

NEW NORMAL CURRICULUM

Instructional Guide

Mathematics

Class: X



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Mathematics
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Royal Education Council
Royal Government of Bhutan

Published by

Royal Education Council, Royal Government of Bhutan

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Acknowledgment

The Royal Education Council (REC) acknowledges the administrative support and funding from the Ministry of Education to develop and publish the Instructional Guide for implementing the New Normal Curriculum for all subjects from 2021 academic year onwards. The REC also acknowledges the administrative support of school principals for relieving the teacher participants for professional inputs. The REC acknowledges the teacher participants also for their professional input and hard work for developing the instructional guidelines.

We also acknowledge the technical and financial support received from all relevant stakeholders towards developing the instructional guides.

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Provisional Edition 2021

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FOREWORD

COVID-19 has suddenly caused unforgiving disruptions in public education all over the world, and brought about threats of fragmentation due to disparities in accessibility and connectivity in many systems. In Bhutan too, continuity of education and learning has been severely affected as a result of nationwide school closures and due to restrictions and health protocols. The disruptions have led to challenges in many existing patterns and trends in education resulting in a massive shift away from learning and teaching in traditional settings with physical interactions to the maximum in terms of relevancy and efficiency. This has caused a major problem for children living in poverty worldwide, who often rely on the physical settings of their schools for educational materials, guidance, and, sometimes, the only decent meal of the day.

In the new normal education, human interaction and well-being is a priority. Technology, particularly digital technology that enables communication, collaboration and learning across distance, is a formidable tool – not a panacea but a source of innovation and expanded potentials. As we embrace this exceptional opportunity to transform the world, and as we reimagine the organization of our educational institutions and learning environments, we will need to think about where we want to go.

In the post COVID 19 era, we must prioritize the development of the whole person, not just academic knowledge. Inspiration for the change can be drawn from the 1996 Delors report, *Learning the treasure within*, in its specification of four pillars of learning as “learning to know”, “to do”, “to be”, and “to live together”. Therefore, curricula must be increasingly perceived as integrated and based on themes and problems that allow learners to learn to live in peace with our common humanity and our common planet. This has the potential in the development of a strong base of knowledge about one’s self and about the world and finding purpose and being better able to participate in social and political milieu.

The New Normal Curriculum is, not just a mere response to the pandemic, but also a culmination of the curriculum reform work for the last four years by the Royal Education Council. It is an attempt to transform education from the teaching of “what” to learning of “how” and “why” towards empowering learners with the transversal competencies and the 21st century skills, and preparing them to be lifelong learners. We are optimistic that this move orients our education process towards nurturing nationally rooted and globally competent citizens.

Wish all our learners and teachers a life enriching experiential teaching and learning.

(Kinga Dakpa)
DIRECTOR GENERAL

1. INTRODUCTION

The 21st Century Education framework stipulates the emphasis on the thematic based learning areas with a comprehensive support system. The theme-based approach broadens opportunities for experiential learning contextualized to the learner's physical, social, political, economic, spiritual and cultural setting. An approach, which mandates learning through active engagement of students. Roles of teachers are transformed from knowledge transmitter to facilitation, guide, evaluator, researcher and motivator.

The conventional education, which is predominantly knowledge based and examination centred teaching and learning has been the time old practices, and the stress of this model is on the learning of textual information perceived by educators important for the grade. On the other hand, with the advancement in ICT, the world is flooded with such information, which are widely read by all at their leisure. What students cannot acquire from the multiple sources are the skills, which are crucial in facilitating students to realise their potential to be socially responsible and productive individuals and contribute in the nation building processes: socio-economic and political development. In the contemporary world, the knowledge-based education compromises the development of psychomotor and affective domains of learning, which affects the holistic development of students.

Despite the devastating effect caused by COVID-19 pandemic, it presented scopes for creation, innovation, generally perceived more efficient and effective in work and social activities. The pandemic situation explicated that the old ways of working, teaching and learning, and lifestyle have limitations. Consequently, new normal ways of how we work and live, teach and learn are the contemporary traditions. In this context, an overhaul of how we think and do is an imperative, not a choice. The transformation of classroom instruction from teacher centred to learner centred teaching and learning, however calls for the following adjustment, or even the overhaul of a few practices.

- i) Reduction of learning content to facilitate deep learning as opposed to the width of the teaching through the active engagement of students.
- ii) Integration of ICT as tools and ends of learner's education. The use of multimedia and ICT software is commonly utilized in teaching and learning as innovation to introduce variation in stimuli and sustain learner's interest and zeal in learning.
- iii) Adoption of theme based learning content, which facilitates to broaden the horizon of learning beyond the four walls, and stimulates the transfer of learnt concepts to the learner's immediate environment. This arrangement makes students aware of the realities of the social, political, economic and cultural practices and ethos of the society. Being aware of the immediate environment of the scopes and challenges, students are sensitized of the opportunities and issues, which may need attention for a better future for the society.
- iv) Consideration to ground the curriculum design and instruction approaches the epistemological theories is imperative to facilitate deep learning as opposed to

factual learning. However, the selection and use of them is subject to the nature of the respective subject. For instance, constructivism is more apt for science, while connectivism is relevant for languages and ICT curricula.

- v) Active engagement of students is imperative of competency-based education and learning. Inevitably, summative assessment has limitations in gauging the progressive development of the learner. This is achieved objectively by the use of the continuous formative assessment (CFA). However, if summative assessment evidence is used to provide feedback to help students in learning, it can serve as one of the techniques of CFA.

The curriculum adapted and grounded on the above wisdom, the principle of competency based learning, inspired by being aware of reality of the immediate environment, and the belief system of the society may be arbitrarily termed as the New Normal Curriculum. Learning is facilitated through the “Instructional Guide” with students taking responsibilities of their learning; teachers facilitate and guide students in the due course of their active engagement and assess their performance for improvement in their learning.

2. PURPOSE OF THE INSTRUCTIONAL GUIDE

In the New Normal Curriculum, deep learning synonymous to “less is more” is facilitated with the use of Instructional Guide for each subject and specific class. The content of the instruction in the guide for respective subjects are aligned with the subject’s curriculum framework with partial reference to the existing textbooks. Therefore, it is purported to achieve the following objectives:

- i) Facilitate learning anywhere, any time with the learner being responsible for the learning.
- ii) Facilitate deep learning with awareness and sensitivity of the realities of the world around.
- iii) Strengthen competency based learning and experiential learning to foster sensitivity of realities of the life and environment.
- iv) Strengthen blended learning and flip classroom with multimedia, digital pedagogies and ICT devices and websites as the tools and learning content.
- v) Guide parents in facilitating learning of their children.
- vi) Inspire teachers to assume the roles of facilitation, guide, motivator and evaluator.
- vii) Helps in the prioritization of learning content with emphasis to create time and space for active engagement of learners.
- viii) Facilitate the use of CFA for learning through objective observation and guidance.

The effective and efficient use of this guide is subject to the nature of the subject and the target class. The section on “How to Use the Guide” included in each subject provides tips on the efficient use of the guide.

3. GUIDING PRINCIPLES IN THE DEVELOPMENT OF THE GUIDE

The priority of education is to deliver learning that is relevant to the life of learners, challenge learners, foster the art of lifelong learning, serve as a source of inspiration and equip them with transversal skills. These principles form the basis for provision of learning experiences and engagement of learners in the developmental process of the curriculum, delivery, ways of achieving, and the context of measuring learner's performance.

a. Competency based

Understanding that the contemporary world is flooded with information, which serve as the sources of knowledge and ideas, the education for the acquisition of knowledge is irrelevant and redundant. Consequently, the priority of education is shifting to empowering learners with transversal skills and life skills as means to help learners realize and develop their potential.

Therefore, this guide is to ensure that the teaching and learning emphasises on the development of skills and foster positive attitude for learning, as opposed to knowledge acquisition, through active engagement of learners in diverse learning experiences.

b. Experiential learning

Learner's learning experiences are contextualised to the immediate environment – social, political, economic and physical, which provide opportunities for the development of competencies of creativity, critical thinking and problem solving, collaboration, communication, citizenship and cultural skills.

This is made possible through active engagement in diverse learning contexts and experiences. Such approach, thus speculates that the stress is on the understanding of fundamental concepts, principles, laws and ideas. This indicates that the peripheral ideas, examples and textual information are learnt as extended information. The integration of blended learning and flip classroom modes and place based education approach of instruction offer greater flexibility and opportunities to generate new knowledge by themselves along with the development of associated skills.

c. Gross National Happiness (GNH)

The principles of GNH should be deeply embedded in the curriculum for the holistic development of the learner. This will prepare the learner to participate and contribute to the culture, society, and economy of the country more meaningfully. The wisdom drawn from this principle is vital in the creation of "living school culture" and upholds the principle of emotional intelligence to foster gender sensitivity, equity and equality to education.

In this context, it is imperative of the guide that the elements of GNH are integrated as the learning content and are practiced as the inclusive pedagogical process in the classroom or at home.

d. Inclusiveness

It should value and include the knowledge, perspectives, and backgrounds and experiences of each learner to realise his or her full potential. Education is intended for all children in Bhutan, and due respect and acceptance is accorded to cohorts of learners from diverse backgrounds, and with cognitive and physical individual differences. It will mean deploying and accepting different starting points, a different pace of learning and ensuring that students are challenged to achieve high standards in ways that complement what they already know, what they can already do, and how they learn best.

This guide upholds the ideology of inclusiveness and education for all through the integration of diverse learning experiences and approaches, and assessment of the progress of their learning.

e. Learner-centered and developmentally appropriate

This implies that curricular contents, teaching techniques and assessment methods for each grade or level of school education are selected in accordance with children's developmental stages and needs of individual learners. Each child is different and the rate at which an individual child grows and reaches various developmental stages varies, although the patterns and sequences for growth and development are usually the same for all. They should be able to progress at a rate, which matches their needs and aptitudes.

The curriculum should be relevant to the learners' lives both current and future. It will be responsive to the social and technological changes and meet the needs of students. It will thus be a balance between what is imperative for all students, and be flexible for learning at the learner's pace and time.

f. Approaches

According to John Dewey and other educators, progressive education must prepare learners for active participation in education. The focus of education must be creating critical thinkers and inquirers who are active learners.

Most progressive education programs have the following qualities in common:

- Integration of entrepreneurship into education
- Strong emphasis on problem solving and critical thinking
- Learning by understanding as the goals of learning as opposed to rote knowledge
- Collaborative and cooperative learning strategies to develop social skills

- Education for social responsibility and democracy
- Personalized learning and living school culture based on differentiated instruction accounting for each individual's personal needs and goals
- Integration of community service and service learning projects into the curriculum
- Emphasis on varied learning resources and de-emphasis on textbooks
- Integration of digital technologies and pedagogies
- Appropriate assessment techniques and tools deployed in the CFA

4. CURRICULUM CONTENT

This is the main part of the instructional guide. It contains suggested approaches to teaching to guide students to achieve the desired competency(ies) through the identified topic(s).

a. Broad theme /Strand/Chapter/Topic

Under this heading, the topic/topics under one strand or under different strands that can be addressed together is/are listed. The topics are taken from the framework and not from the textbooks.

b. Competency(ies)

Under this heading, the main competency(ies) associated with the topic(s) listed under 4.1 above is/are listed.

c. Pedagogy

Under this heading, pedagogy to provide direction to deliver a lesson when the teaching and learning happens through face to face (contact) or through a virtual mode (non-contact) if classes cannot be conducted due to school closures is recommended. The recommended pedagogies are linked to competencies. These pedagogical approaches are only recommendations and teachers have the leeway to design their own plans.

The pedagogies should focus on hands-on, experiential learning through problem-based or project-based approaches. In mathematics, students should be provided opportunities to connect, communicate and represent mathematical ideas. They should be provided with divergent thinking opportunities and reflect on their learning.

In case of non-contact approach, pedagogies should be supported through the:

- i) Use of relevant learning platform – Google Classroom, Sherig LMS, WeChat, WhatsApp, Telegram
- ii) Use of ICT Tools to deliver lessons – video conferencing tools (Zoom and Google Meet, etc.), MS power point, screen recording software, etc.)
- iii) Use of ICT tools for assessment (Google Forms, Google Docs, Google Sheet, etc)

- iv) Use of ICT Tools for recording and reporting the performance (Grading in Google Classroom, Google Sheet, etc. reporting – all assessment records to be transferred to progress report for promotion or detention)

d. Assessment

Under this heading, performance tasks focusing on assessing competencies and not content are recommended. For classes PP – III, teachers can align with the Continuous Formative Assessment (CFA) guide book.

Achievement of learning shall be recorded based on bands of achievement for all students in all classes. The evidence from assessment is to identify individual learning needs, design, and deliver appropriate interventions to support students falling in the beginning and approaching category.

Reporting for classes PP – III shall be on a quarterly basis as per CFA guide book. For other classes, it shall be based on existing policy till there is a change in policy. Marks obtained for each strand and ultimately for each subject from the formative assessment can be converted using appropriate conversions for summative purposes.

$$CA\ Marks = \frac{\text{sum of scores obtained for all competencies}}{\text{sum of highest score for all competencies}} \times CA\ \text{for the term}$$

e. Resources

All resources required for the suggested activities and tasks above are listed under this topic for both contact as well as non-contact teaching.

