootcamp cohort must be empowered to adapt into an active professional network. Mentor based sessions for small groups of teachers, peer knowledge sharing, collaborative activities, and teacher challenges (such as teacher competitions) will ensure the community remains engaged and continues to shape TiL-AI beyond Phase 2.

ANNEXURES

ANNEXURE 1- BOOTCAMP AGENDA

ANNEXURE 2- MEDIA ELEMENTS

ANNEXURE 3- DETAILED ANALYSIS OF NCERT GRADE 10 MATHEMATICS

ANNEXURE 1- BOOTCAMP AGENDA

Programme Agenda

Time	Activity	Speaker
9:00 AM- 9:15 AM		**Registration**
9:15 AM- 10:15 AM	**Introduction & Moderation**	Mr. T Khalid, Consultant, COL-CEMCA
	Welcome Remarks	Dr. B Shadrach, Director, COL-CEMCA
	Keynote Address	Dr. Biswajit Saha, Director, Skill Education, CBSE
	Guest of Honour	Dr. Sunil Bajaj, Additional Director, SCERT Haryana
	Special Address	Dr. Pooja Akshay, Assistant Secretary, Skill Education, CBSE
10:15 AM- 10:45 AM	**Subject Expert Talk**	Dr. R C Srivastava, Consultant, COL-CEMCA
10:45 AM- 11:00 AM	**Round Tap- Group Formation**	Ms. Jasneet Kaur, Facilitator
11:00 AM- 11:15 AM		**Tea Break**
11:15 AM- 01:00 PM	**Activity 1- Math Maze: Finding the Tough Turns**	Dr. R C Srivastava, Consultant, COL-CEMCA
01:00 PM- 02:00 PM		**Lunch Break**
02:00 PM- 02:15 PM	**Team Building Activity**	Ms. Jasneet Kaur, Facilitator
02:15 PM- 03:30 PM	**Activity 2-Think Tank: Building Solutions**	Dr. R C Srivastava, Consultant, COL-CEMCA
03:30 PM- 03:45PM		**Tea Break**
03:45 PM- 04:30PM	**Group Presentation**	
04:30 PM- 05:00PM		**Closing Session**

ANNEXURE 2- MEDIA ELEMENTS

Teachers during the national bootcamp

ANNEXURE 3- DETAILED ANALYSIS OF NCERT GRADE 10 MATHEMATICS

Chapter 1: Real Numbers - Summary of Challenging Areas

This section provides the critical foundation for Number Theory in higher secondary mathematics. It primarily introduces two pivotal theorems: Euclid's Division Lemma and the Fundamental Theorem of Arithmetic. The chapter focuses on using these theorems to calculate the Highest Common Factor (HCF) and Least Common Multiple (LCM) of positive integers, establish the nature of numbers through the algebraic proof of irrationality, and to understand the decimal expansion of rational numbers. Mastery of this chapter is essential for all subsequent algebraic and number-system-based topics.

Chapter Name	Challenging Topics
Real Numbers	• Distinguishing between Euclid’s Lemma and Algorithm • Finding HCF and LCM of three numbers • Solving real-life problems using HCF and LCM • Proofs of irrational numbers • Prime factorisation of large numbers • Application of Division Lemma (a = bq + r) • Understanding why a number raised to the power n ends with 0

Current and Innovative Pedagogical Practices

- **Algorithm Analogy:** Using the analogy of the "making-tea process" to logically explain the sequence and steps of Euclid's Division Algorithm, contrasting it with the Lemma as the fundamental rule.
- **Role Play:** Utilising role-play based on divisibility rules to help students break down and understand the prime factorisation of large numbers.
- **Hands-on Activities:** Implementing grid methods and other hands-on activities to teach the HCF and LCM of three numbers.
- **Logical Exposition:** Providing an in-depth explanation through a classroom scenario to demystify the abstract nature of the irrationality proofs.

Real-Life Applications

- **Euclid's Lemma & Distribution:** Preparing seating arrangements in examination rooms or the general task of making distribution of items.
- **HCF/LCM:** Solving problems related to measurement (finding the largest equal measure), the synchronization of traffic light signals, or the ringing of bells.
- **Prime Factorisation:** Linking the concept to modern technology applications such as coding using number locks and cryptography.
- **Irrationality:** Discussing the presence of π, the diagonals of a square, and the golden ratio in architecture and art.

Assessment and Evaluation Methods

- **Differentiated Worksheets:** Creating worksheets for different ability levels to assess mastery of Euclid's Lemma and proofs of irrationality.
- **Creative Quizzes:** Conducting quizzes and tasking students with framing questions by taking random numbers to test their understanding of the lemma's constraints.
- **Brainstorming:** Utilising brainstorming sessions for abstract conceptual questions, such as the problem of numbers ending with the digit zero.
- **Project-Based Assessment:** Assigning tasks involving HCF through music composition and assessing the synchronisation of games with drum beats to test application-based understanding of HCF/LCM.
- **Higher-Order Questioning:** Employing assertion-reasoning questions and debates (e.g., on the grid method) to evaluate the understanding of HCF and LCM of three numbers.