5. STRAND AND TOPIC-WISE INSTRUCTIONAL GUIDE

A. Competency(ies)

- Demonstrate the understanding of radicals and perform arithmetic operations on radicals

Objectives

- Relate radicals with irrational numbers
- Convert an entire radical to mixed radical and vice versa
- Perform basic arithmetic operations with radical expressions

B. Pedagogy

Contact teaching and learning

- Recap the concepts of rational and irrational numbers. Give some examples of irrational number such as $\sqrt{2}$, $\sqrt{3}$, $\sqrt[3]{3}$ etc. Let students note that most of the radicals are irrational numbers.
- Introduce the concept of radicals: A radical form is also called a root form. Some of the radical forms are square root, cube root, fourth root and so on.
- Recall the concept of fractional exponents and relate them to the radicals:
 - $5^{\frac{1}{2}} = \sqrt{5}$, $5^{\frac{3}{2}} = \sqrt[2]{5^3}$, and etc.
 - Refer to Understanding Mathematics Textbook for Class X page number 53.
- Demonstrate writing of the entire radicals to mixed radicals and vice versa. Refer to Understanding Mathematics Textbook for Class X page number 54. Discuss the examples given on the same page.
 - Provide at least five questions to practice the concept of converting the entire radical to mixed radical and vice versa. Ensure that students get enough practice since it is the basic part of operations with radicals.
- Before teaching operations on radicals, teach the following concepts:
 - Radical is the mathematical opposite of an exponent:
 - $5^2 = 25 \Rightarrow \sqrt{25} = 5$ or $\sqrt{25} = \sqrt{5^2} = 5$. Square and square root cancel out because they are opposite to each other just as the subtraction is opposite to addition. Or simplify using the power law:
 $\sqrt{25} = 25^{\frac{1}{2}} = (5^2)^{\frac{1}{2}} = 5^{2 \times \frac{1}{2}} = 5$.
 - $2^3 = 8 \Rightarrow \sqrt[3]{8} = 2$ or $\sqrt[3]{8} = \sqrt[3]{2^3} = 2$. Cube and cube root cancel out. Or simplify using the power law: $\sqrt[3]{27} = (27)^{\frac{1}{3}} = (3^3)^{\frac{1}{3}} = 3^{3 \times \frac{1}{3}} = 3$.
 - Note that students take the symbol ' \Rightarrow ' as '='. The symbol ' \Rightarrow ' is 'implies' or 'means' and the symbol '=' is 'equal to'.
 - Watch the video <https://www.youtube.com/watch?v=B4zejSl8zho>. It contains a video lesson explaining the meaning of radical and simplifying square roots.
 - Discuss the examples given in page number 54 of Understanding Mathematics Textbook for Class X. See the screenshot pasted below:

• One way to simplify a radical is to look for **perfect powers** as factors under the root sign and then take their roots outside the root sign.

For example: $\sqrt{18} = \sqrt{9 \times 2} = \sqrt{9} \times \sqrt{2} = 3\sqrt{2}$

$\sqrt{150} = \sqrt{25 \times 6} = \sqrt{25} \times \sqrt{6} = 5\sqrt{6}$

$\sqrt[3]{54} = \sqrt[3]{27 \times 2} = \sqrt[3]{27} \times \sqrt[3]{2} = 3\sqrt[3]{2}$

• The principles that apply to numerical **radical expressions** also apply to algebraic radical expressions.

For example: $\sqrt{b^2} = \sqrt{b^2 \times b^0} = b^1$ $\sqrt[4]{b^8} = \sqrt[4]{b^2 \times b^2 \times b^2 \times b^2} = b^2$

$\sqrt[3]{b^6} = \sqrt[3]{b^2 \times b^2 \times b^2} = \sqrt[3]{b^2 \times b^2 \times b^2} \times \sqrt[3]{b^0} = b^2 \times \sqrt[3]{b^0}$

- Assign questions from "Practicing and Applying" of Understanding Mathematics Textbook for class X page number 55. Suggested questions: 1 - 3.
- Explain the operations with radicals. Refer to Understanding Mathematics Textbook for Class X page number 56 and 57.
 - Explain like terms of radicals by comparing to the like terms of polynomials. Demonstrate adding, subtracting, multiplying and dividing radicals.
 - Discuss and explain example 1, 2 and 3 from page number 57 and 58.
 - Assign questions from "Practicing and Applying" page number 60. Suggested questions: 1 - 6.

Non-contact teaching and learning

- Prepare short video lessons on introduction to radicals and share through a learning management system (Google classroom) or other relevant social media platforms.
- Share the video link: <https://www.youtube.com/watch?v=B4zejSI8zho>, it contains a lesson explaining the basic concepts of radicals and its relation with the exponents.
 - Pause the video and make notes as and when required.
- Share the video link <https://www.youtube.com/watch?v=2mejAHKMBiM> to learn how to simplify square roots.
- Share the video link <https://www.youtube.com/watch?v=Ef2gOQbDv7M> It contains a lesson on simplifying radicals explained in a simple way.
 - Pause the video and make notes accordingly.
- Share the video link <https://www.youtube.com/watch?v=4Gq3LPORQ-U> It contains a detailed lesson on operations with radicals.
- Provide at least five questions to practice.

C. Assessment

Contact/Non Contact

Performance task (to access the competency)

Ask students to solve a set of questions selected from the Understanding Mathematics Textbook for Class X page number 63. Suggested questions: 12 - 16.

Design appropriate assessment tools and record the student learning based on the template in the annexure X-A1

D. Resources

Contact

- a) Textbook and guide book (Understanding Mathematics Textbook for Class X)
- b) Online resources:
 - <https://www.youtube.com/watch?v=B4zejSI8zho>
 - <https://www.youtube.com/watch?v=2mejAHKMBiM>
 - <https://www.youtube.com/watch?v=Ef2gOObDv7M>
 - <https://www.youtube.com/watch?v=4Gg3LPORQ-U>

Non-contact

- a) Textbook and guide book (Understanding Mathematics textbook for Class X)
- b) Online resources:
 - <https://www.youtube.com/watch?v=B4zejSI8zho>
 - <https://www.youtube.com/watch?v=2mejAHKMBiM>
 - <https://www.youtube.com/watch?v=Ef2gOObDv7M>
 - <https://www.youtube.com/watch?v=4Gg3LPORQ-U>
- c) Technological gadgets for learning (mobile, desktop, laptop...)

E. Annexure(s)

Template to record assessment

Strand(s): X-A1		Topic(s): Radical		
Competency: Demonstrate the understanding of radicals and performing arithmetic operations on radicals.				
Name of the student	Level of achievement			
	Beginning	Approaching	Meeting	Exceeding

Topic: X-A2 Matrices

A. Competency(ies)

- Identify and describe different types of matrices
- Solve real life problems by applying matrix concepts and operations

Objectives

- Describe matrices and identify the parts of a matrix - elements, row, column, dimension and location (address) of an element.
- Classify types of matrices (square matrix, column matrix, row matrix, identity matrix)
- Justify if two matrices can be multiplied by checking the orders of the matrices
- Apply operations on matrices (addition, subtraction and multiplication) in problem situations
- Represent a network as a matrix and interpret a matrix in terms of a corresponding network situation

B. Pedagogy

Contact teaching and learning

- Describe matrices and identify the parts of matrix (e.g. rows, column, dimension [limit the dimension of matrix up to 3 by 3], location and element)
 - Design a group activity to conceptualize the concept of matrix and parts of matrix (refer class X mathematics textbook, page 2, Try This). Deductively define matrix and name the parts through the activity
 - The web link <http://bit.do/fPjBR> contains a video lesson on matrices and part of a matrix (Include definition and parts of matrix only. The video also explains adding, subtracting and multiplying matrices)
- Classify types of matrices (square matrix, column matrix, row matrix, identity matrix)
 - Design a task by listing examples of matrices (square matrix, column matrix, row matrix, identity matrix) and let children generalize different features from various examples. Deduce the types of matrices based on the features. The link <http://bit.do/fPjD2> explains the concept identity matrix with examples.
- Justify if two matrices can be multiplied by checking the orders of the matrices
 - Explain the limitations of multiplying matrices (two conditions for multiplying matrices)
 - $A_{2 \times 3} \times B_{3 \times 4} = C_{2 \times 4}$. Design an activity to let learners identify if matrices can be multiplied or not. (refer class X mathematics textbook, pages 11, 12 and 14 or other resources)
- Apply operations on matrices (addition, subtraction and multiplication) in problem situations
 - The web link <http://bit.do/fPjBR> contains a video lesson on adding, subtracting and multiplying matrices

- Design a task to evaluate learners understanding on operation with matrix
- Represent a network as a matrix and interpret a matrix in terms of a corresponding network situation
 - Demonstrate understanding on the relationship between network and matrix. Represent network as matrix and matrix as network (include real life situations like the network of a bus visiting various stations). The web link <http://bit.do/fPjHk> contains a video that explains conversion of networks into matrices and vice versa.

Non-contact teaching and learning

- Describe matrices and identify the parts of matrix (e.g. elements, rows, column, dimension [limit the dimension of matrix up to 3 by 3], location of an element)
 - Design and share short notes on the topic or share the web link <http://bit.do/fPjBR> that contains a video lesson on matrices and part of matrix (Include definition and parts of matrix only. The video also explains adding, subtracting and multiplying matrices)
- Classify types of matrices (square matrix, column matrix, row matrix, identity matrix)
 - Share a short video or notes classifying types of matrices (include square matrix, column matrix, row matrix and identity matrix only). Share the link <http://bit.do/fPjD2> which explains the concept identity matrix with examples.
- Justify if two matrices can be multiplied by checking the orders of the matrices
 - Refer class X mathematics textbook, pages 11, 12 and 14 or other resources
- Apply operations on matrices (addition, subtraction and multiplication) in problem situations
 - Share the web link <http://bit.do/fPjBR> contains a video lesson on adding, subtracting and multiplying matrices or refer class X mathematics textbook, pages 5, 8 and 11
 - Design a task to evaluate learners understanding on operation with matrix
- Represent a network as a matrix and interpret a matrix in terms of a corresponding network situation
 - Let children explore real life situations to represent network as matrix and matrix as network. Share the web link <http://bit.do/fPjHk> which contains a video that explains conversion of networks into matrices and vice versa.

C. Assessment

Contact/ Non-contact

Performance task 1

Assess competency 1

Assess, provide feedback and record achievement based on the template given in the annexure A1.

Performance task 2

Assess competency 2

Assess, provide feedback and record achievement based on the template given in the annexure A1.

Performance task 3

Assess competency 3

Assess, provide feedback and record achievement based on the template given in the annexure A1.

Performance task 4

Ask students to solve 2 questions each from each operation based on competency 4 (Questions from Practising and Applying) (Refer class X mathematics textbook, pages 6, 7 and 14 or frame questions from other resources)

Assess, provide feedback and record achievement based on the template given in the annexure A1.

Performance task 5

Ask students to solve questions 1, 2 and 6 based on competency 5 (Questions from Practising and Applying) (Refer class X mathematics textbook, pages 26 and 27 or frame questions from other resources)

Assess, provide feedback and record achievement based on the template given in the annexure A1.

D. Resources

Contact/ Non-contact

- a) Textbook and guide book (Class X mathematics)
- b) Online resources:
 - <http://bit.do/fPjBR>
 - <http://bit.do/fPjD2>
 - <http://bit.do/fPjHk>

E. Annexure(s)

Refer X-A1 for template to record achievements

Topic: X-A3 Commercial Mathematics

A. Competency(ies)

- Solve problems related to purchasing decisions, simple and compound interests, and dividends and stocks

Objectives

- Solve problems involving purchases using idea of percentage
- Demonstrate understanding of the long term difference between simple and compound interest
- Investigate both investments and financing situations
- Solve problems related to dividends and stocks using concepts of dividends, stocks, dividend rate, face value, market value and yield percentages

B. Pedagogy

Contact teaching and learning

- Recall the concept of consumer problems (markup, mark down, cost price, selling price and commission). Discuss terms related to Purchasing Decisions (Refer Understanding Mathematics X, Page 32-34).
- Explain the concept Simple Interest with an example to recall the concept. (Refer Understanding Mathematics X, Page 42, Q1).
- Introduce and explain the terminologies of Compound Interest.
 - Discuss and explain the solved examples (1,2,3 and 4).
 - Assign at least two questions to solve as class work (Refer Understanding Mathematics X, Page 42, Q4(a), Q5(a)).
 - Discuss about payment options and investments to relate commercial math in real life situations (Refer Understanding Mathematics X, Page 51, Q1 and Q2).
 - Suggestion: Invite a resource person to class from any financial institution to give insights on banking.
- Introduce and explain the terminologies of Dividends and Stocks and relate the terminologies in solving problems. (Refer Understanding Mathematics X, Page 44-45 and Solved Examples)
 - Introduce the concept of dividends and stocks using real life examples
 - Demonstrate calculations on dividends and stocks
 - Let students practice the concepts by solving the questions as a classwork (Refer Understanding Mathematics X, Page 46, Q1,Q3,Q5)

Non-contact teaching and learning

- Prepare a video lesson to recall the concept of consumer problems (markup, mark down, cost price and Selling price). Ask students to explore terms related to Purchasing Decisions (Refer Understanding Mathematics X, Page 32-34).
- Prepare a video lesson to Introduce and to explain the terminologies of Compound Interest.

- Create a platform using Google Classroom, messenger, telegram, etc. to discuss the solved examples (1,2,3 and 4).
- Assign at least two questions to practice at home (Refer Understanding Mathematics X, Page 42, Q4(a), Q5(a)).
- Through social media platforms discuss payment options and investments to relate commercial math in real life situations (Refer Understanding Mathematics X, Page 51, Q1 and Q2).
- Through social media platforms discuss how the concepts can be applied in banking and business.
- Prepare a video to Introduce and explain the terminologies of Dividends and Stocks and relate the terminologies in solving problems (Refer Understanding Mathematics X, Page 44-45 and Solved Examples)
 - Let students practice the concepts by solving the questions as a classwork. (Refer Understanding Mathematics X, Page 46, Q1,Q3,Q5) and ask them to share their findings through a social media platform created.

C. Assessment

Contact

Performance task 1

- Ask students to solve questions (Refer Understanding Mathematics X, Page 35).
- Assign questions from Understanding Mathematics X, Page 42 (Q2, Q5-Q9). Assess, provide feedback and record achievement based on the template given in the annexure X A1.

Performance task 2

Assign questions about payment options and investments to relate commercial math in real life situations (Refer Understanding Mathematics X, Page 51, Q3-Q5). Assess, provide feedback and record achievement based on the template given in the annexure X A1.

Performance task 3

Ask students to solve questions. (Refer Understanding Mathematics X, Page 46, Q4,Q6 and Q7)
Assess, provide feedback and record achievement based on the template given in the annexure X A1.

Non-contact

Performance task 1

- Ask students to solve a set of questions. (Refer Understanding Mathematics X, Page 35) and ask students to submit their work through GoogleClassroom, Wechat, Telegram,etc.

- Assign questions from Understanding Mathematics X, Page 42 (Q2, Q5-Q9) and ask students to submit their work through GoogleClassroom, Wechat, Telegram,etc.

Assess, provide feedback and record achievement based on the template given in the annexure X A1.

Performance task 2

Assign questions about payment options and investments to relate commercial math in real life situations.(Refer Understanding Mathematics X, Page 51, Q8, Q9).

Assess, provide feedback and record achievement based on the template given in the annexure X A1.

Performance task 3

Ask students to solve questions. (Refer Understanding Mathematics X, Page 46, Q4,Q6 and Q7) and ask students to submit their work through appropriate social media platforms.

Assess, provide feedback and record achievement based on the template given in the annexure X A1.

D. Resources

Contact/Non-contact

- a) Text book for class X
- b) Teacher's guide book for class X
- c) Technological gadgets for learning (smart phone, laptop, desktop)

E. Annexure(s)

Refer X-A1 for template to record achievement

A. Competency(ies)

- Apply the concept of arithmetic and geometric progression to solve appropriate problems

Objectives

- Determine arithmetic progression and geometric progression for a given set of numbers.
- Calculate n th term (T_n) of A.P. and/or G.P. and the sum of the series (S_n) using the concept of A.P. or G.P.
- Solve numerical problems related to Arithmetic mean and Geometric mean.

B. Pedagogy

Contact teaching and learning

- Define progression(sequence) and series, and their types (finite and infinite series/ sequence) with an example each.
- Define Arithmetic and Geometric Progressions.
- Arithmetic Progression (A.P.)
 - Define what is Arithmetic Progression and ask students to give an example after having understood the definition.
 - Explain the terminology related to A.P. and derive the formula to find a general term (T_n) of an A.P. *Suggestion: Refer BHSEC Mathematics Book I, Page Ch 1-4 (n^{th} term of an A.P)*
 - Demonstrate how to apply the formula in finding a term of an A.P. by discussing the solved examples. *Suggestion: Refer BHSEC Mathematics Book I, Page Ch 1-4 and Ch 1-5 (Ex. 1 to Ex. 6).*
 - Discuss the Useful Results on A.P. *Suggestion: Refer BHSEC Mathematics Book I, Page Ch 1-12 (Useful Results)*
 - Assess the application of the concept by assigning the questions as class work. *Refer BHSEC Mathematics Book I, Exercise 1(a), Q1(i, iii and iv), Q2, Q4 (a,c), Q6, Q7, Q11 and Q13. Note: These questions are not meant to be assigned as a single task at one go.*
 - Derive the general formula to calculate the sum of the stated number of terms of an Arithmetic Series. *Suggestion: Refer BHSEC Mathematics Book I, Page Ch 1-6 and Ch 1-7.*
 - Demonstrate how to apply the formulas in finding the sum of an Arithmetic Series by discussing solved examples. *Suggestion: Refer BHSEC Mathematics Book I, Page Ch 1-7 and Ch 1-8(Ex. 8 to Ex. 13.*
 - Assess the application of the concept by assigning the questions as class work and home work for practice. *Refer BHSEC Mathematics Book I, Exercise 1(b) Q1(i and iv), Q2-Q7, Q10 and Q12. Note: These questions are not meant to be assigned as a single task at one go.*
 - Explain Arithmetic mean and deduce the formula. *Refer BHSEC Mathematics Book I, Page Ch 1-11 (Arithmetic Mean),*

- Assess the application of the concept by assigning the questions as class work or homework to practice. Refer *BHSEC Mathematics Book I, Exercise 1(c), Q1 (all) and Q2.*
- Geometric Progression(G.P.) and Geometric Series (G.S.)
 - Define what is Geometric Sequence and explain the terminology related to it based on an example. (Refer *BHSEC Mathematics Book I, Page Ch 1-15*).
 - Derive the formula to find a general term (T_n) of a geometric sequence.(Refer *BHSEC Mathematics Book I,Page Ch 1-16*).
 - Demonstrate how to apply the formulas in finding the n^{th} term of Geometric sequence by discussing the solved example. Refer *BHSEC Mathematics Book I,Page Ch 1-16 and Ch 1-17(Ex. 23 to Ex.26)*.
 - Discuss the Useful Results on G.P. given in the box highlighted with the title Note. Refer *BHSEC Mathematics Book I,Page Ch 1-27.*
 - Assess the application of the concept by assigning the questions as class work and home work for practice. Refer *BHSEC Mathematics Book I,Exercise 1(d) Q1(a and b), Q2 to Q7). Note: These questions are not meant to be assigned as a single task at one go.*
 - Derive the general formula to calculate the sum of n terms of a geometric series. Refer *BHSEC Mathematics Book I,Page Ch 1-19*
 - Demonstrate how to apply the formulas in finding the sum of n terms of a Geometric Series by discussing the solved examples. Refer *BHSEC Mathematics Book I,Page Ch 1-19 to Ch 1-21(Ex.29 to Ex.34)*.
 - Assess the application of the concept by assigning the questions as class work and homework to practice. Refer *BHSEC Mathematics Book I,Exercise 1(e)(Q1(a and d), Q3, Q4, Q6) and from Exercise 1(f) (Q1 to Q3). Note: These questions are not meant to be assigned as a single task at one go.*
 - Explain Geometric Mean and deduce the formula. Refer *BHSEC Mathematics Book I,Page Ch 1-17 (Geometric Mean)*.
 - Demonstrate how to apply the formula in finding the Geometric Mean by discussing the solved example .Refer *BHSEC Mathematics Book I,Page Ch 1-17(Ex.28)*.
 - Assess the application of the concept by assigning the questions as class work and homework to practice. Refer *BHSEC Mathematics Book I,Exercise 1(d) Q6, and Ch 1-35, Revision Exercise Q7.*

Non-contact teaching and learning

Suggestion: Prepare a online lesson inculcating the following:

- Define sequence and series and the types (finite and infinite series/sequence) with an example each.
- Define what is progression and introduce the two types (Arithmetic and Geometric Progression).
- Arithmetic Progression (A.P.)
 - Define what is Arithmetic Progression and ask students to give an example after having understood the definition.

- Explain the terminology related to A.P. and derive the general formula to find a term of the A.P. Refer *BHSEC Mathematics Book I, Page Ch 1-4 (nth term of an A.P.)*
- Demonstrate how to apply the formulas in finding the term of an A.P. by discussing the solved example. Refer *BHSEC Mathematics Book I, Page Ch 1-4 and Ch 1-5 (Ex. 1 to Ex. 6)*.
- Discuss the Useful Results on A.P. Refer *BHSEC Mathematics Book I, Page Ch 1-12 (Useful Results)*
 - Assess the application of the concept by assigning questions as an activity. Refer *BHSEC Mathematics Book I, Exercise 1(a), Q1(i, iii and iv), Q2, Q4 (a,c), Q6, Q7, Q11 and Q13. Note: These questions are not meant to be assigned as a single task at one go.*
- Derive the general formula to calculate the sum of the stated number of terms of an Arithmetic Series. Refer *BHSEC Mathematics Book I, Page Ch 1-6 and Ch 1-7*.
- Demonstrate how to apply the formulas in finding the sum of an Arithmetic Series by discussing solved examples. Refer *BHSEC Mathematics Book I, Page Ch 1-7 and Ch 1-8(Ex. 8 to Ex. 13)*.
 - Assess the application of the concept by assigning the questions as online activity for practice. Refer *BHSEC Mathematics Book I, Exercise 1(b) Q1(i and iv), Q2-Q7, Q10 and Q12. Note: These questions are not meant to be assigned as a single task at one go.*
- Explain Arithmetic mean and deduce the formula. Refer *BHSEC Mathematics Book I, Page Ch 1-11 (Arithmetic Mean)*,
 - Assess the application of the concept by assigning the questions as online activity for practice. Refer *BHSEC Mathematics Book I, Exercise 1(c), Q1 (all) and Q2.*
- Geometric Progression(G.P.)
 - Define what is Geometric Sequence and explain the terminology related to it based on an example. (Refer *BHSEC Mathematics Book I, Page Ch 1-15*).
 - Derive the general formula to calculate the n^{th} term of a geometric sequence. (Refer *BHSEC Mathematics Book I, Page Ch 1-16*).
 - Demonstrate how to apply the formulas in finding the n^{th} term of Geometric sequence by discussing the solved example. Refer *BHSEC Mathematics Book I, Page Ch 1-16 and Ch 1-17(Ex. 23 to Ex. 26)*.
 - Discuss the Useful Results on G.P. given in the box highlighted with the title Note. Refer *BHSEC Mathematics Book I, Page Ch 1-27*.
 - Assess the application of the concept by assigning the questions as an activity. Refer *BHSEC Mathematics Book I, Exercise 1(d) Q1(a and b), Q2 to Q7). Note: These questions are not meant to be assigned as a single task at one go.*
 - Derive the general formula to calculate the sum of the n terms of a geometric series. Refer *BHSEC Mathematics Book I, Page Ch 1-19*

- Demonstrate how to apply the formulas in finding the sum of the n terms of a Geometric Series by discussing the solved example. Refer *BHSEC Mathematics Book I, Page Ch 1-19 to Ch 1-21(Ex.29 to Ex.34)*.
 - Assess the application of the concept by assigning the questions as an online activity for practice. Refer *BHSEC Mathematics Book I, Exercise 1(e)(Q1(a and d), Q3, Q4, Q6) and from Exercise 1(f) (Q1 to Q3)*. Note: These questions are not meant to be assigned as a single task at one go.
- Explain Geometric mean and deduce the formula. Refer *BHSEC Mathematics Book I, Pag Ch 1-17 (Geometric Mean)*.
 - Demonstrate how to apply the formulas in finding the Geometric Mean by discussing the solved example. Refer *BHSEC Mathematics Book I, Page Ch 1-17(Ex.28)*.
 - Assess the application of the concept by assigning the questions as an online activity for practice. Refer *BHSEC Mathematics Book I, Exercise 1(d) Q6, and Ch 1-35, Revision Exercise Q7*.
- You may use the link to develop the lesson: <http://bit.do/AP-GP> (Explains about A.P., G.P., Arithmetic Mean and GeometricMean).

C. Assessment

Contact

Performance task 1

Assess competency 1

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Non-contact

Performance Task 2

Assess competency 1

Assess, provide feedback and record achievement based on the template given in the annexure X A1

D. Resources

Contact

a) BHSEC Mathematics Book-I

b) Online resources:

- <http://bit.do/AP-GP>

Non-contact

a) BHSEC Mathematics Book-I

b) Online resources:

- <http://bit.do/AP-GP>

c) Technological gadgets for learning (smart phone, laptop, desktop...)

E. Annexure(s)

Refer X-A1 for template to record achievement

A. Competency(ies)

- Interpret linear functions
- Solve inequalities algebraically and graphically

Objectives

- Demonstrate an understanding of the relationship between a relation and a function with examples
- Convert equations of line from one form to another (slope and intercept form)
- Describe inequalities using graph
- Create graphs for given information in a variety of formats using MS Excel/ GeoGebra/ Graphmatica and others

B. Pedagogy

Contact teaching and learning

- Linear Functions: Refer Understanding Mathematics Textbook for class X page number 67 and 68.
 - Explain the concept of relation: "Relation describes how two things (variables) are connected (related)". Explain with some examples of relations such as $y > 2x$, $y = 2x$, $y < x + 1$, etc.
 - Show the value/s of y for each value of x . For instance, consider the relation $y > 2x$. For $x=3$, $y > 2(3) \Rightarrow y > 6$, which means, $y = 6.01, 6.1, 7, 8, 9, 10, 10.1, \dots$, are all solutions to the relation. Students should also know that x value 3 is a value of input variable and y values are the output variables.
 - From the above examples, connect to the introduction of the concept of a function: "A function is a special type of relation where there is only one output variable for one input variable." Introduce the function notation. Let students note that, $y = 2x + 1$, for instance, is an equation and $f(x) = 2x + 1$ is the equation in function form.
 - Explain how to identify a function relation from mapping notations, table of values, set of ordered pairs and graphs(vertical line test).
 - Explain how to identify dependent variables and independent variables from an equation or a function.
 - Introduce three forms of functions: Linear, Quadratic and Exponential functions. Students should be able to recognize a form of a function by looking at the function expressions. Refer to the table given on page number 68.
 - Provide at least three relevant questions for students to practice. Refer to "Practicing and Applying" on page number 71. Suggested questions: 1 - 5.
- Applications of Linear Functions: Refer to Understanding Mathematics Textbook for class X page number 72.
 - Recapitulate the lessons from class IX on two forms of equations: slope and y -intercept form and standard form. Show how to convert an equation

from the slope and y-intercept form to standard form and vice-versa.
Provide at least 5 equations for students to practice.

- Introduce the concept of 'one variable as a function of the other': x as a function of y and y as a function of x . Discuss example 1 and provide at least 3 equations for students to practice.
- Note that if a function is in 'y as a function of x' form then, x is the independent variable (known), and y is the dependent variable (unknown). Discuss example 2 and explain which variable is independent(known) and which variable is dependent(unknown). Discuss relevant problems from Practicing and Applying.
- Graphs of Linear Inequalities: Refer to Understanding Mathematics Textbook for class X page number 78 and 79.
 - Recapitulate the concepts of linear inequality from class IX. Show why a linear inequality is not a function.
 - Introduce graphing of linear inequalities. Using an equality, show that there are many ordered pairs which satisfy the given inequality. Thus, the shaded region shows all the ordered pairs which satisfy the given inequality.
 - Demonstrate graphing an inequality by specifying the steps required. Refer to example 1 and 2 on page number 79 and 80. Use GeoGebra or any other graphing software to verify an inequality graph.
 - Demonstrate writing an inequality statement from a given inequality graph. Specify the steps required. Refer to example 3 on page number 81.
- Take students to a computer lab and let them practice graphing equations and inequalities in GeoGebra or any other software.

Non-contact teaching and learning

- Create three short video tutorials on Linear Functions, Application of Linear Functions and Graphing Inequalities. Share the videos through a relevant online platform (weChat, Telegram, Google Classroom, etc)
- Share the web link <https://www.youtube.com/watch?v=RubZ-JutHVI> . This link contains a video lesson on converting a linear equation from slope intercept form to standard form and vice versa.
- Share the web link <https://www.youtube.com/watch?v=52tpYl2tTqk> . This web link contains a video lesson on functions. It explains the concept of function in a simple way.
- Share the following web links. The web link contains video lessons on graphing inequalities.
 - https://www.youtube.com/watch?v=P_-c9D6mjGA
 - <https://www.youtube.com/watch?v=cskHdgwB5k8&t=143s>

C. Assessment

Contact/ Non-Contact

Performance task 1 (To assess the first competency)

Assign at least 5 questions from "Practicing and Applying" of Understanding Mathematics Textbook for class X page numbers: 71 and 76. Suggested questions: Question 1 - 5 from page 71 and questions 1, 2, 3, 4, 5, and 8 from page 76.