Chapter 2: Polynomials

This chapter introduces students to the algebraic structure of polynomials, focusing primarily on quadratic polynomials. The key concepts include the geometrical meaning of the zeroes, the relationship between the zeroes and the coefficients, and the application of the division algorithm. This chapter serves as a crucial bridge between algebra and geometry, to establish the visual representation of algebraic equations and setting the stage for subsequent chapters on quadratic equations.

Chapter Name	Challenging Topics
Polynomials	• Interpreting sign of coefficients from graph of the polynomial • Difference between zeroes of the polynomial p(x)=y and p(y)=x • Effect of signs and values of a, b, and c on the graph of the polynomial • Applications of zeroes in real-life contexts • Relation between the zeroes and coefficient of the polynomial • Finding values of a and b in ax+bx+c when zeros are given

Current and Innovative Pedagogical Practices

- **Dynamic Graphing Software:** Utilising GeoGebra/ Desmos allows students to try out different polynomial graphs, helping them visually connect algebraic changes to geometric transformations.
- **Identity Derivation:** Explicitly teaching the derivation of identities of higher powers.
- **Coordinate Geometry Integration:** Teachers recommend connecting the analysis of coefficients with coordinate geometry concepts, such as the concept of the intercept, to explain the nature of the coefficient.

Real-Life Applications

- **Business:** Applications in profit and loss analysis.
- **Design and Engineering:** Relevance to Architecture and graphics and animation.
- **Movement and Trajectory:** Used in analysing parabolic motion in space.
- **Technology:** Key concepts are used in navigation.

Assessment and Evaluation Methods

- **Differentiated Algebra:** Assessing the algebra of rational and irrational numbers by progressing from simple to complex problems.
- **Interactive Graphing Tasks:** Assigning tasks using GeoGebra/ Desmos where students are prompted to generate graphs with specific properties.
- **Conceptual Mapping:** Developing questions that require students to connect with coordinate geometry to determine the properties of the graph from its coefficients.

Chapter 3: Pair of Linear Equations in Two Variables

This chapter focuses on simultaneous linear equations, providing both graphical and algebraic methods for their solution. Key topics include the geometric representation of different possibilities for solutions (intersecting, parallel, or coincident lines), the algebraic conditions for consistency and inconsistency, and the three primary methods of algebraic solution: substitution, elimination, and cross-multiplication. The central objective is to model and solve real-life problems using these pairs of equations.

Chapter Name	Challenging Topics
Pair of Linear Equations in Two Variables	• Formation of equations from real-life situations • Solving pairs of equations with irrational coefficients • Equations where constants appear as parameters • Understanding the concept of consistency and inconsistency • Distinguishing between ‘no solution’ and ‘infinite solution’ cases • Forming the second equation when one equation and a condition are given

Current and Innovative Pedagogical Practices

- **Experiential Learning and Storytelling:** Using storytelling and experiential learning by objects in class to anchor the abstract concepts.
- **Role-Playing:** Role-playing is used to help students understand the mechanics of word problems, such as age-related problems.
- **Technology Integration:** The use of ICT animations is recommended for visualising and solving distance-related issues.
- **Alternative and Collaborative Learning:** Encouraging peer study and flipped classes , as well as promoting solutions by alternative approaches, is a core strategy

Real-Life Applications

- **Commerce and Finance:** Problems related to shopping and profit/loss analysis are common.
- **Dynamics and Movement:** Modelling of distance-related issues.
- **Logical Puzzles:** Solutions to age-related problems.
- **Sporting Scenarios:** Application to various sports.
- **General Modelling:** Teachers noted that all problems in this category are effectively real-life situations where linear equations are used for quantitative analysis.

Assessment and Evaluation Methods

- **Differentiated Worksheets:** Providing different worksheets to test procedural and conceptual understanding at varied difficulty levels.
- **Objective Questions:** Use of objective questions to quickly test factual knowledge of consistency rules and coefficient relations.
- **Support for Slow Learners:** Utilising flash cards for slow learners to aid in memorisation of key rules and formulae.
- **Targeted Instruction:** Implementing concept-building classes to address specific areas of weakness.

Chapter 4: Quadratic Equations

This chapter focuses on finding the roots (solutions) of equations in the form ax^2 + bx + c = 0, where “a ≠ 0". It establishes the link between the quadratic equation (representing the roots where the curve cuts the x-axis) and the quadratic polynomial (representing the curve itself). The main solution methods covered include factorisation (splitting the middle term) and the Quadratic Formula (derived from completing the square). A critical conceptual component is the discriminant (D = b^2 - 4ac), which determines the nature of the roots (real/imaginary and distinct/equal).