Assess, provide feedback and record student achievement based on the template given in Annexure X-A1.

Performance task 2 (To assess the second competency)

Assign at least four questions from "Practicing and Applying" of Understanding Mathematics Textbook for class X page number 82 and 83. Suggested questions: 1 - 7.

Assess, provide feedback and record student achievement based on the template given in Annexure X-A1.

D. Resources

Contact

- a) Understanding Mathematics Textbook for class X
- b) Teacher's guide book for class X
- c) Online resources:
 - <https://www.youtube.com/watch?v=52tpYL2tTqk>
 - https://www.youtube.com/watch?v=P_-c9D6mjGA
 - <https://www.youtube.com/watch?v=cskHdgwB5k8&t=143s>

E. Annexure(s)

Refer X-A1 for template to record achievement

A. Competency(ies)

- Solve problems related to system of linear equations

Objectives

- Analyze a variety of situations and model them into algebraic equations
- Solve a system of linear equations by comparison method/ substitution method/ elimination method

B. Pedagogy

Contact teaching and learning

- Analyze a variety of situations and model them into algebraic equations
 - Demonstrate process of modeling a situation into algebraic equations as follows:
 - Define a variable (Explore the idea of variable representation beyond 'x' and 'y')
 - Write an equation using the variable.
 - Solve the equation.
 - If the variable is not the answer to the word problem, use the variable to calculate the answer.
 - Design a task to evaluate the process of modeling situation into algebraic equations (refer class X mathematics textbook, pages 89 and 90, questions 3, 4 and 5)
- Solve system of linear equations by comparison method/ substitution method/ elimination method (note: avoid specifying a strategy while developing test items)
 - Demonstrate solving system of linear equations by comparison strategy
 - Demonstrate solving system of linear equations by substitution strategy
 - Demonstrate solving system of linear equations by elimination strategy
 - The web link <http://bit.do/fPjWF> contains a video lesson demonstrating the solving of a system of linear equations using all three methods.
 - Design a task to let learners explore other methods of solving a system of linear equations (Example; graphical, matrix, etc.). Use the template given in the annexure to let learners choose a suitable strategy to approach the solution of the system of linear equations. The template also provides room for learners to explore other methods of solving the problem.

Non-contact teaching and learning

- Share notes on process of modeling a situation into algebraic equations as follows:
 - Define a variable (Explore the idea of variable representation beyond 'x' and 'y')
 - Write an equation using the variable.
 - Solve the equation.

- If the variable is not the answer to the word problem, use the variable to calculate the answer.
- Design a task to evaluate the process of modeling situation into algebraic equations (refer class mathematics X textbook, pages 89 and 90, Questions 3, 4 and 5)
- Solve linear equations by comparison strategy/ substitution strategy/ elimination strategy (note: avoid specifying a strategy while developing test items)
- Share notes/refer to class X mathematics textbook, pages 86, 91 and 95 or share the web link <http://bit.do/fPjWF> that contains a video demonstrating the solving system of linear equations using all three methods.
- Design a task where learners demonstrate that a system of linear equations can be solved using multiple approaches. Provide the template given in the annexure to let learners choose a suitable strategy to approach the solution of the system of linear equations. The template also provides room for learners to explore other methods of solving the problem.

C. Assessment

Contact/ Non-contact

Performance task 1

Assess competency 1

Assess, provide feedback and record achievement based on the template given in the annexure A1.

Performance task 2

Assess competency 2

Assess, provide feedback and record achievement based on the template given in the annexure A1.

D. Resources

Contact/ Non-contact

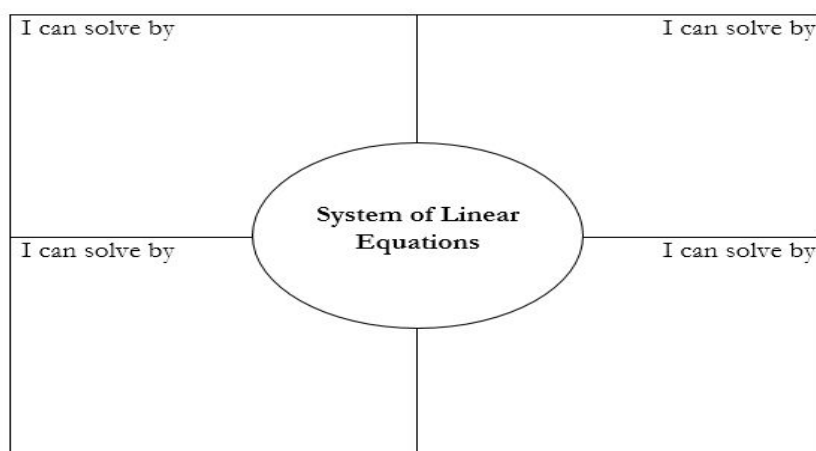
a) Textbook and guide book (Class X mathematics)

b) Online resources:

- <http://bit.do/fPjWF>

E. Annexure(s)

- Refer X-A1 for template to record achievements
- Template



A. Competency(ies)

- Construct and analyze the graphs of quadratic functions

Objectives

- Sketch the graph of a quadratic function in factored form and vertex form manually and verify using a graphing software
- Determine the solution (roots) of a quadratic equation graphically
- Connect algebraic and geometric transformations to draw graphs using $y = x^2$ as a basis using relevant software
- Sketch images under certain transformations, equations or mapping rules

B. Pedagogy

Contact teaching and learning

- Sketch the graph of a quadratic function in factored form and vertex form manually and verify using graphing software
 - Demonstrate graphing of quadratic functions in factored form manually (use appropriate graphing software such as geogebra, graphmatica, gsp, etc.)(refer class X mathematics textbook, page 135)
 - Demonstrate graphing of quadratic functions in vertex form manually (use appropriate graphing software such as geogebra, graphmatica, gsp, etc.) the web link <https://www.youtube.com/watch?v=7QMoNY6FzvM> contains a video on graphing quadratic functions in vertex form.
- Connect algebraic and geometric transformations to draw graphs using $y = x^2$ as a basis using a relevant software
 - Demonstrate geometric transformation of quadratic function manually and using appropriate graphing software such as geogebra, graphmatica, gsp, etc. (refer class X mathematics textbook, pages 141, 142 and 143)
 - Sketch images under certain transformations, equations or mapping rules
- Determine the solutions (roots) of a quadratic equation graphically
 - The web link <https://www.youtube.com/watch?v=Na3po6pA958> contains a video lesson on calculating roots of a quadratic equation from its corresponding graph.

Non-contact teaching and learning

- Sketch the graph of a quadratic function in factored form and vertex form manually and verify using graphing software
 - Share a short video or notes on graphing of quadratic functions in factored form manually (use appropriate graphing software such as geogebra, graphmatica, gsp, etc.)(refer class X mathematics textbook, page 135)
 - Share the web link <https://www.youtube.com/watch?v=7QMoNY6FzvM> which contains a video on graphing quadratic functions in vertex form.

- Connect algebraic and geometric transformations to draw graphs using $y = x^2$ as a basis using a relevant software
 - Share a short video or refer class X mathematics textbook, pages 141, 142 and 143 on geometric transformations of quadratic functions
 - Share comprehensive notes on how to sketch images under certain transformations, equations or mapping rules (refer pages 144 and 145, examples)
- Calculate the roots of a quadratic equation from its corresponding graph
 - Share the web link <https://www.youtube.com/watch?v=Na3po6pA958> which contains video on calculating roots of a quadratic equation from its corresponding graph.

C. Assessment

Contact/ Non-contact

Performance task (To assess competency)

- Assign at least three questions from (Practising and Applying) Mathematics textbook page 138. Suggested questions: 3, 4 and 6
- Assign at least four questions from (Practising and Applying) Mathematics textbook page 147. Suggested questions: 1, 2, 3 and 5

Assess, provide feedback and record achievement based on the template given in the annexure A1.

D. Resources

Contact/ Non-contact

- a) Textbook and guide book (Class X mathematics)
- b) Online resources:
 - <https://www.youtube.com/watch?v=7QMoNY6FzvM>
 - <https://www.youtube.com/watch?v=Na3po6pA958>

E. Annexure(s)

Refer X-A1 for template to record achievements

A. Competency(ies)

- Solve problems related to non-linear equations

Objectives

- Develop factoring strategies for polynomials in one variable that are products of binomials (degree one)
- Use the x-intercepts to determine the solutions of a quadratic equations

B. Pedagogy

Contact teaching and learning

- Conduct a pre-assessment test on dividing a trinomial of degree 2 by a binomial. Link to the factoring of polynomials: Explain that the factors are represented by the dimensions of the rectangle and the product is the area of the rectangle.
- Demonstrate the factoring of the polynomials of each type:
 - Factoring by using a common factor: eg. $6x^2 - 3x$. Students should note that this method can be used only for binomials of degree 2 having common factors. Refer to example 2 of the Understanding Mathematics Textbook for class X on page number 154.
 - Factoring of difference of squares using the formula, $a^2 - b^2 = (a + b)(a - b)$: eg. $x^2 - 4$. Note that to develop understanding, show the factoring of such type using tiles before introducing the formula. Refer to example 3 of the Understanding Mathematics Textbook for class X on page number 154.
 - Factoring of trinomials of degree 2: First show the factoring of this type using tiles. Then introduce the various strategies of factoring:
 - Algebraic model. Refer to example 1 of the Understanding Mathematics textbook for class X on page number 152.
 - Sum product rule. Check <https://www.youtube.com/watch?v=TLV2XSJure8> to know more about factoring using the sum product rule.
 - The method shown in the video link <http://bit.do/factoringtrinomials> . This link contains a video lesson on factoring and solving of polynomials using a different strategy.
 - Provide at least four questions to practice. Refer to "Practicing and Applying" of Understanding Mathematics Textbook for class X on page number 156: Suggested questions: Question number 1, 2, 3, 5, 6, 8, and 9.
- Solving Quadratic Equations by Factoring. Refer to the Understanding of Mathematics Textbook page number 158:
 - First introduce the zero-product rule. Demonstrate solving of a quadratic equation by factoring using the zero-product rule. After solving, graph the quadratic equation using a relevant software (GeoGebra or Graphmatica) and show that the solutions are the x-intercepts of the parabola. Students

should note that the x-intercepts are also called as the roots of the functions - finding roots, x-intercepts and solutions of a quadratic equation mean the same thing.

- Discuss the examples given on page number 159 and 160.
- Provide at least five questions from "Practicing and Applying". Suggested questions: 1-12.

Non-contact teaching and learning

- Create two short video tutorials on factoring of polynomials and solving quadratic equations. Share the videos through a relevant social media platform (weChat, Telegram, Google Classroom, etc)
- Share the web link <http://bit.do/solveqequations> . This link contains a video lesson from Bhutan e-Learning project on solving quadratic equations by factoring.
- Provide the questions suggested in the contact teaching and learning part for students to practice.

C. Assessment

Contact/Non-Contact

Performance task 1

Assign at least 5 questions from "Practicing and Applying" of Understanding Mathematics Textbook for class X 156 or frame a set of relevant questions. Assess, provide feedback and record student achievement based on the template given in Annexure X-A1.

Performance task 2

Assign at least five questions from "Practising and Applying" from Understanding Mathematics Textbook for class X page number 161. Assess, provide feedback and record student achievement based on the template given in Annexure X-A1.

D. Resources

Contact/ Non-contact

- a) Understanding Mathematics Textbook for class X
- b) Teacher's guide book for class X
- c) Graphing softwares: GeoGebra, MsExcel, Graphmatica, etc
- d) Online resources:
 - <https://www.youtube.com/watch?v=TLV2XSJure8>
 - <http://bit.do/solveqequations>

E. Annexure(s)

Refer X-A1 for template to record achievement

A. Competency(ies)

- Estimate and calculate surface area of prisms, cylinders, pyramids, cones and spheres using formulas

Objectives

- Estimate and calculate the surface area of a variety of 3-D shapes
- Solve problems related to finding:
 - dimensions when surface area is given
 - surface area when dimensions are given
- Calculate surface area of composite shapes using appropriate formulas

B. Pedagogy

Contact teaching and learning

- Explain how the total surface area of a 3-D shape is determined.
 - Introduce the general formula to find the total surface area of prisms. Refer *Understanding Mathematics IX, Page 243*
 - Discuss questions related to calculation of surface area of prisms (when dimensions are given) and missing dimensions (when surface area is given). *Suggestion: Refer Understanding Mathematics IX, Page 244-245 (Solved example 1) and Page 247 (Practising and applying Q8 part c)*
 - Connect the concept of area of circle and rectangle in derivation of the surface area of Cylinder. Refer *Understanding Mathematics IX, Page 253*. *Suggestion: watch the video from this link: <http://bit.do/cylinder> to develop the lesson.*
 - Discuss questions on calculation of surface area of a cylinder (when dimensions are given) and missing dimensions (when surface area is given). *Suggestion: Refer Understanding Mathematics IX, Page 254(Solved example 1 and 2) and Page 258 (Practising and applying Q5)*
 - Watch the video lesson using the link: <http://bit.do/sphere-practical> and discuss the surface area of the cylinders (radius = height) and relate it in deriving the total surface area of Spheres. *Suggestion: Refer Understanding Mathematics IX, Page 253 and Page 260.*
 - Discuss questions on calculation of surface area of a sphere (when dimensions are given) and missing dimensions (when surface area is given). *Suggestion: Refer Understanding Mathematics IX, Page 254(Solved example 1), develop questions based on spherical objects like football, basketball, tennis ball, etc. available.*
 - Demonstrate how to find the area of curved lateral surface using a circular-shaped paper and relate it to finding the surface area of cones

(Note that SA of a cone is one third the SA of a cylinder). *Suggestion: Refer Understanding Mathematics IX, Page 257-258.*

- Discuss questions on calculation of surface area of cones (when dimensions are given) and missing dimensions (when surface area is given). *Suggestion: Refer Understanding Mathematics IX, Page 258 (Solved example 1) and Page 259 (Practising and applying Q1, Q3, and Q4).*
- Introduce the general formula to find the surface area of pyramids. *Refer Understanding Mathematics IX, Page 248-249*
 - Discuss questions on calculation of surface area of a pyramid from given dimensions, and a missing dimension from a surface area. *Suggestion: Refer Understanding Mathematics IX, Page 249 (Solved example 1) and Page 251 (Practising and applying Q1).*
- Let students work in groups to explore and to calculate the total surface area of different composite shapes and ask them to present their strategies applied in finding the surface area after the completion of the task. *Refer Understanding Mathematics IX, Page 252 (Practising and applying Q6), Page 259 (Practising and applying Q5) and Page 262 (Practising and Applying (Q4). Suggestion: You May use the link: <http://bit.do/Surface-Area-3D-Shapes> to explore the surface area of 3-D shapes.*

Non-contact teaching and learning

- Share the given link: <http://bit.do/SurfaceArea-prism> (Surface Area of Prisms and solved examples) to students and instruct them to take notes from the link. Advise students to use *Understanding Mathematics Textbook for IX, Page 243 and Page 248-249 to acquire clear ideas on the topic.*
 - Using the Zoom App, discuss questions on calculation of surface area of prisms (with dimension given) and missing dimension (when surface area is given). *Suggestion: Refer Understanding Mathematics IX, Page 244-245 (Solved example 1) and Page 247 (Practising and applying Q8 part c).*
- Ask students to watch the video from this link: <http://bit.do/cylinder> to understand derivation of the total surface area of a cylinder formula and to apply the formula.
 - Through Zoom App, discuss the solved examples (1 and 2) given in *Understanding Mathematics IX, Page 254* and assign questions (*Understanding Mathematics IX, Page 258, Practising and applying Q5*) as online activity to practice the concept.
- Let student watch the video lesson on Sphere using the link: <http://bit.do/Sphere-formula> (Derives the formula of total surface area of a sphere) or <http://bit.do/sphere-practical> (derives the formula of surface area of sphere by relating it with the surface area of cylinder) and <http://bit.do/hemisphere-formula> (explains and derives the formula of hemisphere)

- Share the link: <http://bit.do/sphere-hemisphere-example> (Demonstrates calculation of surface area of sphere and hemisphere using the formula)
- Instruct students to watch the video lesson through the link: <http://bit.do/cones-pyramid> (Exhibits the calculation of surface area for the 3-D shapes: cone and pyramid) and <http://bit.do/Slant-height> (shows how to calculate slant height).
Suggestion: You may instruct students to explore the lessons through this link: <https://www.onlinemathlearning.com/geometry-help.html> before the actual lesson.

C. Assessment

Contact

Performance task 1

Assign questions from Page 246, 'Practising and Applying' (Q2, Q4, Q5 (a), Q6, Q7 and Q8 (b)) to assess the concept about Surface Area of Prism

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 2

Assign tasks to students to calculate the total surface area of cylindrical shapes (at least two shapes) to assess the application of formula to calculate the surface area of cylindrical shapes.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 3

Assign questions on calculation of surface area of sphere (when dimensions are given) and missing dimensions (when surface area is given). *Suggestion: Refer Understanding Mathematics IX, Page 261, Practising and Applying (Q1 and Q2). You may explore a few appropriate questions on hemisphere and assign to students.*

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 5

Let students solve questions related to conical shapes. *Suggestion: Refer Understanding Mathematics IX, Page 259 (Solved example 1) and Page 259 (Practising and applying Q5, and Q6)*

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 6

Assign questions from *Understanding Mathematics IX, Page 252, Practising and applying Q4, Q5, and Q6*

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 7

Let students calculate the total surface area of different composite shapes. Refer *Understanding Mathematics IX, Page 252 (Practising and applying Q5) and Page 262 (Practising and Applying (Q3, Q5 and Q6))*.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Non-contact

Performance task 1

Post an online assessment including Questions from Page 246, Practising and Applying (Q2, Q4, Q5 (a), Q6, Q7 and Q8 (b)) to assess the concept about Surface area of Prism. Ask them to upload on the google classroom and other platforms to provide feedback and to assess their work.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 2

Prepare an online activity, assigning tasks to students to calculate the total surface area of cylindrical shapes available at their homes/school/hostels (at least two shapes) to assess the application of formula to calculate the surface area of cylindrical shapes and ask them to upload to google classroom and other platforms to provide feedbacks and to assess their work.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 3

Post an online task, assigning questions on calculation of surface area of sphere from given dimensions and finding dimensions from a given surface area.

Suggestion: Refer Understanding Mathematics IX, Page 261, Practising and Applying (Q1 and Q2). You may explore a few appropriate questions on hemisphere and assign to students.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 4

Prepare an online post on solving questions related to conical shapes using. *Suggestion: Refer Understanding Mathematics IX, Page 259 (Solved*

example 1) and Page 259 (Practising and applying Q5, and Q6). Ask students to upload to google classroom or other platforms to provide feedback and to assess their work.

Assess, provide feedback and record achievement based on the template given in the annexure X A1 .

Performance task 5

Assign questions from *Understanding Mathematics IX, Page 252, Practising and Applying Q4, Q5, and Q6 online*. Ask them to upload to google classroom to provide feedbacks and to assess their work

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 6

Let students calculate the total surface area of different composite shapes online. Refer *Understanding Mathematics Textbook for class IX, Page 252 (Practising and applying Q5) and Page 262 (Practising and Applying (Q3, Q5 and Q6)*. Use google classroom, wechat, whatsapp and so on.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

D. Resources

Contact

- a) Understanding Mathematics Textbook for class IX
- b) Teacher's guide book for class IX
- c) Online resources:
 - <http://bit.do/cylinder>
 - <http://bit.do/sphere-practical>
 - <https://www.onlinemathlearning.com/geometry-help.html>
- d) Technological gadgets for learning (smart phone, laptop, desktop...)

Non-contact

- a) Understanding Mathematics Textbook for class IX
- b) Teacher's guide book for class IX
- c) Online resources:
 - <http://bit.do/Surface-Area-3D-Shapes>
 - <http://bit.do/SurfaceArea-prism>
 - <http://bit.do/Sphere-formula>
 - <http://bit.do/hemisphere-formula>
 - <http://bit.do/sphere-hemisphere-example>
 - <http://bit.do/cones-pyramid>
 - <http://bit.do/Slant-height>
 - <https://www.onlinemathlearning.com/geometry-help.html>

d) Technological gadgets for learning (smart phone, laptop, desktop...)

E. Annexure(s)

Refer X-A1 for template to record achievement

A. Competency(ies)

- Estimate and calculate the volume of prisms, cylinders, pyramids, cones and spheres using formula

Objectives

- Estimate and calculate the volume of prisms, cylinders, cones and spheres (memorization of formulas is not intended at this level)
- Apply formula of volume to solve variety of constructed composite figures

B. Pedagogy

Contact teaching and learning

- Students must be encouraged to understand the volume formulas instead of mere memorizing.
 - Before teaching the volume of any shape, teach the concept of why volume is expressed in cubic units: A container with a volume 10 cm^3 means 10 cubes of $1\text{ cm} \times 1\text{ cm} \times 1\text{ cm}$ will fit into that container. Similarly, a container with a volume 10 m^3 means 10 cubes of $1\text{ m} \times 1\text{ m} \times 1\text{ m}$ will fit into that container. Use linking-cubes to demonstrate the concept of volume. Refer to Understanding of Mathematics Textbook for class IX page number 225.
- Volume of prisms and cylinders:
 - Watch the video <https://www.youtube.com/watch?v=qJwecTgce6c> to understand the volume of prisms and cylinders. This video explains about the volume of prisms, cylinders, cones and spheres.
 - Explain using the linking cubes why the volume of a prism = Area of Base \times Height.
 - Refer to page number 225 - 226 of the Understanding Mathematics Textbook for class IX and teach the volume of different prisms.
 - Derive the formula of the volume of cylinders on the basis Volume = Area of Base \times Height.
 - Discuss example 1, 2 and 3 from Understanding Mathematics Textbook for class IX on page number 228.
 - Assign at least three questions to practice from "Practicing and Applying" of Understanding Mathematics Textbook for class IX on page number 229 and 230.
- Volume of Pyramids and Cones:
 - Explain that the volume of pyramids and cones are $\frac{1}{3}$ of the area of prisms and cylinders respectively, i.e Area of pyramids and cones = $\frac{1}{3} \text{Area of Base} \times \text{height}$. Watch <http://bit.do/vofpyramids> to know why the volume of pyramid has $\frac{1}{3}$ as a factor.
 - Discuss example 1 and 2 on page number 235 of the Understanding Mathematics Textbook for class IX.
 - Assign about four questions to practice from "Practicing and Applying" of Understanding Mathematics Textbook for class IX on page number 237, 238 and 239.

- Volume of spheres and composite shapes:
 - To derive the formula of spheres, first show that $\text{volume of a sphere} = 2 \times \text{volume of a cone}$ with the same radius and height. Derive the formula of volume of a sphere using the volume of cone:
 - Volume of sphere: $= \frac{\pi r^2 h}{3} + \frac{\pi r^2 h}{3}$

$$= \frac{\pi r^2 2r}{3} + \frac{\pi r^2 2r}{3} \text{ since height = diameter.}$$

$$= \frac{2\pi r^3}{3} + \frac{2\pi r^3}{3}$$

$$= \frac{4\pi r^3}{3}$$
 - Watch the video from this web link: <http://bit.do/cone-sphere> . This video shows the proof that the volume of a sphere is two times the volume of a cone.
 - Refer to the video link <http://bit.do/volumesphere> to see the derivation of the volume of the sphere using the volume of a cone.
 - Other relevant derivations of the volume of the sphere could be used if available.
 - Demonstrate finding the volume of composite 3-D shapes. Discuss the example on page number 240 from the Understanding Mathematics Textbook for class IX.
 - Provide about four questions to practice from "Practicing and Applying" on page number 241 and 242.

Non-contact teaching and learning

- Create two short video tutorials on volume of prisms and cylinders, and volume of pyramids and cones, and share through a relevant social media platform (weChat, Telegram, Google Classroom, etc)
- Share the web link <https://www.youtube.com/watch?v=qJwecTqce6c> . This video explains about the volume of prisms, cylinders, cones and spheres.
- Share the weblink <https://www.mathexpression.com/volume-of-solids.html> . This web link contains explanations on volumes of 3-D shapes.
- Provide the questions suggested in the contact teaching and learning part.

C. Assessment

Contact/Non-Contact

Performance task 1

Conduct a test/assign at least five questions relevant to the volume of prisms, cylinders, pyramids, cones, spheres and composite shapes. Questions could be framed or selected from "Practicing and Applying" of Understanding Mathematics Textbook for class IX on page numbers 229, 230, 236, 237, 238, 241 and 242.

Assess, provide feedback and record student achievement based on the template given in Annexure X-A1.

D. Resources

Contact/Non-Contact

- a) Understanding Mathematics Textbook for class IX
- b) Teacher's guide book for class IX
- c) Online resources:
 - <https://www.youtube.com/watch?v=qJwecTgce6c>
 - <https://www.mathexpression.com/volume-of-solids.html>

E. Annexure(s)

Refer X-A1 for template to record achievement

Topic: X-C3 Properties of 3-D efficiency

A. Competency(ies)

- Apply properties of 3-D efficiency in real life situations

Objectives

- Examine maximizing volume while restricting surface area and minimizing surface area while restricting volume
- Explore efficiency design of 3-D using a relevant software

B. Pedagogy

Contact teaching and learning

- Examine maximizing volume while restricting surface area and minimizing surface area while restricting volume
 - Demonstrate efficiency of 3D shapes in terms of volume (with a constant surface area, a 3D shape that includes maximum volume is efficient).
 - Design a task where learners have two cylinders with the same surface area (but different diameter and height). Evaluate which cylinder is more efficient based on their volumes.
 - Demonstrate efficiency of 3D shapes in terms of surface area (with a constant volume, a 3D shape that has minimum surface area is efficient).
 - Design a task where learners make two cylinders with the same volume (but different diameter and height). Evaluate which cylinder is more efficient based on their surface areas.
 - The web link <http://bit.do/fPn5D> contains a video on 3D efficiency (Exclude 2D efficiency from the video lesson)
- Explore efficiency design of 3-D using relevant software (use relevant software such as geogebra, graphmatica, etc. to visualize the efficiency of 3D shapes. Software can be used to create net out of a 3D shape and compare the efficiency)
- Demonstrate understanding of 3D efficiency as following:
 - The most efficient 3D shape (Sphere)
 - The most efficient:
 - Prism
 - Cylinder
 - Pyramid
 - Cone

Non-contact teaching and learning

- Examine maximizing volume while restricting surface area and minimizing surface area while restricting volume

- Share a short video or notes on efficiency of 3D shapes in terms of volume (with a constant surface area, a 3D shape that includes maximum volume is efficient).
 - Design a task where learners have two cylinders with the same surface area (but different diameter and height). Evaluate which cylinder is more efficient based on their volumes.
- Share a short video or notes on efficiency of 3D shapes in terms of surface area (with a constant volume, a 3D shape that has minimum surface area is efficient).
 - Design a task where learners make two cylinders with the same volume (but different diameter and height). Evaluate which cylinder is more efficient based on their surface areas.
- Share the web link <http://bit.do/fPn5D> that contains a video on 3D efficiency (Exclude 2D efficiency from the video lesson)
- Explore efficiency design of 3-D by creating nets of the 3D shapes.
- Let learners explore and demonstrate understanding of 3D efficiency as following:
 - The most efficient 3D shape (Sphere)
 - The most efficient:
 - Prism
 - Cylinder
 - Pyramid
 - Cone

C. Assessment

Contact/ Non-contact

Performance task (To assess competency)

Assess the performance task

Assess, provide feedback and record achievement based on the template given in the annexure A1.