Chapter Name	Challenging Topics
Quadratic Equations	• Quadratic equations involving surds or irrational coefficients • Derivation of the quadratic formula • Connecting quadratic equations with real-life situations • Finding roots of quadratic equations involving irrational numbers • Using the quadratic formula for solving equations • Comprehending and translating word problems into quadratic equations • Understanding the discriminant (D) and distinguishing between real and imaginary roots

Current and Innovative Pedagogical Practices

- **Visualisation Tools:** Using visual aids like graphs and dynamic tools like GeoGebra/ Desmos to show the impact of the discriminant (number of roots).
- **Conceptual Contrast:** Recommended practice to compare linear, quadratic and cubic functions for better contrast.
- **Derivation Focus:** Emphasis on step-wise derivation of the quadratic formula.
- **Problem Modelling:** Comparing word problems side by side: "linear vs quadratic". Encouraging students to create their own word problems and using group discussion for identifying the type of problem.
- **Error Analysis:** Stressing the checking of feasibility of solutions in word problems , including role-play ("policeman" rejecting invalid answers).

Real-Life Applications

- **Physics and Motion:** Projectile motion (time of flight, range), and trajectories in sports (Basketball, cricket).
- **Business and Economics:** Maximising/ minimising profit functions and general economics profit revenue models.
- **Design and Engineering:** Designing dimensions (e.g., rectangular garden area), calculations in geometry, construction/engineering feasibility checks, and architecture (parabolic arches in bridges).
- **Time and Distance:** Solving speed/ time/ distance problems and age problems.

Assessment and Evaluation Methods

- **Practical Graphing:** Students plot Q.P. and identify the roots (solutions).
- **Creative Assessment:** Giving puzzles where students must arrange numbers that multiply and add up correctly (for factorisation).
- **Differentiated Practice:** Use of dedicated and focused worksheets, including new questions related to the concept and same worksheet with three levels (basic, intermediate, advanced).
- **Conceptual Tasks:** Worksheets with parameter 'k' to analyse different cases, a sorting activity to find D and identify the various roots.
- **Project-Based Learning:** Assigning project-based learning where students identify real-life quadratic situations, including outdoor experiments (e.g., throwing a ball and recording time).
- **Collaborative/Self-Assessment:** Encouraging students to frame questions, check with peers, and engage in group discussion.

Chapter 5: Arithmetic Progressions

This chapter focuses on introducing students to a specific type of sequence where the difference between consecutive terms remains constant, known as the common difference (d). The chapter provides methods to find the n^{th} term of an AP and the sum of the first n terms. It bridges the gap between patterns observed in nature and their algebraic representation, serving as a critical tool for modelling linear growth and accumulation.

Chapter Name	Challenging Topics
Arithmetic Progressions	• Confusion or mix-up between for the n^{th} term and sum of n terms of an A. P • Deciding when to apply the last term formula versus the n^{th} term formula • Finding the n^{th} term from the end of a sequence • Understanding and explaining the derivation and reasoning behind AP formulas • Proving results and providing reasoning in AP-related questions • Distinguishing between sequence, series, and progression • Relating Arithmetic Progressions to real-life contexts and examples

Current and Innovative Pedagogical Practices

- **Visual and Concrete Models:** Using number lines, dot patterns, visual models to make the concept of "equal spacing" concrete.
- **Formula Derivation:** Derive formulae from real-life contexts and focus on step-wise derivation.
- **Scaffolding and Progression:** Give mixed examples (whole numbers, fractions, decimals, algebra). Scaffold practice from numeric to simple algebraic to complex algebraic. Use structured templates for word problems.
- **Conceptual Clarity:** Use double-column tables (n vs a_n) and contrasting questions to reinforce the distinction between coefficient of terms and number of terms.
- **Reasoning and Inquiry:** Encourage guided reasoning/fill-in proofs and implement the ideology of productive failure by using real-life hooks and guiding students to find concepts by themselves (CPT - connecting with the bonds).

Real-Life Applications

- **Finance and Savings:** Daily savings increase by a fixed amount , salary hike/pocket money every year by a fixed amount, and helping mom to calculate milk budget.
- **Arrangement and Design:** Patterns in the staircase, rows of chairs in an auditorium , designing patterns where lengths increase linearly, and planning tree planting at equal distances along a road.
- **Logistics and Scheduling:** Bus stops placed at equal intervals along a route, assigning room numbers for an examination, and the cost of movie tickets increasing row by row.
- **General Context:** Any day-to-day example and phone number observation based on AP.

Assessment and Evaluation Methods

- **Differentiated Tasks:** Differentiated work where weaker students calculate manually and advanced students generalise the n^{th} day.
- **Creative/Visual Tasks:** Designing a floor or room using patterns and visual skills. Use of manipulatives and card games.
- **Collaborative Learning:** Quiz, games, activity, think-pair-share and collaboration with Excel sheets (IT).
- **Conceptual Questioning:** Thinking-based questions on the concept of productive failure, and asking students to prove a sequence is an AP.
- **Technology Integration:** Using GeoGebra slider.

Chapter 6: Triangles

This chapter focuses on introducing students to the concepts and application of similarity in geometric figures, with a special focus on triangles. The chapter establishes criteria for similarity, introduces the Basic Proportionality Theorem (BPT) (also known as Thales' theorem) and its converse, and focuses on applying these principles, along with similarity criteria (like SAS criterion for similarity of triangles), to solve complex geometric problems.

Chapter Name	Challenging Topics
Triangles	• Application of similarity in solving problems from other topics • Difference between congruency and similarity • Correspondence of sides and angles in similar figures • Identifying triangles to be proved similar • Application of Basic Proportionality Theorem • Application of Converse of BPT • Deciding when to use BPT or its converse

Current and Innovative Pedagogical Practices

- **Visual Aids:** Using cut-outs of squares, equilateral triangles and circles to physically demonstrate similarity and congruence.
- **Graphing Activity:** Use 1 cm and 1-inch graph sheets for replicating figures.
- **Technology Integration:** Employing a GeoGebra applet for the Basic Proportionality Theorem.
- **Conceptual Tools:** Utilising Frayer's model and concept maps to clarify terms and relationships.
- **Reinforcement:** Providing More practice questions and showing videos.
- **Foundational Review:** Revision of axioms of congruency to properly contrast with similarity.
- **Demonstration:** Using Explanation on Board and demonstration through activity for BPT.

Real-Life Applications

- **Scaling and Design:** Examples like photographs, A3 and A4 photocopy, architectural blueprints, miniatures, Expansion and contraction, and shadows.
- **Engineering:** Applications in Construction, estimation of heights, and the building of bridges.
- **Measurement:** Used directly in Measuring heights.

Assessment and Evaluation Methods

- **Traditional Tests:** Regular Class tests.
- **Digital Quizzing:** MCQs through Google form.
- **High-Order Questioning:** Use of Case based questions.
- **Collaborative Assessment:** Conducting a Debate and group discussion to evaluate conceptual understanding.

Chapter 7: Coordinate Geometry

This chapter focuses on introducing geometrical figures using the algebraic framework of the Cartesian plane. It introduces key algebraic tools- the Distance Formula, the Section Formula (including the midpoint case), and the Area of Triangle Formula—to calculate lengths, find division points, and determine areas within the two-dimensional coordinate system. The chapter's success hinges on a student's ability to visualise abstract algebraic expressions as concrete geometrical positions and relationships.

Chapter Name	Challenging Topics
Coordinate Geometry	• Derivation of distance and section formulas • Concept of external division of a line segment • Difference between geometry and coordinate geometry • Helping students visualize the Cartesian plane • Real-world problem applications • Confusion in the application of section formula.

Current and Innovative Pedagogical Practices

- **Visualisation Tools:** Plotting on blackboard or GeoGebra to help students visualise. The use of geometric shape of bindi and position of bindi on the forehead is also used to explain the difference with traditional geometry.
- **Derivation Justification:** The teacher derives using Pythagoras' theorem on the board for the formulae.
- **Art Integration:** Art-integrated activity using mandala art is used for plotting.
- **Error Analysis:** Giving students a solved example with a hidden mistake and asking them to spot and correct the error step by step is an effective strategy to foster procedural rigour.
- **Integrated Problems:** Encouraging integrated problem linking coordinate geometry with algebra/geometry (e.g., proving collinearity and then finding area).

Real-Life Applications

- **Mapping and Navigation:** Giving students a simple school map and ask them to plot the library, playground and classrooms as coordinate points. This includes GPS distance applications.
- **Design and Engineering:** Problems related to designing dimensions and the insight that wrong calculation can cause money loss or faulty design in engineering.
- **Distance Calculation:** Asking students to calculate the shortest straight-line distance between their school and home.
- **Ratio and Division:** Present a real-life scenario (dividing a Choco-bar between two brothers in a ratio) to introduce the section formula.
- **Geometrical Representation:** Find coordinates of vertices of our national flag corner with origin on bottom left corner of green colour.

Assessment and Evaluation Methods

- **Traditional Tests:** Regular Class tests.
- **Digital Quizzing:** MCQs through GoogleForms.
- **High-Order Questioning:** Use of case-based questions.
- **Collaborative Assessment:** Conducting a debate and group discussion to evaluate conceptual understanding.