D. Resources

Contact/ Non-contact

- a) Textbook and guide book (Class X mathematics)
- b) Online resources:
 - <http://bit.do/fPn5D>

E. Annexure(s)

Refer X-A1 for template to record achievement

A. Competency(ies)

- Deduce the relation between degrees and radians
- Demonstrate understanding of trigonometric functions (types, sign conventions, magnitude, period)
- Apply trigonometric functions in different contexts

Objectives

- Deduce the relationship between degrees and radians
- Convert degrees to radians and vice versa.
- Demonstrate an understanding of signs of trigonometric functions (types, sign conventions, magnitude, period)
- Apply t-ratios of standard angles and allied angles to solve problems
- Examine graphs of trigonometric functions to determine periods using relevant graphing software (Geogebra)
- Use fundamental trigonometric relations to prove simple trigonometric identities

B. Pedagogy

Contact teaching and learning

- Start the lesson on Radian and its relationship with degrees by screening the video to the class through this link: <http://bit.do/radian> (Derives the relation between π radians = 180 degrees and defines radian) or use other related sources. *Suggestion: you may introduce the radian and its relation with degrees by referring BHSEC Book I, Page Ch 7-6 to Ch 7-7 (article 7.07 to 7.09).*
- Associate the concept of the above lesson in converting the radians to degrees and vice versa by solving a few questions. *Refer BHSEC Book I, Page Ch 7-7 Ex.1(i, ii and iii) and Ex.2 (i, ii,iii) note: Exclude minutes and seconds while converting the radian to degree form.*
- Using flipped classroom share the link: <https://youtu.be/IQ5TuVdtKNU> (convention of signs) and <https://www.youtube.com/watch?v=qkYfvMbJDP8> (explains signs of trigonometric functions based on x and y coordinates) via google classroom and explain why they need to watch the videos before they attend the next lesson on sign conventions. During Face to Face teaching, recall and check their understanding on convention of signs, further explain the concept if required. After the lesson you may discuss Q1 (Page Ch 8-8, Oral Examples for class discussion) to strengthen their understanding. *Suggestion: You may refer BHSEC Mathematics Book I, Page 8-7 to Page 8-8 (Article 8.06 and Article 8.07, you may also explore Article 8.08 to enhance the limits of the values of t-function). Note: Article 8.08 is not intended for students.* Discuss and solve questions from BHSEC Mathematics Book I, Exercise 8(c), Q1 and Q6.
- Illustrate how to determine the t-ratios of standard angle (0° , 30° , 45° , 60° and 90°) using 30-60-90 and 45-45-90 special triangles. *Suggestion: May use the*

online link: <http://bit.do/T-ratios-standard-angles> (Illustration on determining the t-ratios of standard angles) to explore and to develop the lesson.

Suggestion: You may also refer BHSEC Mathematics Book I, Page 8-9 to Page 8-11 (T-ratio of standard angles) to plan the lesson.

- Discuss example 11 from Page 8-11 from BHSEC Mathematics Book I and assign questions to practice from BHSEC Mathematics Book I, Page 8-12 Exercise 8 (c) Q9 and Q10 as class tasks and assist students in solving the questions as and when required.
- Screen the video lesson in the classroom and watch along with students through this link: <https://youtu.be/ZULTCDc01KE> (Explains about allied angles of t-functions) and you may refer BHSEC Mathematic Book I Ch 8-13 to Ch 8-16 (t-ratios of allied angles) to derive the t-ratio of allied angles using geometry.
 - Demonstrate how to apply the t-ratio of allied angles by solving problems from BHSEC Mathematics Book I, Ex.12 to Ex. 17 (Ch 8-15 to Ch 8-18).
- Graphing trigonometric functions.
 - Demonstrate on graphing sine function using the table of trigonometric functions. Use this link: <http://bit.do/trig-table-values> to download the table of trigonometric functions.
 - Provide the worksheet for cosine function and ask students to fill the table of trigonometric functions. *Note: Students can use a scientific calculator to find the values of the t-function.*
 - After they complete filling the table provided to them, instruct students to use it to plot the graph of cosine function.
- Explain the Periods of trigonometric functions using the graphs of t-functions.
 - Define what is Period and explain how to determine the period of a given trig-function from the graph. Refer BHSEC Mathematics Book I, Page Ch 8-17 (Periods of Trigonometric Functions) or the given link: <http://bit.do/Definition-period> (Defines period and pictorial illustration on how to determine the period from a t-function graph).
 - Suggestion: You may use geogebra to graph the t-function and to explain about the periodicity of the t-functions or use the link: <http://bit.do/trig-graph> (graphs of t-functions illustrated using geogebra) *Direction: To Download (Click on the given link - click on the download icon - click on save file - click OK). Note: Follow the instructions indicated in the direction carefully to use the given link.*
 - Show the simulation through this link: <http://bit.do/trig-simulation> (Simulation of the trig-function graph) to enhance the understanding of the concept further.
- Recapitulate the relationship between the trigonometric ratios (reciprocal relations, quotient relations and square relation/pythagorean identity) taught in class IX through discussion. Derive and Illustrate the other two pythagorean identities (secant and tangent, cosecant and cotangent square relations/ pythagorean identities). Refer BHSEC Book I, Page Ch 8-4, Article 8.03.

- Explain the procedures to prove trigonometric identities, refer BHSEC Book I, Page Ch 8-4, Article 8.05 and Demonstrate it by solving solved examples (Ex.1 to Ex.5) given in BHSEC Book I, Page Ch 8-6.

Non-contact teaching and learning

- Share the given link: <http://bit.do/radian> (Derives the relation between π radians = 180 degrees and defines radian) to students, instruct them to watch and take note by pausing videos.
- The concept of conversion of radians to degrees and vice versa can be disseminated through the link: <http://bit.do/concept-on-conversion> (meaning and conversion from degree to radians and vice versa). Ask students to practice the concept assigned in the link: <http://bit.do/Conversion-radian-to-degree> (Worksheet on conversion of degrees to radians and vice versa) and provide immediate feedback after they submit their task through an appropriate social media platform.
- Share the link: <https://youtu.be/IQ5TuVdtKNU> (convention of signs) and <http://bit.do/t-function-signs> (explains signs of trigonometric functions based on x and y coordinates) via google classroom and the objectives of sharing the videos to students. *Suggestion: You may ask them to refer BHSEC Mathematics Book I, Page 8-7 to Page 8-8 (Article 8.06 and Article 8.07, students may also explore Article 8.08 to further enhance knowledge on the limits of the values of t-functions though it is not intended for them).* Share the link: <http://bit.do/t-ratio> (finding the t-ratios of θ from one of the given t-ratios) to students.
- Start the lesson on t-ratios of standard angles by asking students to watch the video lessons through this given link: <http://bit.do/t-ratio-standard-angle> (presents how the t-ratios of standard angles are derived) and instruct students to watch and write down the notes by pausing the video.
 - Direct students to watch the video lesson on solving problems using t-ratio of standard angles using the link: <http://bit.do/Problem-standard-angles> (Demonstrates the application of values of t-ratios of standard angle in problem solving). Ask students to go through the solved example 11 (Page Ch 8-11) for further understanding.
- Instruct students to explore about the t-ratios of allied angles. Refer to BHSEC Mathematic Book I Ch 8-13 to Ch 8-16 which derives the t-ratio of allied angles using geometry before watching the video lesson given in the link: <http://bit.do/allied-angle> (Explains about allied angles of t-functions) through google classroom. Demonstrate how to apply the t-ratio of allied angles.
 - Ask students to go through the solved problems from BHSEC Mathematics Book I, Ex.12 to Ex. 17 (Ch 8-15 to Ch 8-18). Also watch the videos which illustrates the application of t-ratios of allied angles in solving problems through the given links:
 - https://www.youtube.com/watch?v=_bXDdUZVADo&t=182s

- <https://www.youtube.com/watch?v=QDfgeTsdZy0>
- <https://www.youtube.com/watch?v=eMOSDsYpmic>
- <https://www.youtube.com/watch?v=9qZD0XHwYxw>
- <https://www.youtube.com/watch?v=5uyB4VsZZUM&t=5s>
- Graphing trigonometric functions.
 - Using an appropriate social media platform (eg. Zoom, messenger etc.) demonstrate how to graph sine function using the table of values of trigonometric functions. Use this link: <http://bit.do/trig-table-values> to download the table of values of trigonometric functions.
 - Share the worksheet: <http://bit.do/trig-table-values> and ask students to copy it in their notebook.
 - Instruct students to fill the table for cosine function and to use it to plot the graph of the function. *Note: Students can use a scientific calculator to find the values of the t-function.* Provide feedback on the assigned task after they upload it in the google classroom.
- To explain the Periods of trigonometric functions using the graphs of t-functions share the link: <https://youtu.be/QmxMPPkZpME> (Explains about determining the periods of trig-functions and further shows how the graph changes when some parameters are introduced in the function). For students to watch the video lesson, share the pictorial note: <http://bit.do/Definition-period> (Defines period and pictorial illustration on how to determine the period from the t-function graph) through google classroom. Instruct them to refer to BHSEC Mathematics Book I, Page Ch 8-17 (Periods of Trigonometric Functions) as well. Share the simulation link: <http://bit.do/trig-simulation> (Simulation of the trig-function graph) to enhance their understanding of the concept further.
- Instruct students to watch the video given in the link: <http://bit.do/square-relations> and also refer to the BHSEC Book I, Page Ch 8-4, Article 8.03 to understand the relationship between the trigonometric ratios.
 - Ask students to read and understand the procedures to prove trigonometric identities given in BHSEC Book I, Page Ch 8-4, Article 8.05 and solved examples (Ex.1 to Ex.5) given in BHSEC Book I, Page Ch 8-6. Share this link: <http://bit.do/verifying-trig-identities> (strategies to prove the identities using various trig-ratios relationships) to students to watch the video.

C. Assessment

Contact

Performance task 1

Assign the questions from *BHSEC Book I, Page Ch 7-9 Exercise 7 (a) Q1 and Q2* (except part i) to assess whether students know how to convert degrees to radians and vice versa.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 2

Allocate Question from BHSEC Mathematics Book I, Q2 (Page Ch 8-8, Oral Examples for class discussion) to evaluate proficiency of students in determining the signs of trigonometric function.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 3

Ask students to solve the problems from BHSEC Mathematics Book I, Exercise 8(c), Q4, Q7 and Q8 (Page Ch 8-12).

Performance task 4

Ask students to solve the problems from BHSEC Mathematics Book I, Exercise 8(c), Q11 and Q12 (Page Ch 8-12).

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 5

Ask students to solve the problems from BHSEC Mathematics Book I, Exercise 8(d), Q1(b, c, f and g) Q4, Q5, Q6 and Q8 to evaluate proficiency of students in determining the applications of trigonometric ratios of allied angles.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 6

Ask students to fill the table given in this link: <http://bit.do/trig-table-values> to plot the graph for the remaining trig-functions (tangent, cosecant, secant and cotangent)

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 7

Ask students to complete the task assigned in this link: <http://bit.do/Activity-trig-period>. Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 8

Assign questions from BHSEC Mathematics Book I, Exercise 8(c) Q4, Q6, Q8 and Q12.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Non-contact

Performance task 1

Assign the questions from *BHSEC Book I, Page Ch 7-9 Exercise 7 (a) Q1 and Q2 (except part i)* to assess whether students have understood to convert degrees to radians and vice versa. Provide feedback through an appropriate social media platform.

Performance task 2

Allocate Question from *BHSEC Book I, Q1 and Q2 (Page Ch 8-8, Oral Examples for class discussion)* to evaluate proficiency of students in determining the signs of trigonometric function. Feedback needs to be provided to students after they submit their task through appropriate social media.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 3

Ask students to solve the problems from *BHSEC Mathematics Book I, Exercise 8(c), Q19 to Q12 (Page Ch 8-12)* and then to upload their work in google classroom for assessment.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 4

Ask students to solve the problems from *BHSEC Mathematics Book I, Exercise 8(c), Q11 and Q12 (Page Ch 8-12)* and then to upload their work in google classroom for assessment.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 5

Ask students to solve the problems from *BHSEC Mathematics Book I, Exercise 8(d), Q1(b, c, f and g) Q4, Q5, Q6 and Q8* to evaluate proficiency of students in determining the applications of trigonometric ratios of allied angles and then to upload their work in google classroom for assessment.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 6

Ask students to fill the table given in this link: <http://bit.do/trig-table-values> to plot the graph for the remaining trig-functions (tangent, cosecant, secant and cotangent) and then to upload their work in google classroom for assessment.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 7

Assign the activity: <http://bit.do/Activity-trig-period> to students and ask them to upload their work in google classroom for assessment.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

Performance task 8

Assign questions from BHSEC Mathematics Book I, Exercise 8(c) Q4, Q6, Q8 and Q12 to students and ask them to upload their work in google classroom for assessment.

Assess, provide feedback and record achievement based on the template given in the annexure X A1

D. Resources

Contact

- a) BHSEC Mathematics Book I
- b) Online resources:
 - <http://bit.do/radian>
 - <https://youtu.be/IQ5TuVdtKNU>
 - <http://bit.do/t-function-signs>
 - <http://bit.do/T-ratios-standard-angles>
 - <http://bit.do/allied-angle>
 - <http://bit.do/Definition-period>
 - <http://bit.do/trig-graph>
 - <http://bit.do/trig-simulation>
 - <http://bit.do/trig-table-values>

Non-contact

- a) BHSEC Mathematics Book I
- b) Online resources:
 - <http://bit.do/radian>
 - <http://bit.do/concept-on-conversion>
<http://bit.do/Conversion-radian-to-degree>
 - <http://bit.do/t-ratio-standard-angle>
 - <http://bit.do/Problem-standard-angles>
 - <http://bit.do/allied-angle>
 - illustrates the application of t-ratios of allied angles in solving problems through the given links:
 - ✓ <http://bit.do/TRoAA-1>
 - ✓ <http://bit.do/TRoAA-2>

- ✓ <http://bit.do/TRoAA-3>
- ✓ <http://bit.do/TRoAA-4>
- ✓ <http://bit.do/TRoAA-5>
- <https://youtu.be/QmxMPPkZpME>
- <http://bit.do/Definition-period>
- <http://bit.do/trig-simulation>
- <http://bit.do/Activity-trig-period>
- <http://bit.do/square-relations>
- <http://bit.do/verifying-trig-identities>

c) Technological gadgets for learning (smart phone, laptop, desktop...)