Chapter 8: Introduction to Trigonometry

This chapter focuses on introducing the relationship between the sides and angles of a right-angled triangle. It defines the basic Trigonometric Ratios (sin, cos, tan, and their reciprocals), focuses on the ratios of standard angles (0, 30, 45, 60, 90 degrees), and introduces the fundamental Trigonometric Identities. The core of the chapter involves applying these ratios to find unknown sides and angles in geometric problems, serving as a critical foundation for advanced mathematics and its real-world applications.

Chapter Name	Challenging Topics
Introduction to Trigonometry	• Difference between infinity and undefined • Finding other T-ratios when one T-ratio is given • Difference between geometry and trigonometry, and understanding trigonometric ratios and functions • Importance of angle in trigonometric ratios • Confusion in treating the numerator/denominator of a ratio as perpendicular/base/hypotenuse • Applying trigonometric identities correctly • Proving or finding the value of expressions when variables are in T-ratio form

Current and Innovative Pedagogical Practices

- **Visual Aids:** Using teaching aids and showing the triangle by rotating it (cut-outs) to help students correctly Identify perpendicular and base.
- **Proof and Derivation:** Geometrical proof must be discussed for the values of standard angles to prevent rote learning.
- **Activity-Based Learning:** Using match sticks, hands of a clock activities to derive values.
- **Contextual Clarity:** Addressing sin A vs sin x A, through activity and proving that sin has no meaning without angle A.
- **Technology:** Utilising GeoGebra/Wordwall.net/Desmos for interactive simulations and to visualise the concepts.
- **Broadening Scope:** Use examples of tilted objects to subtly suggest applications beyond simple right-angled triangle alignment.

Real-Life Applications

- **Measurement:** Measuring height without actually climbing (e.g., using a clinometer), and the estimation of heights of tilted objects.
- **Navigation and Surveying:** Applications in Navigation, Surveying, and how pilots use T-ratios for finding angle.
- **Science and Engineering:** Used extensively in Physics and Engineering, including medical imaging and signal processing.
- **Practical Examples:** Solving situational problems like a person on top or ground, and using the concept to solve problems related to height of a tower (similar to the next chapter).

Assessment and Evaluation Methods

- **Conceptual Quizzes:** A simple quiz with true/false questions or multiple-choice questions on notation (e.g., $\sin^2 A = \sin A \times \sin A$).
- **Integrated Questions:** Questions involving both sin and cos to give True/False or Assertion Reason problems.
- **Creative Tasks:** Quizzes, Puzzles, and Games on Identities to test application in a fun way.
- **Visual Assessment:** Worksheets with different figures and angles along with rotation to test side identification.
- **Practical Application:** Worksheets for maximum practice and an assessment test for identity use.
- **Project-Based:** Assigning a mini-project to encourage students to explore and learn the applications.

Chapter 9: Applications of Trigonometry

This chapter focuses on introducing the basic trigonometric ratios (sin, cos, tan) to solve real-world problems involving calculating heights and distances that cannot be measured directly. The chapter introduces two key concepts: the Angle of Elevation (the angle formed when looking up) and the Angle of Depression (the angle formed when looking down). The fundamental strategy involves translating the problem into a correctly labelled right-angled triangle and then applying the appropriate ratio to find the unknown quantity.

Chapter Name	Challenging Topics
Applications of Trigonometry	• Drawing and labeling right-angled triangles from word problems • Two objects or two observation based trigonometrical problems • Problems involving angles from two different points- Identifying angle of elevation and depression • Height vs. distance confusion: mixing up vertical height and horizontal distance • Choosing the correct trigonometric ratio • Mixed angle of elevation and depression problems

Current and Innovative Pedagogical Practices

- **Practical Measurement:** Compulsory use of Clinometers or improvised devices (e.g., protractor, straw, weight) to measure the Angle of Elevation of real-life objects (like the school building or a tree).
- **Drawing to Scale:** Assigning activities where students must draw the figure to scale on graph paper. This reinforces the correct geometric relationships and improves visualisation.
- **Visualisation Technology:** Using GeoGebra or Desmos simulations to demonstrate how the Angle of Elevation and Depression change as the observer moves, and to visually confirm the tan 45 degrees result (where height equals distance).
- **Error Spotting:** Providing partially solved problems with incorrect diagrams and asking students to critique and correct the figure and the ratio selection.
- **Role-Playing:** Role-playing scenarios (one student as the observer, another as the object, a third holding the horizontal line) to physically define the Angle of Depression.

Real-Life Applications

- **Surveying and Mapping:** Calculation of the height of buildings, towers, and mountains from ground level (Inaccessible distances).
- **Navigation:** Used by pilots, sailors, and air traffic controllers to calculate distances to landmarks or the altitude of an aeroplane.
- **Design and Engineering:** Determining the angle of inclination of ramps, conveyor belts, or the length of cables needed for utility poles or bridge supports.
- **Astronomy:** Basic principles are used in early astronomy to estimate the distance to celestial bodies.

Assessment and Evaluation Methods

- **Diagram-Only Tasks:** Giving word problems and asking students to only draw and label the correct figure, assigning marks for correct angles and positioning.
- **Case-Based Questions:** Using case-based questions that present a single scenario and then ask multiple questions (e.g., finding height, then distance, then the angle from a new position) to test sequential strategic thinking.
- **Practical Assessment:** Assessment using the clinometer activity, where students submit a report detailing the object, measured angle, measured distance, and final calculated height.
- **Ratio Selection Quizzes:** Quick-fire Multiple-Choice Questions (MCQs) that provide a labelled triangle (without numbers) and ask students to choose the correct ratio for a given side/angle pair.
- **Error Analysis Tasks:** Asking students to identify the error in a solution where the Angle of Depression was incorrectly plotted.

Chapter 10: Circles

This chapter focuses on introducing the properties of a tangent to a circle. It introduces the concepts of a tangent (a line that intersects the circle at exactly one point), a secant (a line that intersects the circle at two points), and a chord (a line segment whose endpoints lie on the circle). The chapter is built around two critical theorems: the perpendicularity of the radius to the tangent at the point of contact, and the equality of tangent segment lengths drawn from an external point. These theorems form the basis for solving geometric problems involving circles.

Chapter Name	Challenging Topics
Circles	• Concept of tangents: understanding that a tangent is the limiting position of a secant • Application of tangents in circular motion; determining the number of tangents at one or multiple points on a circle • Measuring the length of a road using tangents • Real-world applications of tangents • Triangles/quadrilaterals circumscribing a circle • Length of a tangent segment: explanation and application

Current and Innovative Pedagogical Practices

- **Hands-on Activity:** Use of a bangle and pen for explanation. Stone-sling activity to demonstrate that the released object moves along the tangent.
- **Kinetic Demonstration:** Using the pulley system to show the concept of tangents in motion.
- **Proof Activities:** Using a protractor to measure the angle for the converse proof of Theorem 10.1. geoboard rubber scale activity and group activity positioning students to demonstrate the theorems.
- **Technology Integration:** Utilising GeoGebra library and Interactive Simulations to visualise the limiting position of a secant becoming a tangent.
- **Assessment as Learning:** Allowing learners to create questions as per their own understanding to gauge conceptual depth and foster open-ended questioning.

Real-Life Applications

- **Mechanics:** Applications in a pulley system and roller coaster design (where the path of the car at any instant is tangential).
- **Transportation:** The design of transportation track and curve (wheel) design for vehicles. The road makes a tangent on the lowest point of the tyre of the vehicle.
- **Navigation and Space:** The Projection of Chandrayaan on Moon's orbit from elongated Earth's orbit as an example of a tangent or limiting position.
- **Art and Design:** Applications in art and creativity, interiors, and architecture.
- **Logistics:** Choosing a time-efficient route for travel.

Assessment and Evaluation Methods

- **Differentiated Worksheets:** Use of worksheets with geometrical figures varying from MCQ, short-answer types, to long-answer type questions.
- **Creative Questioning:** Creating open-ended questions and scenario based questions using blended learning.
- **Proof Assessment:** Assigning assertion reasoning questions from case-based questions to test the justification of steps in a proof.
- **Technology-Based Assessment:** Technology integration and Peer teaching to assess understanding.
- **Real-World Integration:** Case-based questions linked directly to real-world applications (e.g., train track design).

Chapter 11: Areas Related to Circles

This chapter focuses on introducing the basic concepts of area and circumference to specific parts of a circle. It introduces the key concepts of Arc Length and the area of a Sector (a region bounded by two radii and an arc) and a Segment (a region bounded by a chord and an arc). The chapter culminates in solving problems involving finding the areas of combinations of plane figures by applying a combination of these formulas along with the area formulas of basic rectilinear shapes (squares, triangles, rectangles).

Chapter Name	Challenging Topics
Areas Related to Circles	• Identification of sectors and segments of a circle • Calculations of area, circumference, etc. • Inscribed and circumscribed figures • Length of an arc and area of a sector (derivation and formula) • Applying circle concepts to real-world problems • Finding the area of a triangle when the subtended angle is 120°

Current and Innovative Pedagogical Practices

- **Formula Derivation:** Instead of direct presentation, teachers should guide students to derive the formulas for arc length and sector area as a fraction of the whole circle (θ /360°) multiplied by the whole measure (circumference or area).
- **Hands-on Activities:** Use cut-out activities where a circular paper is cut into sectors and rearranged to approximately form a rectangle, visually justifying the area formula.
- **Visual Decomposition:** Use layered diagrams and coloured sheets to physically demonstrate how complex shaded areas are calculated by adding and subtracting basic shapes.
- **Technology:** Employ dynamic geometry software (GeoGebra/Desmos) to allow students to manipulate the radius (r) and angle (θ) to see the instantaneous changes in arc length and sector area.