E. Annexure(s)

Refer X-A1 for template to record achievement

Topic: X-D1 Symmetry

A. Competency(ies)

- Explain polygonal shapes using symmetry and relate line and point symmetry in regular polygon, plane and axis symmetry in regular polyhedron

Objectives

- Compare 2-D and 3-D mirror symmetry
- Name regular polygonal shapes by using symmetry
- Relate line and point symmetry in regular polygons and, plane and axis symmetry in regular polyhedrons
- Compare mirror and rotational symmetry
- Explore 2-D and 3-D reflectional and rotational symmetry using technology

B. Pedagogy

Contact teaching and learning

- Compare 2-D and 3-D mirror symmetry (reflectional symmetry)
 - The web link <https://byjus.com/maths/reflection-symmetry/> explains the concept of 2D reflectional symmetry.
 - The web link <https://www.youtube.com/watch?v=ivyxxMLZCvE> explains the concept of 3D reflectional symmetry.
 - Design quiz questions to evaluate learner's understanding of the concept on 2D and 3D mirror/ reflectional symmetry
 - Explore 2-D and 3-D Reflectional symmetry using technology
- Name regular polygonal shapes by using symmetry
 - Design a worksheet which will enable learners name regular polygon based on number of lines of symmetry

Sl. No.	No. of edges/ vertices	No. of lines of symmetry	Name of regular polygon
1	3	3	Triangle
2	4	4	Square
3	5	5	Pentagon
4	6	6	Hexagon

- Relate line and point symmetry in regular polygons, and plane and axis symmetry in regular polyhedrons
 - Describe the concept of 2D rotational symmetry (point symmetry). Animate the concept using relevant software or the web link <http://bit.do/fPpPi> explains the 2D rotational symmetry with animation.
 - Explain the concept of 3D rotational symmetry (axis of symmetry). Animate the concept using relevant software or the web link <http://bit.do/fPpQb> explains the 3D rotational symmetry with animation.
 - Determine order of turn symmetry for 2D and 3D rotational symmetry

- Design a task where learners can make different types of 3D shapes to calculate their order of turn symmetry.
- Explore 2-D and 3-D Rotational symmetry using technology
- Compare mirror and rotational symmetry
 - Analyze the difference between reflectional and rotational symmetry. The web link <https://www.mathsisfun.com/geometry/symmetry.html> contains an explanation on comparing rotational and reflectional symmetry.

Non-contact teaching and learning

- Compare 2-D and 3-D mirror symmetry (reflectional symmetry)
 - Share the web link <https://byjus.com/maths/reflection-symmetry/> which explains the concept of 2D reflectional symmetry.
 - Share the web link <https://www.youtube.com/watch?v=ivyxxMLZCvE> which explains the concept of 3D reflectional symmetry.
 - Design quiz questions to evaluate learner's understanding on the concept 2D and 3D mirror/ reflectional symmetry
 - Let learners explore 2-D and 3-D Reflectional symmetry using a relevant software.
- Name regular polygonal shapes by using symmetry
 - Design and share a worksheet which will enable learners name regular polygon based on number of lines of symmetry

Sl. No.	No. of edges/ vertices	No. of lines of symmetry	Name of regular polygon
1	3	3	Triangle
2	4	4	Square
3	5	5	Pentagon
4	6	6	Hexagon

- Relate line and point symmetry in regular polygons and, plane and axis symmetry in regular polyhedrons
 - Share comprehensive notes on 2D rotational symmetry (point symmetry). Share the web link <http://bit.do/fPpPi> which explains the 2D rotational symmetry with animation.
 - Share comprehensive notes on 3D rotational symmetry (axis of symmetry). Share the web link <http://bit.do/fPpQb> that explains the 3D rotational symmetry with animation.
 - Determine order of turn symmetry for 2D and 3D rotational symmetry
 - Design a task where learners can make different types of 3D shapes to calculate their order of turn symmetry.
 - Explore 2-D and 3-D Rotational symmetry using technology

- Compare mirror and rotational symmetry
 - Analyze the difference between reflectional and rotational symmetry.
Share the web link <https://www.mathsisfun.com/geometry/symmetry.html> which contains an explanation on comparing reflectional and rotational symmetry.

C. Assessment

Contact/ Non-contact

Performance task (To assess competency)

Assess the performance task

Assess, provide feedback and record achievement based on the template given in the annexure A1.

D. Resources

Contact/ Non-contact

- a) Textbook and guide book (Class X mathematics)
- b) Online resources:
 - <https://byjus.com/maths/reflection-symmetry/>
 - <https://www.youtube.com/watch?v=ivyxxMLZCvE>
 - <http://bit.do/fPpPi>
 - <http://bit.do/fPpQb>
 - <https://www.mathsisfun.com/geometry/symmetry.html>

E. Annexure(s)

Refer X-A1 for template to record achievements

A. Competency(ies)

- Construct circumcircles, incircles and angle bisectors using ruler, compass and pencil and verify using a relevant software.

Objectives

- Construct perpendiculars and angle bisectors
- Locate incentres and circumcentres and construct incircles and circumcircles using perpendicular and angle bisector constructions
- Construct medians and altitudes of triangles
- Locate centroids (centres of gravity) and ortho centres using medians and altitudes constructions, respectively

B. Pedagogy

Contact teaching and learning

- Demonstrate the construction of perpendicular and angle bisectors. Let students practice the construction with some examples.
- Revise the constructions of some standard angles that students have learned in class VII: 30° , 45° , 60° , 90° and 120° .
- Demonstrate the construction of an incircle of a triangle using the angle bisectors with an example.
 - Specify that the intersection point of the angle bisectors of a triangle is the incenter of the triangle. Incircle is constructed from the incenter.
 - To locate the incenter of a triangle, any two angle bisectors would suffice, but to get the incenter accurate, it is advised to construct all three angle bisectors.
 - Refer to page number 287 of the Understanding Mathematics Textbook for class X, and discuss example 3 on page number 289.
 - Verify your constructions using a relevant drawing software such as GeoGebra or GSP (Geometer's Sketchpad)
 - Provide about three to four questions for students to practice.
 - Assign the questions from "Practicing and Applying" on page number 290. Suggested questions: 3 and 4.
- Demonstrate the construction of a circumcircle using the perpendicular bisectors with an example.
 - Specify that the intersection point of the perpendicular bisectors of the sides of the triangle is the circumcenter of the triangle.
 - To locate the circumcenter, it is sufficient to construct perpendicular bisectors of any two sides of the triangle. However, to get the accurate circumcenter, it is advised to construct all three perpendicular bisectors of the triangle.
 - Demonstrate the construction of the circumcircle of a triangle with an example. Refer to page number 287 of the Understanding Mathematics Textbook for class X, and discuss example 2 on page number 288.
 - Provide about three to four questions for students to practice.

- Assign questions from "Practicing and Applying" on page number 290. Suggested questions: 1 and 4.
- Demonstrate the construction of medians of a triangle and locating the center of gravity or centroid of the triangle.
 - Specify that the intersection point of the medians of a triangle is the center of gravity or the centroid of the triangle. Clarify that perpendicular bisector constructions are needed for both the circumcenter and centroid, but for the centroid, the perpendiculars are constructed just to locate the mid points of the sides of the triangle to get the medians.
 - Demonstrate the construction of medians and locating the center of gravity of a triangle with one example. Discuss and demonstrate the example 1 on page 292 of the Understanding Mathematics Textbook for Class X.
 - Provide about three to four questions for students to practice. Refer to Practicing and Applying on page number 294. Suggested questions: 1 and 2.
- Demonstrate the construction of altitudes of a triangle and locating the orthocenter of the triangle.
 - Before teaching the construction of an altitude of a triangle, let students practice the construction of a perpendicular line from a point to a line segment. Refer to Understanding Mathematics Textbook for Class X page number 286.
 - Demonstrate the construction of altitudes of a triangle.
 - Show that the intersection point of the altitudes of a triangle is the orthocenter of the triangle. To locate the orthocenter of a triangle, the construction of any two altitudes is sufficient. However, to get the accurate orthocenter, it is necessary to construct all the altitudes.
 - Discuss and demonstrate example 2 on page number 294 of the Understanding Mathematics Textbook for class X.
 - Show the location of the orthocenters of different types of triangles: acute triangle, right triangle and obtuse triangle.
 - Demonstrate the determination of the area of a triangle using the constructed altitude using an example.
 - Assign the questions from Practicing and Applying on page number 294 of the Understanding Mathematics Textbook for class X. Suggested questions: 3, 4, 5, and 6.

Non-contact teaching and learning

- Create short video tutorials on construction of incircle, circumcircle, centres of gravity and orthocenter, and share through a relevant online medium (weChat, Telegram, Google Classroom, etc)
- Share the web link <https://www.youtube.com/watch?v=yn0YQBECaQ&t=108s> . This video demonstrates the construction of incircle and circumcircle.

- Follow along with the video by pausing the video after each step.
- Practice the relevant questions from "Practicing and Applying" on the page numbers given in the contact teaching part.
- Share the weblink <https://www.youtube.com/watch?v=EZ4rHobpDOA> . This weblink contains a video lesson on constructing all the centers of the triangle.
 - Follow along with the video by pausing the video after each step.
 - Practice relevant questions from "Practicing and Applying" on the page numbers given in the contact teaching part.
- Provide the questions suggested in the contact teaching and learning part.

C. Assessment

Contact/Non-Contact

Performance task 1

Assign at least 5 questions relevant to the construction of incircle, circumcircle, centroid and orthocenter.

Assess, provide feedback and record student achievement based on the template given in Annexure X-A1.

D. Resources

Contact/Non-Contact

- a) Understanding Mathematics Textbook for class X
- b) Teacher's guide book for class X
- c) Online resources:
 - <https://www.youtube.com/watch?v=yn0YQBECaQ&t=108s>
 - <https://www.youtube.com/watch?v=EZ4rHobpDOA>

E. Annexure(s)

Refer X-A1 for template to record achievement

Topic: X-E1 Collecting, Displaying and Analyzing Data

A. Competency(ies)

- Apply various methods of data collection and display data in different ways
- Compare various methods of displaying data which are grouped in intervals and evaluate their effectiveness: stem and leaf plots, box and whisker plots and histograms
- Analyze, interpret and explain data distributions

Objectives

- Collect data using various methods such as survey questionnaires, interviews, etc...
- Compare various methods of displaying data which are grouped in intervals and evaluate their effectiveness: stem and leaf plots, box and whisker plots and histograms
- Predict, observe and explain how the different measures of central tendency are affected by extreme data values (or outliers)
- Discuss the appropriate use of the measures of central tendency in different contexts
- Demonstrate an understanding of the properties of a data distribution
- Identify situations that give rise to U-shaped, skewed, and normal common distributions
- Demonstrate an understanding of the properties of the normal distribution (e.g., the mean, median, and mode are equal; the curve (and data) is symmetric about the mean)

B. Pedagogy

Contact teaching and learning

- Collect data using various methods such as survey questionnaires, interviews, etc...

Data Management comprises a series of steps. It is the process of data collection, data organisation, data display, data analysis, drawing conclusions and making recommendations. All these processes need to be followed strictly to get evidence based results.

Suggestion: Design a project based learning activity for collecting and displaying data

Steps for data collection

Step 1 Identifying a problem

Before collecting any data, first a problem/issue needs to be identified.

Some examples of problems/issues could be:

- *How would walking distance between the school and place of stay of class IX students affect students health and academic performance?*
- *Identifying areas students spend money on.*
- *Data related to a pertinent issue in the community you live.*
- *Any other data that you have already collected in any other subject*

Step 2 Sampling the respondents

Sampling means identifying a small portion that will be used to collect data to represent the whole population.

Random sampling is one of the easiest ways to sample respondents. Some ways to random sample respondents could be by lottery or by generating a random number.

Step 3 Designing tool to collect data

There are many ways to collect data.

Interview is one way. While conducting interview, an interviewer asks a series of questions and records the answers. Interviews are often used when you can talk to the people you want to survey.

When interview is not possible, people may be asked to answer a list of questions called a **questionnaire**.

Observation is another way to collect data. Instead of asking questions directly, an observer watches, measures, and records the data.

For some kinds of data, observation is the only way to collect information.

Depending on the type of data required, a particular way or a combination of ways can be used to collect data.

Example 1 Sample survey questions on student attitude

	Not at all	A little bit	Somewhat	A lot
1. I can wait in line patiently	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. I can wait for my turn to talk	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. I can easily become normal after becoming very happy or very sad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I do all homework myself	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Step 4 Collecting and arranging data

The data collected from the sample needs to be arranged appropriately so that it can be analysed for findings.

A table is usually used to arrange the collected data.

For your project arrange the collected data from the respondents in a table.

Example 2 Arranging collected data

The following table can be used to represent the data collected for example 1 above.

Respondent ID	Q1				Q2				Q3				Q4			
	Not at all	A little bit	Some-what	A lot	Not at all	A little bit	Some-what	A lot	Not at all	A little bit	Some-what	A lot	Not at all	A little bit	Some-what	A lot
1																
2																
3																

- Compare various methods of displaying data which are grouped in intervals and evaluate their effectiveness: stem and leaf plots, box and whisker plots and histograms
 - The web link <http://bit.do/choosing-graph> contains concepts on which graph (Limit to stem and leaf plot, box and whisker plot and histogram) to choose for a given set of data.
 - The web link <http://bit.do/fPpZ8> explains the process of creating histogram
 - The web link <http://bit.do/fPp2y> explains the process of creating stem and leaf plots
 - The web link <http://bit.do/fPp2J> explains the process of creating box plot
 - Compare and analyze different methods of data display (Refer class X textbook, pages 167, 168, 169, 178, 179 and 180)
 - Choose a suitable method to display the data collected in the above part
- Predict, observe and explain how the different measures of central tendency are affected by extreme data values (or outliers)
 - Demonstrate methods of calculating central tendency (mean, median and mode)
 - Design a task where learners calculate the central tendency of the data set collected earlier.
 - Discuss the appropriate use of the measures of central tendency in different contexts (When is it best to use a particular central tendency)
 - **When is the mean the best measure of central tendency?**

The mean is usually the best measure of central tendency to use when your data distribution is continuous and symmetrical, such as when your data is normally distributed. However, it all depends on what you are trying to show from your data.

■ **When is the mode the best measure of central tendency?**

The mode is the least used of the measures of central tendency and can only be used when dealing with nominal data. For this reason, the mode will be the best measure of central tendency (as it is the only one appropriate to use) when dealing with nominal data. The mean and/or median are usually preferred when dealing with all other types of data, but this does not mean it is never used with these data types.