Real-Life Applications

- **Architecture and Landscaping:** Calculating the area of circular gardens or pathways (annulus), or the cost of flooring a sector-shaped room in a building.
- **Engineering and Mechanics:** Calculating the distance travelled by a gear or wheel (circumference) and determining the area or length of belts in motors and gears.
- **Navigation:** Calculating the area swept by a lighthouse beam (sector area) or the distance covered by a ship travelling along a curved path (arc length).
- **Design:** Calculating the size of a pizza slice (sector) or the area of a semi-circular window.

Assessment and Evaluation Methods

- **Decomposition Tasks:** Tasks that present a complex shaded region and ask students to only write the final expression (e.g., Area of Circle - 4 x Area of subtended 90° at the centre) before calculation.
- **Formula Matching:** Quizzes requiring students to match the correct formula to the named part of a circle (sector, segment, arc).
- **Case-Based Problems:** Scenario-based questions involving real-life contexts like a sprinkler system (sector area) or a circular race track (annulus area).
- **Error Analysis:** Presenting a problem where π was used incorrectly (e.g., the wrong value of π was used, or the formula for arc length was used instead of area) and asking students to identify and correct the error.

Chapter 12: Surface Areas and Volumes

This chapter focuses on introducing the surface areas and volumes of various standard 3D solids (cuboid, cube, cylinder, cone, sphere, hemisphere) and, more complexly, combinations of these solids. The chapter emphasises understanding the difference between area (the exposed surface) and volume (the space occupied/contained) and applying the formulas strategically to solve real-world problems like finding the cost of painting, the capacity of a container, or the number of new objects formed by melting one large object.

Chapter Name	Challenging Topics
Surface Areas and Volumes	• Visualisation of 3D combined figures • Differentiating between TSA (Total Surface Area) and CSA (Curved Surface Area) • Frustum of a cone • Combination of non-standard solids • Mensuration in real-life contexts (case-based problems) • Determining whether the common area of combined figures should be added or subtracted • Conversion between different solid shapes

Current and Innovative Pedagogical Practices

- **Hands-on Modelling:** Compulsory use of clay or dough for students to create combined 3D models (e.g., soft-serve cone, dumbbell, tent) and then physically highlight the surfaces to be painted (Surface Area) or the space inside (Volume).
- **Mnemonic for Units:** Using mnemonics for unit conversion (e.g., KING HARRY DIED MOTHER DIDN'T CRY MUCH for Kilometer to Millimeter) to improve accuracy.
- **Technology Integration:** Use of digital tools and GeoGebra to visually demonstrate exposed and hidden surfaces and the relationship between net and solid (net folding activity).
- **Formula Logic:** Explaining the formula for LSA/CSA as AREA OF BASE x HEIGHT for uniform cross-section shapes (prisms).
- **Error Analysis:** Using practical experiments (like measuring volume of water displaced) and focusing on CPA approach (Concrete-Pictorial-Abstract) to build conceptual depth.

Real-Life Applications

- **Architecture and Engineering:** Calculating the capacity of water tanks, the volume of water displaced (Buoyancy), the volume of construction materials needed, and the cost of painting walls/tunnels.
- **Manufacturing and Design:** Applications in jewellery making, candle making, rice farming (storage capacity), and the manufacturing of pens, buoys, and other combined objects.
- **Logistics:** Calculating the storage capacity of warehouses or the volume of material required for packaging.
- **Astronomy:** Basic principles for estimation (noted as a real-life application).

Assessment and Evaluation Methods

- **Visualisation Quizzes:** Quizzes using pictures of combined solids and asking students to list the individual components and the surfaces that contribute to the total surface area.
- **Case Study Questions:** Case-based questions (CBQs) on real-life scenarios (e.g., a water tank, a tent, a dome) that require multiple calculations and unit conversions.
- **Project-Based:** Assigning a project to make a model using different combinations of solids (e.g. a model church, dumbbell) and calculating its surface area/volume.
- **Differentiated Worksheets:** Worksheets that focus on breaking the problem into smaller parts (e.g., find h first, then CSA).
- **Peer Assessment:** Encouraging peer assessment and group discussions to check the logic of formula selection.

Chapter 13: Statistics

This chapter focuses on introducing the measures of central tendency for grouped data: Mean, Median, and Mode. Students are expected to compute these measures using various algebraic methods (like the assumed mean and step-deviation methods for the Mean) and to graphically estimate the Median (using Ogives).

Chapter Name	Challenging Topics
Statistics	• Understanding why grouping is needed in data • Handling cases when the frequency of two modal classes is the same • Drawing cumulative frequency curves and finding the median, showing axes, scale, and the kink • Identifying the median class, especially with missing frequency and differentiating between frequency (f) and cumulative frequency (cf) • Understanding inclusive and exclusive types in grouped data • Converting “more than/less than” into frequency tables • Identification of f0, f1, f2 in the central tendency formula

Current and Innovative Pedagogical Practices

- **Formula Explanation:** The calculation methods are often taught using direct delivery of formula.
- **Technology & Simulation:** Using simulation and AI tools is proposed to explain the need for grouping and to deal with cases where two modes have the same frequency.
- **Hands-on Learning:** Using hands-on activities and the Diffit website is suggested for assessment.

Real-Life Applications

- **Manufacturing and Inventory Management:** The Mode is critical for identifying the most popular size of products (e.g., shoe sizes, clothing, vehicle parts).
- **Economic and Salary Analysis:** The Median is widely used in economics to report typical income or house prices.
- **Public Health and Research:** Mean is used to calculate average patient recovery time, average birth weight, or average life expectancy. Grouping Data (frequency distribution) is used to categorise health data, such as patients by age range or blood pressure level, to simplify analysis and target medical interventions.
- **Quality Control:** The Mean is applied in factories to ensure product consistency by calculating the average weight or average lifespan of a sample of products.
- **Scientific and Meteorological Data:** Statistical measures help in analyzing large volumes of environmental data. For example, calculating the average temperature or average wind speed over a period (Mean), or identifying the most common day of the week for a specific weather event (Mode).
- **Demographic Planning:** Governments and urban planners use grouped data (e.g., population distribution by age, income, or educational level) to organise data for planning public services like schools, transportation, and healthcare facilities.

Assessment and Evaluation Methods

- Utilising Quizzes and Puzzles.
- Incorporating resources like the Diffit website for assessment.
- Using hands-on activity as an evaluation method.

Chapter 14: Probability

This section introduces the primary student challenges that are linguistic and combinatorial. Students struggle with the precise mathematical interpretation of phrases like "at most," "at least," and the logical connectors "and"/"or." Furthermore, students find it difficult to systematically enumerate all possible outcomes (the sample space) for multi-step experiments like those involving two dice or a leap year. This difficulty is compounded by calculation errors in finding the complement of an event and a weak foundation in the number system (primes, factors) needed to define favorable outcomes.

Chapter Name	Challenging Topics
Probability	• Understanding and correctly using “at most” / “at least” in probability problems • Playing cards: nomenclature and concepts (e.g., suits, face cards) • Events and types of events • Axiomatic and theoretical approach in probability • Probability of non-occurrence of an event / complement of an event • Terms such as and/or, leap year, and area between figures • Pair of dice problems

Current and Innovative Pedagogical Practices

- **Language Support:** Explaining complex phrases like "at most/at least" in the mother tongue or easy language.
- **Hands-on/Visual Aids:** Using actual cards and dice as teaching aids, and using charts to make the entire sample space (like the 36 outcomes of two dice) visible.
- **Foundation Building:** Dedicating at least one class to basic number system concepts before starting the chapter.
- **Technology Integration:** Using ICT Tools and AI for assessment and generating varied examples.

Real-Life Applications

- **Weather Forecasting:** Used by meteorologists to estimate the likelihood of rain or other weather events, helping people and organizations prepare for disasters.
- **Insurance and Finance:** Actuaries use probability to calculate the risk of an event (e.g., a car accident, property damage) occurring, which is the basis for determining the cost of insurance premiums and financial planning.
- **Political and Social Surveys:** Used for exit poll analysis and public opinion polling to predict election outcomes or market preferences within a margin of error.
- **Gaming and Sports Strategy:** Probability is the core of all gaming and lottery systems. It is used to analyze the chances of winning or to develop optimal strategies in sports like poker or fantasy leagues.
- **Quality Control:** In manufacturing, probability is used to predict the failure rate of a batch of products (e.g., light bulbs, machinery) by testing a small sample, thus maintaining quality standards.

Assessment and Evaluation Methods

- **Quizzes and Worksheets:** Regular quizes are used, along with differentiated worksheets specifically designed for high achievers, average students, and weak students.
- **Technology-Based Assessment:** Utilising ICT Tools and AI tools for assessment and providing immediate feedback.
- **Practice of Sample Space:** Evaluation includes tests specifically focused on the practice of sample space (listing all possible outcomes) to check for combinatorial understanding.
- **Reward Systems:** Using AI and giving some rewards is suggested as an innovative motivational technique for assessment.
- **Example-Based Assessment:** Asking students to prepare questions with similar answers to form groups or to solve example-based problems.