■ **When is the median the best measure of central tendency?**

The median is usually preferred to other measures of central tendency when your data set is skewed (i.e., forms a skewed distribution) or you are dealing with ordinal data. However, the mode can also be appropriate in these situations, but is not as commonly used as the median.

- Explain the concept of outliers (extreme values)
- Demonstrate an understanding of the properties of the data distribution
 - Demonstrate an understanding of the properties of a normal distribution and identify situations that give rise to it. The web link <http://bit.do/fPqbu> demonstrates real life situations of normal distribution.
 - Demonstrate an understanding of the properties of a skewed distribution and identify situations that give rise to it.
 - Demonstrate an understanding of the properties of U-shaped distribution and identify situations that give rise to it.
 - Demonstrate an understanding of the properties of a uniform distribution and identify situations that give rise to it.
 - Design a task where learners will explore real life examples of skewed, U-shaped and uniform distribution.
 - Refer class X mathematics textbook, pages 186, 187 and 188

Non-contact teaching and learning

- Collect data using various methods such as survey questionnaires, interviews, etc...

Data Management comprises a series of steps. It is the process of data collection, data organisation, data display, data analysis, drawing conclusions and making recommendations. All these processes need to be followed strictly to get evidence based results.

Suggestion: Design a project based learning activity for collecting and displaying data

Steps for data collection (Depending on situation, collection of data would not be possible sometimes, in such circumstances, instruct learners to use data from online resources or books)

Step 1 Identifying a problem

Before collecting any data, first a problem/issue needs to be identified.

Some examples of problems/issues could be:

- *How would walking distance between the school and place of stay of class IX students affect students health and academic performance?*
- *Identifying areas students spend money on.*
- *Data related to a pertinent issue in the community you live.*
- *Any other data that you have already collected in any other subject*

Step 2 Sampling the respondents

Sampling means identifying a small portion that will be used to collect data to represent the whole population.

Random sampling is one of the easiest ways to sample respondents. Some ways to random sample respondents could be by lottery or by generating a random number.

Step 3 Designing tool to collect data

There are many ways to collect data.

Interview is one way. While conducting interview, an interviewer asks a series of questions and records the answers. Interviews are often used when you can talk to the people you want to survey.

When interview is not possible, people may be asked to answer a list of questions called a **questionnaire**.

Observation is another way to collect data. Instead of asking questions directly, an observer watches, measures, and records the data.

For some kinds of data, observation is the only way to collect information.

Depending on the type of data required, a particular way or a combination of ways can be used to collect data.

Example 1 Sample survey questions on student attitude

	Not at all	A little bit	Somewhat	A lot
1. I can wait in line patiently	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. I can wait for my turn to talk	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. I can easily become normal after becoming very happy or very sad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I do all homework myself	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Step 4 Collecting and arranging data

The data collected from the sample needs to be arranged appropriately so that it can be analysed for findings.

A table is usually used to arrange the collected data.

For your project arrange the collected data from the respondents in a table.

Example 2 Arranging collected data

The following table can be used to represent the data collected for example 1 above.

Respondent ID	Q1				Q2				Q3				Q4			
	Not at all	A little bit	Somewhat	A lot	Not at all	A little bit	Somewhat	A lot	Not at all	A little bit	Somewhat	A lot	Not at all	A little bit	Somewhat	A lot
1																
2																
3																

- Compare various methods of displaying data which are grouped in intervals and evaluate their effectiveness: stem and leaf plots, box and whisker plots and histograms
 - Share the web link <http://bit.do/choosing-graph> that contains concepts on which graph (Limit to stem and leaf plot, box and whisker plot and histogram) to choose for a given set of data.
 - Share the web link <http://bit.do/fPpZ8> that explains the process of creating histogram

- Share the web link <http://bit.do/fPp2y> which explains the process of creating Stem and leaf plot
- Share the web link <http://bit.do/fPp2J> which explains the process of creating box plot
- Compare and analyze different methods of data display (Refer class X textbook, pages 167, 168, 169, 178, 179 and 180)
- Choose a suitable method to display the data collected in the above part
- Predict, observe and explain how the different measures of central tendency are affected by extreme data values (or outliers)
 - Share notes demonstrating methods of calculating central tendency (mean, median and modes)
 - Design a task where learners calculate the central tendency of the data set collected earlier.
 - Share notes on appropriate use of the measures of central tendency in different contexts (When is it best to use a particular central tendency)
 - **When is the mean the best measure of central tendency?**
The mean is usually the best measure of central tendency to use when your data distribution is continuous and symmetrical, such as when your data is normally distributed. However, it all depends on what you are trying to show from your data.
 - **When is the mode the best measure of central tendency?**
The mode is the least used of the measures of central tendency and can only be used when dealing with nominal data. For this reason, the mode will be the best measure of central tendency (as it is the only one appropriate to use) when dealing with nominal data. The mean and/or median are usually preferred when dealing with all other types of data, but this does not mean it is never used with these data types.
 - **When is the median the best measure of central tendency?**
The median is usually preferred to other measures of central tendency when your data set is skewed (i.e., forms a skewed distribution) or you are dealing with ordinal data. However, the mode can also be appropriate in these situations, but is not as commonly used as the median.
 - Share a short video or notes on the concept of outliers (extreme values)
- Demonstrate an understanding of the properties of a data distribution
 - Demonstrate an understanding of the properties of a normal distribution and identify situations that give rise to it. Share the web link <http://bit.do/fPqbu> which demonstrates real life situations of a normal distribution.
 - Share notes on understanding of the properties of a skewed distribution and identify situations that give rise to it.
 - Share notes on understanding of the properties of a U-shaped distribution and identify situations that give rise to it.
 - Share notes on understanding of the properties of a uniform distribution and identify situations that give rise to it.

- Design a task where learners will explore real life examples of a skewed, U-shaped and uniform distribution.
- Refer class X mathematics textbook, pages 186, 187 and 188

C. Assessment

Contact/ Non-contact

Performance task 1 (To assess competency 1 and 2)

Assess the performance task (Project on collecting and displaying data)

Assess, provide feedback and record achievement based on the template given in the annexure A1.

Performance task 2 (To assess competency 3)

Assess the performance task

Assess, provide feedback and record achievement based on the template given in the annexure A1.

D. Resources

Contact/ Non-contact

a) Textbook and guide book (Class X mathematics)

b) Online resources:

- <http://bit.do/choosing-graph>
- <http://bit.do/fPpZ8>
- <http://bit.do/fPp2y>
- <http://bit.do/fPp2J>
- <http://bit.do/fPqbu>

E. Annexure(s)

Refer X-A1 for template to record achievements

Topic: X-E2 Data Involving Two Variables

A. Competency(ies)

- Explain correlations and estimate the correlation coefficients using scatter plots
- Draw a line/curve of best fit from a scatter plot and draw conclusions

Objectives

- Demonstrate understanding that a correlation coefficient is a description of how well data fits a linear pattern using relevant software
- Identify the difference between a strong and weak correlation and between a negative and positive correlation based on the scatter plot and the value of the correlation coefficient
- Explore curve fitting for non-linear data

B. Pedagogy

Contact teaching and learning

- Explain the concept of correlation that students have learned in class IX.
 - Explain the meaning of variables - Dependent and Independent variables
 - Explain the concept of continuous and discrete data.
 - Explain the concept of scatter plot. Demonstrate with an example of scatter plot and a line of best fit - The line of best fit can be drawn only if the data is continuous..
 - Instead of just drawing a random scatter plot, collect the real data from the class: age of students and their heights. After collecting, then plot the data on a graph.
 - Refer to Understanding Mathematics Textbook for Class X page number 195 and 196.
- Explain the types of correlation and their respective correlation coefficients:
 - Show the basic two types of correlation: Positive and Negative Correlation. Explain with a real life situation.
 - For positive correlation, explain the perfect, strong and weak correlation and their associate correlation coefficient.
 - Similarly for negative correlation, explain the perfect, strong and weak correlation and associated correlation coefficients.
 - Explain the concept of no correlation and the correlation coefficient 0.
 - Students must identify each type of correlation and tell the value of correlation coefficient from a scatter plot. The web link <http://bit.do/Corr-Coef> contains a correlation coefficient simulator to demonstrate scatter plots of positive to negative correlation.
 - Using a scatter plot and the line of best fit, students should be able to predict the value of one quantity given the other quantity.
 - Discuss the examples 1, 2 and 3 on page numbers 200, 201 and 202 of the Understanding Mathematics Textbook for Class X. To get the best estimate during the explanation, It is advised to use a relevant graphing software to plot scatter plots.
 - Assign about four questions from “Practicing and Applying” on page number 203 and 204. Suggested questions: 1, 2, 3, 5, 6, 7.

- Curves of Best Fit:
 - Explain the concepts of curves of best fit for non-linear data.
 - Explain the different types of non-linear curves: quadratic curve, exponential curve, periodic curve and cubic curve. Since exponential curve and cubic curve look alike, teachers should specifically differentiate between the two curves: Cubic curve can pass through the origin or x-axis, whereas, exponential curve will never touch the x-axis.
 - From a given curve, students should be able to identify the type.
 - Discuss example 2 given on page number 209 of Understanding of Mathematics Textbook for Class X.
 - Assign some questions from "Practicing and Applying" on page number 210 and 211 of Understanding Mathematics Textbook for class X.
Suggested Questions: 1, 2, and 3.

Non-contact teaching and learning

- Create short video tutorials on correlation and line of best fit, and curves of best fit. Share the videos through a relevant online platform (weChat, Telegram, Google Classroom, etc)
- Share the web link <http://bit.do/two-variable-data> . This is a complete lesson on data-involving two variables from Bhutan e-Learning Project.
 - Pause the video and take notes whenever required.
 - Practice the relevant questions from "Practicing and Applying" on the page numbers given in the contact teaching part.
- Share the web link <http://bit.do/Corr-Coef> which contains a correlation coefficient simulator to demonstrate scatter plots of positive to negative correlation.
- Provide the questions suggested in the contact teaching and learning part.

C. Assessment

Contact/Non-Contact

Performance task 1

Frame at least 5 questions relevant to the correlation, correlation coefficient, the lines of best fit and the curves of best fit. Or assign the questions suggested from "Practicing and Applying".

Assess, provide feedback and record student achievement based on the template given in Annexure X-A1.

D. Resources

Contact/Non-Contact

- a) Understanding Mathematics Textbook for class X
- b) Teacher's guide book for class X
- c) Online resources:
 - <http://bit.do/two-variable-data>

E. Annexure(s)

Refer X-A1 for template to record achievement

A. Competency(ies)

- Determine theoretical probability for dependent and independent events and apply to real life situations

Objectives

- Calculate probability of dependent and independent events
- Distinguish between two events that are dependent or independent using reasoning and calculations

B. Pedagogy

Contact teaching and learning

- Revise the concept of probability and the terminologies related to probability: events, outcomes (favourable and possible) and sample space.
 - Random experiments: Tossing of coins, rolling of dice, spinning of spinners, taking out a card from a well-shuffled deck of playing cards, etc.
 - Event: event is an outcome or defined collection of outcomes of a random experiment.
 - Sometimes, one random experiment can have two or more events. For instance, in a random experiment of rolling a die once, two events could be “getting an even number” and “getting an odd number”. For this, both the events are from a single random experiment. Thus, it is important to check if the outcomes are from two different random experiments or from a single random experiment.
 - Outcome: result of a random experiment.
 - Sample space: all possible outcomes
- Explain the meaning of dependent and independent events. Refer to the Understanding Mathematics Textbook for class X page number 213-214.
 - Explain each type using an appropriate example.
 - Show how to check if the events are dependent and independent using reasoning.
 - Additional ideas for the reasoning part: Relate to the sets and venn diagram that students have learned in class IX: Represent the favourable outcomes of each event in a separate set. If there are common elements in the two sets ($A \cap B \neq \Phi$ or $n(A \cap B) \neq 0$), then the events are dependent because the outcome of the first event will affect the outcome of the second event.
 - Discuss example 1 and 2 on page number 215 and 216.
 - Assign about four questions from "Practicing and Applying" on page number 217.
 - Show how to check if the events are dependent and independent by calculations. Using an example, explain each step of checking the dependency of the events. Refer to the Understanding Mathematics Textbook for class X page number 219 and 220.

- Discuss example 1 on page number 220 of the textbook.
 - Provide some relevant questions or assign questions from "Practicing and Applying" on page number 222. Suggested questions: 1, 2 and 3.
- Conditional Probability. Refer to the Understanding Mathematics Textbook for Class X page number 220.
 - Explain the concept of conditional probability and the notations, $P(A|B)$ and $P(B|A)$ with an example.
 - Explain the following relations of conditional probability with an example:
 - $P(A \text{ and } B) = P(B) \times P(A|B)$
 - $P(A \text{ and } B) = P(A) \times P(B|A)$
 - Discuss example 2 on page number 221.
 - Assign the questions to practice from "Practicing and Applying" on page number 222. Suggested questions: 4, 5 and 6.

Non-contact teaching and learning

- Create short video tutorials on each topic mentioned in the contact teaching and learning part. Share the videos through a relevant online medium (weChat, Telegram, Google Classroom, etc)
- Share the web link <http://bit.do/probabilities> . This link contains a video lesson from Bhutan e-Learning Project on probabilities of dependent and independent events .
 - Pause the video and take notes whenever required.
 - Practice the relevant questions from "Practicing and Applying" on the page numbers mentioned in the contact teaching and learning part.
- Share the web link https://www.youtube.com/watch?v=_XAqXGJ7fu0 . This link contains a video lesson on conditional probability with some examples.
 - Pause the video and take notes whenever required
 - Practice the relevant questions as assigned in the contact teaching and learning part.

C. Assessment

Contact/Non-Contact

Performance task 1

Frame at least 5 questions relevant to the topics mentioned in the pedagogy part. Assess, provide feedback and record student achievement based on the template given in Annexure X-A1.

D. Resources

Contact/Non-Contact

- a) Understanding Mathematics Textbook for class X
- b) Teacher's guide book for class X
- c) Online resources:
 - <http://bit.do/probabilities>
 - https://www.youtube.com/watch?v=_XAqXGJ7fu0

E. Annexure(s)

Refer X-A1 for template to record achievement